Safety Evaluation of the General Chemical-Richmond Works Facility

Final Report to

Contra Costa Health Services
Hazardous Materials Program
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Executive Summary

The Executive Summary provides a brief overview of the evaluation as well as a summary of the major findings and recommendations. The reader is encouraged to review the entire report to gain a better understanding of all the findings and recommendations.

Scope and Approach

A safety evaluation was conducted at the General Chemical-Richmond Works (GCRW) facility in Richmond, California, from October 7–11, 2002, at the request of the Contra Costa Health Services (CCHS) and the City of Richmond.

The objectives of the Safety Evaluation were to complete a thorough evaluation of the current management practices and safety culture at the GCRW facility. The focus of the evaluation was on the safety management systems, human factors, and safety culture.

The scope of work for this assignment was developed by an ad hoc safety evaluation committee, consisting of Contra Costa County, the City of Richmond, the Hazardous Materials Commission, the public, and General Chemical. The evaluation was not intended as a compliance audit, and as such, this report is not meant to imply legal certification of compliance or noncompliance with safety regulations. Rather, the evaluation was intended to evaluate the GCRW safety management systems in relation to industry practices and to identify potential deficiencies.

The evaluation was designed and implemented in a manner intended to be impartial and objective. The evaluation was conducted using a team of safety professionals working at the GCRW facility over a one week period starting on October 7, 2002. During this period, the evaluation team conducted more than 30 interviews with individuals and groups, and a wide range of program documents and related data. Prior to the onsite evaluation a draft work plan was issued to the public and a public workshop was held to receive comments on the draft work plan. Appendix A contains a copy of the safety evaluation work plan, and Appendix B contains a list of the comments received on the work plan at the October 2, 2002 public workshop. Appendix B also contains responses to the comments received at the public workshop.

A Draft Safety Evaluation Report was issued to the public on November 18, 2002, for a 30-day public comment period. A public workshop was held on December 2, 2002, at the Richmond City Hall in Richmond California to take comments on the Draft Report. Appendix C contains copies of all of the comments received on the Draft Report along with written responses.

The findings related to safety management are based on evidence gathered during the evaluation. This evidence was obtained from interviews with key people involved in the development and implementation of the respective programs, review of documents, and limited physical observations. A safety culture survey of General Chemical employees was also conducted. Because of the nature of the evaluation, this report focuses on observations with respect to the team's view of good safety management practices, human factors, and safety culture.

Regarding the findings for human factors and safety culture, it must be recognized that organizational culture is developed over a long period of time and reflects individual and group values and perceptions of the way in which the GCRW facility runs, as well as the actual policies, written programs, and procedures. This information must be taken into consideration when reviewing the findings. Because the findings do reflect perceptions, they may not be indicative of "reality," and there may be apparent conflicts between the factual evidence gained as part of the safety management systems evaluation and the anecdotal evidence gathered from interviews with facility workers. The recommendations for the safety culture findings were developed to address these apparent conflicts.

Recommendations were developed for each finding to address the deficiency. All recommendations were intended to provide a way to achieve safety performance improvement. The recommendations were prioritized based on the degree of risk associated with the finding.

Strengths

The evaluation team identified several strengths in safety management, human factors, and safety culture, as described below:

- Top management (General Chemical Corporate) has a good understanding of safety management systems and the importance for having effective systems developed and implemented. Top management understands the imperative need to commit resources to this facility, both for equipment upgrades and for program implementation.
- General Chemical has made a number of decisions that demonstrate a company commitment to safety at this facility. These include the completion of an oleum risk reduction project to eliminate the transportation of large quantities of oleum between Richmond and Bay Point, and the commitment of funds for a new caustic tower to mitigate potential releases to the environment. The Company has also allocated substantial funds for developing and implementing a Mechanical Integrity Program at the facility, which included the creation of two new staff positions in the maintenance department.
- Overall the management systems at the facility, including program documents and safety policies, appeared to be reasonably complete and they were, for the most part, being implemented by the facility employees. A considerable amount of work has been done in the last 2 years to improve these documents and their effectiveness.
- It is evident that there has been a positive change at the corporate level during the last two or 3 years with a shift away from tight cost control to a much greater emphasis on safety. The General Chemical Director of Manufacturing was serving as the interim Plant Manager at the time the safety evaluation was conducted. In November 2002, General Chemical hired a new Plant Manager for the Richmond Works facility. Both he and the Director of Operations are actively involved in the operation of GCRW during the interim period, and it appears they have the support they need from corporate executives to make investments for improving safety. From the interviews and survey responses, it was apparent that workers, in general, thought that managers were supportive of safety issues.
- The interim Plant Manager appears to be effectively implementing a policy of discipline for conscious procedural violations.

- It appears that workers are free to question or stop unsafe work activities without reprisal, and workers were well aware of their authority to do this.

Weaknesses

The evaluation team identified areas that require improvement as described in the individual findings, Section 2.0. The reader should refer to the complete list of findings to gain a good understanding of the issues identified. Some of the key issues identified by the evaluation team are summarized below:

- There is no collective vision of what the safety program is at GCRW. The Company's emphasis on the 3P (People, Processes, and Performance) program is intended more for non-risk management plan (RMP) facilities to "catch up" with RMP facilities, so it's usefulness at GCRW is limited.
- There is a poor sense of team spirit and teamwork at GCRW. Workers (especially in Operations) tend to do their jobs as individuals rather than as part of a team. One contributing factor could be the shift structure that is being used.
- The Plant Manager position has been open since July, and there has been considerable turn-over in the management team during the last few years. Workers would likely benefit from having a consistent and cohesive management team. The success of the safety program at this facility will be largely influenced by the person selected as the new Plant Manager and his/her ability to provide safety leadership. (General Chemical hired a new Plant Manager in November 2002.) As other management positions become open, the selection process needs to give weight to candidates' commitment to safety and their ability to provide leadership.
- The failure to allocate adequate resources for preventative maintenance has resulted in an attitude to maintenance that is heavily biased towards corrective maintenance ("if it breaks, fix it") with much less attention paid to preventive and predictive maintenance.
- There is a consensus amongst workers and managers (but not supervisors) that near misses are under-reported. Possible reasons for this are that workers are not trained to recognize near misses and there may be a lingering fear that they will be blamed for making mistakes. Also, there is no formal incentive program for reporting near misses.
- The technologies used for process control and the alarms for notifying Operators of conditions that are out of limits are old and the interpretability is non-intuitive, particularly for inexperienced Operators and for all Operators under upset or stressful conditions. There is a high degree of inconsistency among display formats, and a lack of displays that provide a quick, overall, "at-a-glance" summary of the state of plant processes. General Chemical is currently evaluating the installation of a distributed control system (DCS) for the facility. This project, if implemented, would help to address this deficiency.
- While the safety program documents and policies are generally complete, the facility does not have a well-defined Document Control System. This makes it difficult to understand whether a particular version of a document is current and what the distribution requirements are for implementation.

Conclusions

To achieve a high performance safety program, there needs to be a "culture of safety," and a commitment from upper management, with demonstrated and consistent leadership. Culture cuts across the management system elements, and without a positive safety culture, the management systems and the success of the program are vulnerable. There should be a formal management system, fully implemented and funded, and there should be operational discipline on the part of all employees to make it happen.

The Safety Evaluation Team observed many strengths at the GCRW facility. There appears to be a commitment from senior management, and many of the required systems are becoming more formalized. There also appears to be a willingness to implement the necessary discipline to make the safety program work. A number of safety management systems deficiencies were identified, but the findings are not unlike those found in other safety management systems audits for similar facilities. In general, the safety management systems were well documented and were being implemented.

A number of human factors issues were identified, notably with respect to the design of control room displays and alarm systems, the lack of familiarity among key plant personnel of human factors and ergonomic safety issues, and the insufficient use of drills and simulations for training. However, none of these issues were considered to be so serious that they warrant immediate, extreme measures.

Most of the immediate limitations appear to be attributable to the plant culture, which has built over time in response to fairly austere and authoritarian practices that were used by General Chemical in the recent past. At present there is a lack of vision for the safety program, and the evaluation team noted the need for improving teamwork and harnessing the full capabilities of the employees. Also noted were the need for improving attitudes and awareness to near-miss reporting, and to maintain a consistent and coherent management team, given the management changes that have taken place in recent years.

Recommendations have been included to address these important issues and the other findings included in this report. For these recommendations to be effective in improving safety performance, it will take a genuine commitment from all parties concerned. Changing a plant culture can be a slow process. It requires intelligent application of a "transformation process," and a strict adherence over time to implementing the necessary change strategies. There is often a great deal of inertia to prevent change and keep things the way they are. Only after years of constant reinforcement and clear commitment to the new vision can the workforce institutionalize the new programs. There is a need for ongoing commitment and determination by management to maintain the operational discipline necessary to "steer" the organization in line with the safety vision.

The Safety Evaluation Report does not provide a timetable for implementation, nor does it include specific details of what the implementation process should entail. General Chemical will be required to develop an action plan that addresses how they will implement each of the findings/recommendations. As part of this action plan, General Chemical will establish a timetable for implementation. However, the report does provide a ranking of the findings/recommendations, which serves to provide General Chemical with an indication of

which findings/recommendations the evaluation team thinks are of high, medium, and low priority. General Chemical must develop the action plan based on their interpretation of how best to accomplish the desired change, and working within the constraints of available resources, workload at the facility, and facility procedures.

Some recommendations can be closed out quickly, but the ones needed to achieve lasting change will require ongoing attention and commitment. Over time, the ongoing implementation of recommendations applicable to safety culture and human factors will lead to a progressive integration of safety-related issues into the decision making processes and the day-to-day work practices.

Progress and improvement in these areas are hard to measure, but repeating the safety culture survey at 6-month or yearly intervals could provide some measure of progress. Contra Costa County and the City of Richmond will track the progress being made on implementing the findings and recommendations as part of their regular audits and inspections at the facility.

1.0. Introduction

Because of incidents that have occurred at the General Chemical-Richmond Works (GCRW) facility, the communities surrounding the facility, the Richmond City Council, the Contra Costa County Board of Supervisors, and the Contra Costa Health Services (CCHS) are concerned about safety at the facility. In response to the most recent incidents, the Richmond City Council and CCHS arranged for a third party safety evaluation to be performed on this facility.

A Safety Evaluation Oversight Committee was formed that included CCHS, the City of Richmond, General Chemical, the General Chemical employee union, Hazardous Materials Commission, and the public. This committee solicited bids from a number of consulting firms to conduct the third party safety evaluation. The committee selected MRS to conduct the evaluation. This report summarizes the results of the safety evaluation conducted by MRS at the GCRW facility located in Richmond, California.

1.1 Purpose and Objectives

The objectives of the Safety Evaluation were to complete a thorough evaluation of the current management practices and safety culture at the GCRW facility. The focus of the evaluation was on the safety management systems, human factors, and safety culture.

The evaluation was not intended as a compliance audit, and as such, this report is not meant to imply legal certification of compliance or noncompliance with safety regulations. Rather, the evaluation was intended to evaluate the GCRW facility safety management systems in relation to industry practices, and to identify potential deficiencies. The emphasis was also on process safety to evaluate the management systems in place to prevent accidents and incidents that could impact workers and the community.

The evaluation covered the entire facility, so it was not limited to operating units where incidents have occurred. Also, it is important to emphasize that this evaluation was not intended as an incident investigation or root cause analysis for any particular release or event.

The evaluation was impartial and objective. However, because the findings do reflect perceptions, they may not be indicative of "reality," and there may be apparent conflicts between the factual evidence gained as part of the safety management systems evaluation and the anecdotal evidence gathered from interviews with facility employees.

1.2 Scope

The scope of work for this assignment was developed by an ad hoc safety evaluation Oversight Committee, which included Contra Costa County, the City of Richmond, the Hazardous Materials Commission, the public, and General Chemical. The scope of work emphasized the need to evaluate GCRW safety management systems, human factors issues, and the safety

culture at the facility. It also specified which safety management elements were to be addressed (se Appendix A, Safety Evaluation Work Plan). While the evaluation examined the management systems associated with most California Accidental Release Prevention Program (CalARP) elements, the scope of work did not include a detailed verification of Process Safety Information (PSI) or Mechanical Integrity.

Some of the key questions that were addressed are as follows:

- How is management intent, as expressed in internal policies, carried out at field level?
- How are procedures developed? What does GCRW do when work methods fall outside of the written procedures?
- How is bottom-up input provided and on what range of subject matter? How are disagreements resolved?
- What systems are in place to ensure that management policies and/or procedures are carried out? Do these systems include audits?
- What accountability exists at each level of the organization? Who is accountable for what and to whom?

1.3 Approach

The process by which this evaluation was conducted is consistent with the general state of safety management and the best professional judgment of the evaluation team. MRS used a well established process for conducting the evaluation. Figure 1 shows the key steps in the evaluation process. It should be understood that the approach involved evaluating a sample of practices and was conducted over a short period of time. Efforts were made toward sampling major facets of safety performance during the period under review, but it is important to recognize that this method is intended to uncover major system deficiencies and the evaluation may not have identified all potential strengths or weaknesses.

There were four main components in the approach to this evaluation:

- Safety Management Systems,
- Human Factors,
- Safety Culture, and
- Public Participation.

The first three components were addressed using a team of three safety professionals working at the CGRW facility over a one week period beginning October 7, 2002. During this period, the evaluation team conducted more than 30 interviews with individuals and groups and reviewed a wide range of program documents and related data.

Figure 1 Key Steps in the Safety Evaluation Process

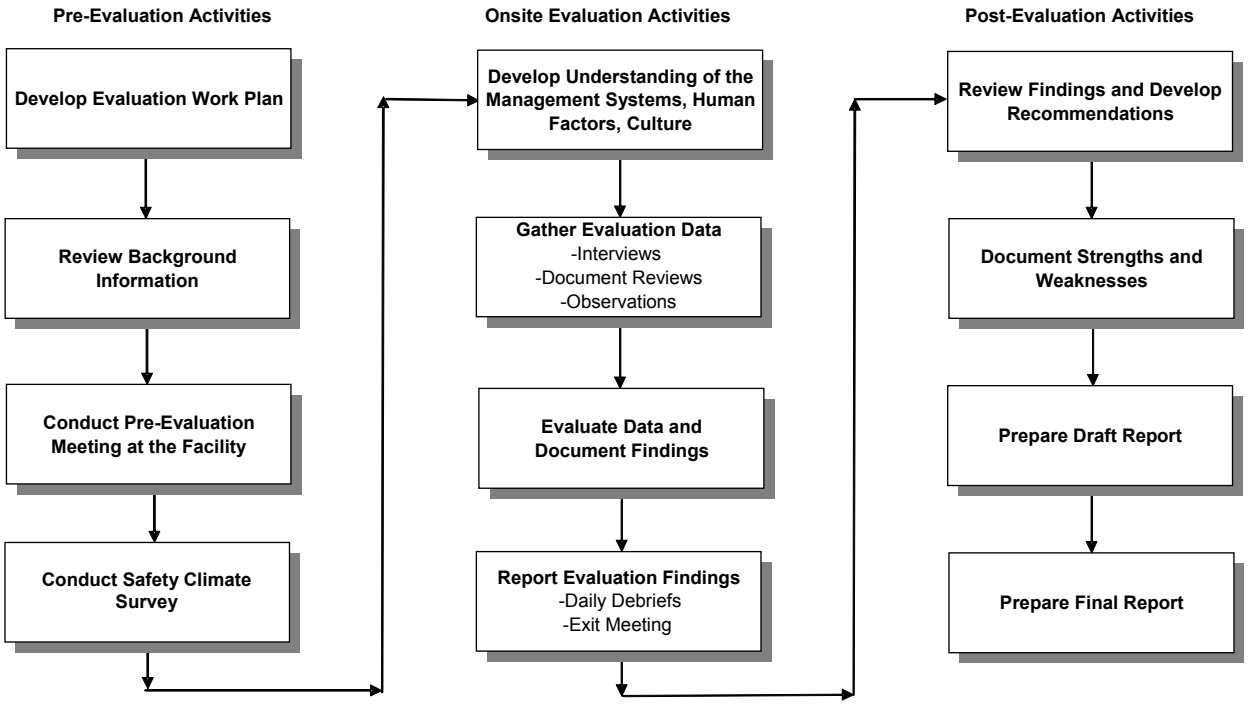


Table 1 Safety Management Systems Topics

- Operating Procedures
- Training
- Management Of Change
- Pre-Start-Up Safety Reviews
- Incident Investigation
- Hot Work
- Contractors
- Emergency Response Program
- Compliance Audits
- Employee Participation
- Process Hazard Analysis

The public participation component commenced prior to the onsite assessment, and involved the review of the draft work plan and a public workshop to allow the public to comment on the assessment work plan. The approach for each of these four main components is summarized below.

Safety Management Systems

We used the CCHS protocol to evaluate safety management systems. The safety management systems addressed as part of the evaluation are listed above in Table 1.

The basic approach to the evaluation involved reviewing the GCRW polices and procedures covering safety management systems and conducting a limited sampling of documents, reports, and other associated files to answer the key questions below for each of the management system elements.

Management System Element	Key Questions
Assessing	Do they know what they need to know?
Planning	If they do what they say they'll do, will that be sufficient?
Implementing	Are they doing what they say they're doing, and is it effective?
Reviewing	Is the 'program' reviewed and its effectiveness improved over time?

The safety management system assessment, focused on the effectiveness of program implementation, and explored any issues that indicated potential failures of the management systems due to safety culture and/or human factors issues. The assessment included a review of past safety management system audits conducted by outside consultants and CCHS. The assessment also explored issues associated with past incidents and near misses.

Human Factors

The specific methods used in performing the human factors evaluation were as follows:

- Interviews with individuals from each significant level of management, including workers, shift supervisors, middle management, safety management, senior management, and corporate management.
- Focus group discussions with individuals from the levels listed above.
- Review of relevant documentation, including training materials, checklists, safety procedures, incident reports, documentation procedures, etc.
- Facility tours with individuals from each level of management listed above.

The human factors evaluation approach involved obtaining a general sense of the level of human factors awareness and concern at the facility. Appendix A describes the types of questions that were addressed in each interview.

Safety Culture

Safety culture is the product of the individual and group values, attitudes, competencies, and patterns of behaviour that determine the commitment to and the style and proficiency of an organization's health and safety programs. Safety culture is, *"The way we do things around*

here." Workers interpret safety culture through their work environment and individual experiences. Organizations with a positive safety culture are characterized by communications founded on mutual trust, by shared perceptions of the importance of safety, and by confidence in the efficacy of preventive measures.

An organizational culture that supports safety is critical to the prevention of injuries and illness for employees, the economic viability of the organization, and preventing incidents that may affect the community. The purpose of this element is to evaluate the health of the existing organizational culture and to identify gaps and "unwritten rules" that discourage safe behaviors and practices.

Critical aspects of the management practices and programs that influence the behavior of workers include:

- What is measured and rewarded,
- How persuasion and coercion are exercised,
- How leaders model behavior and communicate expectations,
- How workers are trained and supported,
- How incidents and near misses are reported, investigated, and resolved, and
- Where accountability for safety performance really resides.

To begin the evaluation of safety culture, a Safety Culture Survey was used prior to the onsite work. The survey was based on the Health and Safety Climate Survey Tool developed by the United Kingdom (UK) Health and Safety Executive (HSE).

The survey was issued to the employees at the facility prior to conducting the onsite evaluation. Survey forms were also issued to contractors and corporate staff. The survey was used to obtain an initial perspective of people's views and perceptions on some key aspects of health and safety in the GCRW facility, as it exists today. The survey results are discussed in Section 2.3 of this report.

As part of the onsite evaluation additional questions were used to discover the perceptions of employees and others directly involved in day-to-day operations. These perceptions were investigated through a well-defined interviewing technique on a sampling of several categories of employees that included:

- Senior Management,
- Middle Management,
- Supervisors, and
- Workers.

A high percentage of the employees were interviewed during the onsite evaluation. The majority of the interviews were conducted one on one. In a number of cases, group interviews were used. All interviews were held on a strictly confidential basis to help ensure open and candid dialog.

The interview process consisted of six parts. These parts were as follows:

1. An introduction to include the confidentiality of the interview and the purpose for conducting the interview.
2. A discussion of how the person interviewed perceives the current state of safety at the GCRW facility based on the safety culture protocol questions.
3. A review of what they perceive their role to be in terms of the safety program.
4. A review of why they think accidents, incidents, and near misses occur.
5. An open-ended opportunity to contribute views related to safety.
6. A closing and opportunity to contribute later.

The results of the safety culture interviews were combined with information gathered from the other aspects of the evaluation (i.e., review of the safety management system and human factors evaluation) to develop findings and recommendations for improvement.

Public Participation

Public participation is an important aspect of this safety evaluation and continued throughout the evaluation process. The draft work plan for the safety evaluation was issued for public comment. A public workshop was held on October 2, 2002, to take comments on the draft work plan. Each comment received was considered carefully and addressed in one of two ways. If the comment applied to the scope of work, it was included and addressed. If the comment was not covered by the scope, an explanation was provided as to why it was not addressed in the evaluation. The comments received on the draft work plan are included in Appendix B, along with responses.

The Draft Safety Evaluation Report was issued to the public for a 30-day comment period. During this comment period, a second public meeting was held on December 2, 2002 at the Richmond City Hall in Richmond California. The purpose of this public meeting was to present the results of the evaluation and to take comments on the Draft Report. Appendix C contains copies of all the comments received on the Draft Report along with written responses to the comments.

Public presentations will be held with the Contra Costa County Board of Supervisors and the Richmond City Council to present the results of the safety evaluation. These hearings are expected to occur in January 2003.

1.4 Report Format

Section 2.0 of this report describes specific findings by functional area; and Section 3.0 includes recommendations that are prioritized as high, medium, and low. Section 4.0 presents the overall conclusions of the evaluation. Because this report is an “exception-based” report, the emphasis is

on the findings identified in the evaluation. This report does not include a complete discussion of all programs and issues reviewed by the evaluation team, nor does it provide legal certification of any program areas where no findings were identified. This report contains three appendices that provide the scope of work for the evaluation, comments received on the draft scope of work, and responses to the comments received on the Draft Report.

2.0 Evaluation Findings

The findings in this section are presented separately for safety management systems, human factors, and safety culture. The findings related to safety management are based on evidence gathered during the evaluation. This evidence was obtained from interviews with key people involved in the development and implementation of the respective programs, a review of documents, and limited physical observations.

Regarding the findings for human factors and safety culture, it must be recognized that organizational culture is developed over a long period of time and reflects individual and group values and perceptions of the way which the GCRW facility runs, as well as the actual policies, written programs, and procedures. This information must be taken into consideration when reviewing the findings. Because the findings do reflect perceptions, they may not be indicative of "reality," and there may be apparent conflicts between the factual evidence gained as part of the safety management systems evaluation and the anecdotal evidence gathered from interviews with facility workers. The recommendations for the safety culture findings were developed to address these apparent conflicts.

2.1 Safety Management Systems

The evaluation of the safety management systems was not intended as a compliance audit, and as such, this report is not meant to imply legal certification of compliance or noncompliance with safety regulations. Rather, the evaluation was intended to evaluate the GCRW facility safety management systems in relation to industry practices and to identify potential deficiencies. The emphasis was to evaluate the safety management systems in place to prevent incidents that could impact workers and the community.

Safety management systems are the policies, procedures and practices that a facility uses to ensure that the facility is operated in a safe manner and to ensure that process related incidents are minimized to the maximum extent feasible.

The GCRW facility has a written set of safety management systems in place. The facility has done a considerable amount of work on the safety management procedures over the past 2 years. They have updated the majority of these procedures within the last year, including the operating procedures, the incident investigation procedures, portions of the emergency response manual, as well as the management of change (MOC) procedure.

The facility has a written process hazards analysis (PHA) procedure, and all of the PHAs have been revalidated within the past year. As part of this revalidation process the facility conducted a human factors and facility siting assessment.

Over the past few years there has been a significant improvement in the use of the MOC process and the associated documentation. This has been particularly true for process related changes, as well as changes to the operating procedures.

In the area of incident investigations, the facility has been using a "root cause" analysis as part of the investigation process; however, it does not appear that all the team leaders have been trained in the use of root cause analysis. For significant incidents the facility uses a team approach to conducting the investigation and they have also developed and implemented a number of recommendations that should serve to improve safety at the facility. For example, GCRW is planning to install a caustic scrubber at the facility, which would mitigate potential releases to the environment.

In general, the facility was found to have well-documented safety management systems that were, for the most part, being implemented. The following findings were developed based on the review of the safety management systems.

Safety Management System Findings

2.1.1 The PHAs do not include sufficient documentation to show how past incidents were addressed in the PHA.

2.1.2 There is no written procedure that covers the development, revision, and certification of operating procedures.

2.1.3 A review of the Emergency Response Manual showed that the list of contacts was out of date.

2.1.4 The Emergency Response Manual does not contain a written procedure for reviewing and updating the manual, and for specifying how any changes are communicated to the employees.

2.1.5 The Emergency Response Manual does not contain a written policy regarding the rescuing of workers.

2.1.6 Some of the Operators are unclear as to what is the proper procedure for agency notifications in the event of an emergency.

2.1.7 Evacuation drills have not been conducted to test the Emergency Action Plan.

2.1.8 Changes in policies and procedures that affect operations and safety have not always been handled through the MOC process.

2.1.9 Changes in key personnel assignments or responsibilities have not undergone the MOC process as required by the facility's Management of Change Procedures dated June 7, 2002.

2.1.10 A review of incident and near-miss reports for the years 2000, 2001, and 2002 indicate that near misses are being under reported. For example in the year 2001, only 4 of the 29 reported incidents were near misses and this reporting is much lower than would normally be expected for this type of facility.

2.1.11 Incident investigation recommendations do not appear to be closed out in a timely manner. A review of 2002 incident investigation recommendations showed that 18 of 53 have not been closed out by the target completion date. A number of these items showed target completion dates in March 2002.

2.1.12 Documentation showing that recommendations from incident investigations had been closed out was not consistently tracked. Of the 32 closed incident recommendations reviewed for the period of 2001 and 2002, twelve did not have documentation verifying that the recommendation had been closed.

2.1.13 There is no systematic application of incident investigation action items to like equipment/systems throughout the facility.

2.1.14 There is no documented training course for incident investigation team leaders.

2.1.15 The incident investigation procedure does not indicate who is qualified to conduct incident investigations, and incident investigators do not receive training in the incident investigation technique and how to identify root causes.

2.1.16 The work order form generated by the Maximo system does not show who requested the work to be performed.

2.1.17 In reviewing the Contractor Program documents, the following issues were identified:

- The date of the job-specific training for each contract employee is not always the same as the date provided on the top of the sign-in form.
- The job-specific training form includes a number of information items that are not required, and are often left blank on the completed forms. These items include the AR No., Job No., Req No., PO No., Owners Representative and Title.

2.1.18 Several safety management programs lack adequate document control to ensure that they are developed, implemented, revised and distributed in an effective manner.

2.2 Human Factors

Human factors engineering is a multidisciplinary practice that seeks to promote safety through more effective design of sociotechnical systems (i.e., systems that are comprised of complex interactions between people and technology). Its primary focus is the effect of human-machine interactions on safe work performance. However, human factors also include related issues such as training, teamwork and team performance, and the effect of fatigue, workload, and stress on worker performance.

As part of our evaluation of safety culture at the GCRW facility, effort was devoted to examining human factors issues related to safe work practices. Generally speaking, the chemical industry as a whole has not devoted the time and resources to human factors safety issues that other industries have, and GCRW is no exception. While, in general, the human factors issues that

were noted are not so serious that they warrant immediate, extreme measures, they should be addressed in an effective and timely fashion.

Primary human factors areas of concern noted in this report include:

- The design of control room displays and alarm systems.
- The lack of familiarity amongst key plant personnel of human factors and ergonomic safety issues, and the lack of emphasis on these issues in plant safety briefings.
- The insufficient use of effective training techniques such as drills and simulations, and the absence of advanced training systems (e.g., desktop simulation systems).
- The absence of a cohesive "teamwork" mindset among Operators.

Human Factor Findings

2.2.1 The majority of displays in the control room are comprised of very old technology whose interpretability is non-intuitive, particularly for inexperienced Operators and for all Operators under upset or stressful conditions. There is a high degree of inconsistency among display formats, and a lack of displays that provide a quick, overall, "at-a-glance" summary of the state of plant processes. The mimic displays that are available for the CP plant are good, particularly at providing at-a-glance summaries of CP processes. However, similar displays are not available for other processes throughout the facility.

2.2.2 Senior management and training personnel have not had sufficient training or background in human factors and ergonomics. Their lack of training in these areas prevents them from being able to adequately train plant personnel in these areas and prevents them from being sufficiently aware of human factors and ergonomic safety issues throughout the facility.

2.2.3 Human factors and human performance issues are not adequately covered as part of training for plant personnel. The majority of plant personnel have had no exposure to concepts related to causes of human error, human performance risk factors for injury, etc.

2.2.4 Control room alarms lack sufficient discriminability and are not sufficiently prioritized. For instance, when Operators are outside the control room and hear an alarm it is generally not possible to identify its source without returning to the control room or communicating with someone in the control room. Additionally, once alarms are acknowledged they will not repeatedly sound even if Operators fail to address the underlying condition. This could cause an Operator to forget about an alarm condition should he/she become preoccupied with another existing situation.

2.2.5 The current approach to training relies heavily on classroom-style instruction and testing, as well as on-the-job training. However, simulations and drills are not used to full advantage as training methods. While minimal use of these techniques has recently been introduced in the facility, they are not sufficiently employed. Additionally, there

appears to be a lack of awareness amongst managers of modern training technologies such as desktop computer-based simulation tools.

2.2.6 There is insufficient emphasis placed on reward and positive reinforcement as a means of increasing good safety behaviors and practices. While discipline for unsafe practices appears to be well enforced, there is no formal arrangement for plant personnel to be rewarded (e.g., with letters of commendation, awards, informal positive statements from management, etc.) for good safety decisions and practices.

2.2.7 There is little or no "team concept" among plant Operators, perhaps primarily due to the fact that the current shift structure prevents the formation of cohesive teams (i.e., Operators do not work with the same individuals on a consistent basis). This prevents Operators from forming the type of teamwork bonds that promote a sense of caring and awareness of other team members' strengths, weaknesses, habits, etc.

2.3 Safety Culture

Background

The General Chemical-Richmond Works was started in 1944 to serve the neighboring Standard Oil of California (now ChevronTexaco) Refinery. The facility continues to regenerate sulfuric acid for the Chevron Richmond Refinery. The GCRW facility also manufactures industrial grade sulfuric acid for other wholesale customers and electronics grade acid for the semi-conductor industry. There are two "processes" at the plant, one that generates industrial grade (93–99%) sulfuric acid, and the other for high purity electronics grade acid.

The total number of people working at the plant is 35, with ten salaried positions and 25 hourly workers. Many of the hourly workers have been at the plant for more than 20 years, so they have considerable experience with the operation and maintenance of the plant. However, most of the salaried employees (including some of the managers) have been at the plant for less than 3 years.

During the 1990s, the plant went through many changes that have had an influence on the culture of the organization as it is today. In 1993, there was an offsite release of oleum from a rail car that triggered a period of intense scrutiny from the General Chemical Corporation, outside regulators, and the local community.

During the latter half of the 1990s, General Chemical was instituting an aggressive program of cost-cutting measures. Some managers commented that funds for safety projects were difficult to secure during this period, even for mechanical integrity and reliability projects. As a result, many of the safety management systems were never fully implemented during the 1990s. The evaluation team was informed that a punitive culture prevailed through this period, with coercion and discipline being hallmarks of the senior management within the Company.

Some workers describe some of the process technologies used at GCRW as "arcane" or "stone-age" (notably the process control and the effluent treatment systems). The complexity of the older equipment requires more time for an Operator to fully understand the process and the

interdependencies of the process components. Indeed the Operators with most experience at this plant are proud of their individual ability to master this system. This experience is valuable, but it limits operational flexibility, and may result in increased "pressure" on the Operators during an upset event.

In 1998, the GCRW facility suffered a tragic event when a disgruntled worker shot and killed three employees at the plant. This event resulted in two critical management positions being left open for more than a year, and it had a profound effect on the workers.

Over time, there has been a relatively low turnover of hourly workers and this has resulted in a very experienced workforce. However, the hourly workers have been rather isolated with little exposure to other General Chemical plants, or other similar plants in the industry, or the local area. As a result, a rather parochial culture has developed at the GCRW facility. On the other hand, there has also been a relatively high turn over of staff in the salaried positions during the last 3 years. The previous Plant Manager resigned in late 2001, but remained in the position until July 2002, and a permanent replacement has only just been found. (The new manager started in November 2002.)

Several hourly workers commented that safety leadership was lacking from the mid 1990s, and they consider some safety issues (such as developing a common vision for safety) to be still on hold until a new Plant Manager is appointed. Workers indicated they have not had a chance to "settle down" with a stable management team, and some indicated there was still a lingering tendency to punish workers for their mistakes, rather than making a genuine effort to prevent them from happening again.

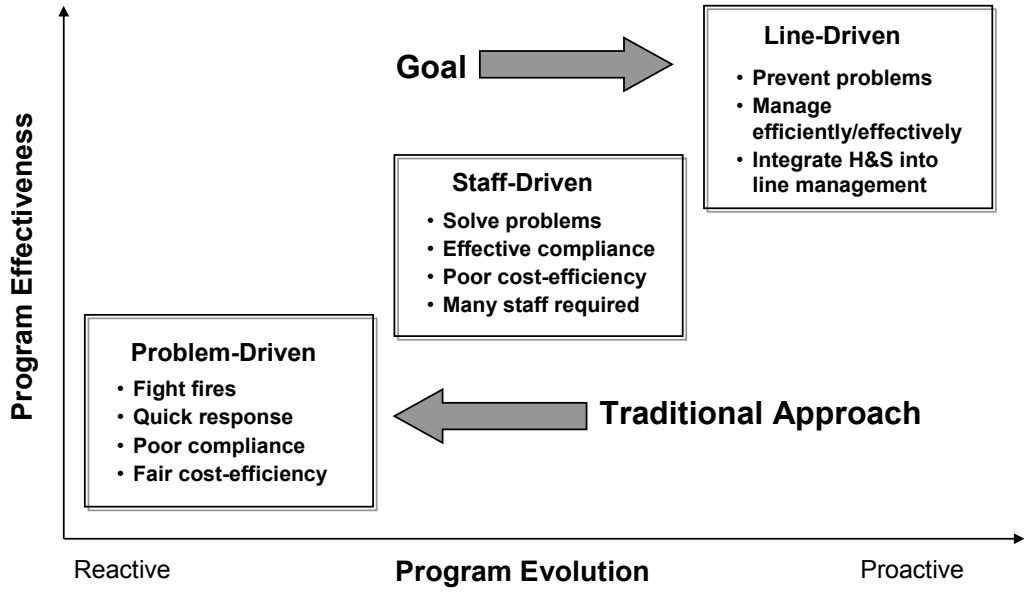
During the 1990s there were some positive developments that started to introduce more formality to the GCRW safety programs. The first Risk Management and Prevention Program was completed in the mid 1990s, and the Chemical Manufacturers Association (CMA) Responsible Care Program was initiated. In 1999, a federal Risk Management Plan (RMP) was submitted to the EPA and to the CCHS for oleum, and a state-only RMP was submitted to the CCHS for sulfur dioxide and sulfur trioxide (the plant is not subject to the Occupational Safety & Health Administration [OSHA] Process Safety Management Standard).

Up until 2 or 3 years ago, basic safety compliance was the priority for General Chemical, but in the last 3 years there has been more support from the Company for more formality in the safety programs. The 3P Program (People, Processes, and Performance) has been instituted, and all plants in the Performance Products Division are required to implement process safety management (PSM)/RMP-type management systems. Also, the interim Plant Manager and the other salaried employees at GCRW are now receiving support from General Chemical to continue with safety improvements.

Figure 2 presents a model of how safety culture evolves when a plant (or company) strives to enhance safety performance by transferring more and more responsibility for health and safety to the line organization. The model suggests three phases, the first being a *"problem-driven"* mode in which the organization reacts to incidents and deals with safety problems as they arise. The *"staff-driven"* phase occurs when an organization devotes resources to establish a more formal safety program. In this phase, staff (or outside consultants) are often hired to develop the

programs and conduct training, and the day-to-day responsibilities of the line organization involve a much greater emphasis on developing and implementing safety programs.

Figure 2 Evolution of Safety Culture



In the *"line-driven"* phase, an optimum is achieved in which the line workers are trained in the safety requirements, and they begin to execute these requirements as part of their normal day-to-day tasks. At this point, safety becomes more integrated into the business process. When this is achieved, fewer health and safety staff are needed, and those that remain help to provide direction, review the program, and make changes where necessary to improve the program.

The opinion of the Safety Evaluation Team is that the GCRW facility is transitioning out of the problem-driven mode and is now in the staff-driven mode. Several observations lead to this conclusion:

- Supervisory staff are facing ongoing conflicts trying to balance workloads between the demands for safety and operations,
- To date, many of the safety programs are relatively new, and there is a lack of formality in the document systems, and
- Workers are only now beginning to receive the top level support needed.

These observations are characteristic of a staff-driven organization, and they represent a necessary phase for the organization to move through in transitioning to a line-driven organization. While some line-driven programs have been implemented for several years, such as the "safety team" concept for conducting safety inspections, there is a ways to go before the plant reaches the line-driven phase.

The remainder of the safety culture section discusses the results of the evaluation. The first part gives a summary of the results of the safety culture survey, and the subsequent sections provide a discussion of the topical areas evaluated as part of safety culture, which included:

- Management and Line Organization Commitment to Safety,
- Communications,
- Personal Involvement in Safety,
- Workmates Influence,
- Training, Competence, and Awareness of Responsibilities,
- Risk-Taking Behavior,
- Obstacles to Safe Behavior,
- Attitudes toward Reporting and Investigating Accidents and Near Misses, and
- Job Satisfaction and Job Security.

The safety culture findings are presented at the end of this section.

Safety Culture Survey Results

As part of the Safety Evaluation, a safety culture survey of General Chemical employees was conducted. Workers, supervisors, managers and corporate managers were asked to provide their views on the state of safety at the facility. The "Safety Climate Tool" available from the UK HSE was used to conduct the survey. This tool includes more than 70 statements that are grouped into eleven "factors" that are used to evaluate a plant culture.

Survey recipients were informed that the responses would be completely confidential, and no remarks or comments would be attributable to an individual. The questionnaire was distributed to approximately 40 people in total, and 33 responses were received (21 from plant workers, six from plant supervisors, and three each from plant management and corporate managers).

For each statement on the survey form, the recipients were asked to rate their degree of agreement with the statement on a scale of 1 to 5. The responses were entered into a computer for analysis using the custom software provided as part of the Safety Climate Tool. In the analysis, responses were grouped as favorable, neutral, or unfavorable, based on the employees' ratings. Factors with a high percentage of favorable responses may be considered as indicative of a positive culture. Factors with a relatively high percentage of unfavorable responses show areas where cultural barriers may be a concern for safety. The data was also used to analyze the responses for each of four employee categories (workers, supervisors, managers, and corporate managers) and the differences between them.

A summary of the results is presented in Figures 3 and 4. Figure 3 shows the percentages of favorable responses for each cultural factor and for each employee category, and Figure 4 shows percentages of unfavorable responses. Apart from helping to identify the factors where there may be cultural concerns, the two figures highlight the factors where the employee categories differ in their perspectives. Note that the summation of favorable and unfavorable responses in Figures 3

and 4 do not usually add up to 100% because they do not include the neutral responses (not shown).

Note that the Safety Culture Tool is a "perception survey," and it represents employees' ***opinions*** of safety issues. As such, it may not be a true indicator of where potential problems exist. However, the survey responses did help to identify important issues that the survey team was able to explore further during the onsite evaluation.

Some of the main factors of concern identified in the survey results were job security, obstacles to safe behavior, accidents and incidents, risk taking, and organizational commitment. The cultural issues and the results of the survey are discussed further in the following sections.

Management and Line Organization Commitment to Safety

With some minor exceptions, there appears to be a genuine commitment for safety from the line organization, plant management, and the corporate organization. It appears that safety is becoming more integral to the business operations than it has in the recent past.

Workers generally agreed that senior management takes health and safety seriously, and that sufficient resources are available for health and safety. GCRW has approved funding for a major investment in the mechanical integrity program, and funds are also approved for a new caustic scrubber to mitigate potential releases. Other risk reduction projects—such as an onsite power generator and the conversion of the oleum tower to a smaller unit—are also being considered for funding.

In the survey responses, some workers indicated that management is reluctant to act quickly and decisively on health and safety concerns. This could be because the authorization process can sometimes result in long delays before safety projects are implemented, it could be related to the time taken for closure of safety action items (See Finding # 2.1.11 for example), or it may be a perception based on past experiences.

Hourly workers generally stated that management is present in the workplace, and provides good safety leadership. The workers indicated that they do get answers and resolution to the safety issues they raise. They reported that their bosses would do what they can to ensure health and safety, and they would be receptive to ideas on how to improve health and safety.

Many employees indicated that senior management commitment to safety has been lacking in the past, and a small percentage of workers are still skeptical that safety is as important as productivity. These attitudes likely stem from past practices at the plant when there was only minimal spending on safety. However, some managers also reported they do not always receive the help they ask for on health and safety issues.

Figure 3 Safety Culture Survey - Favorable Responses

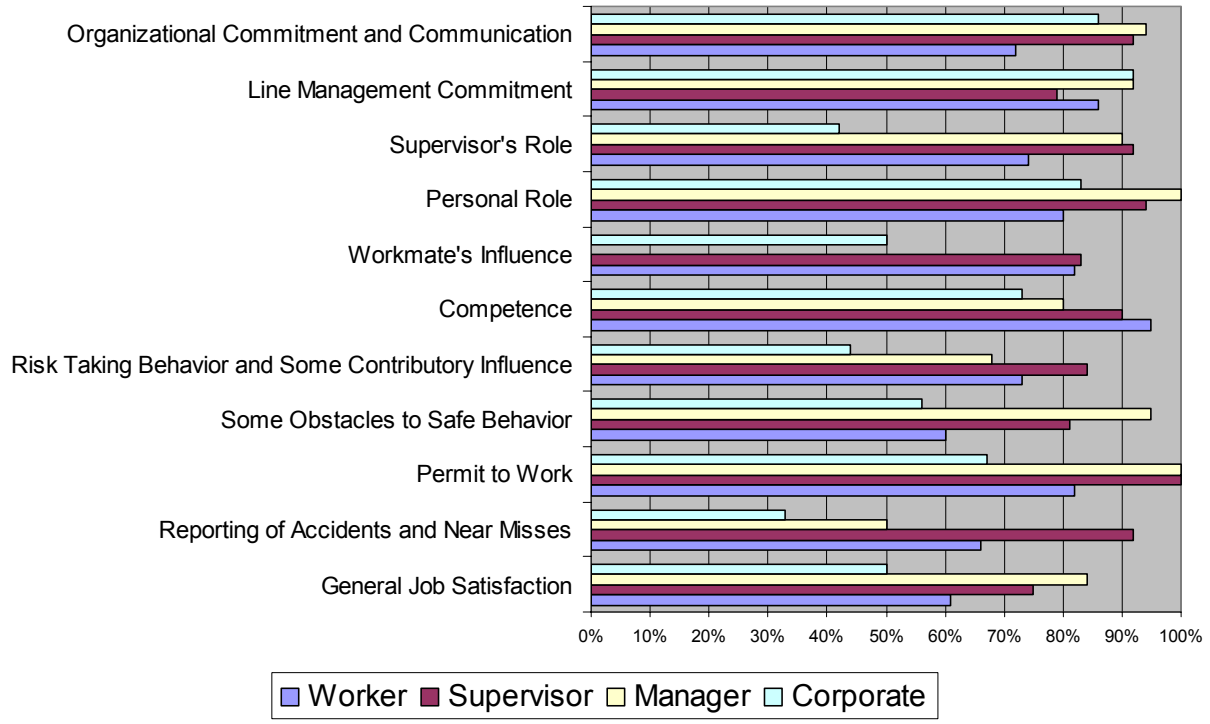
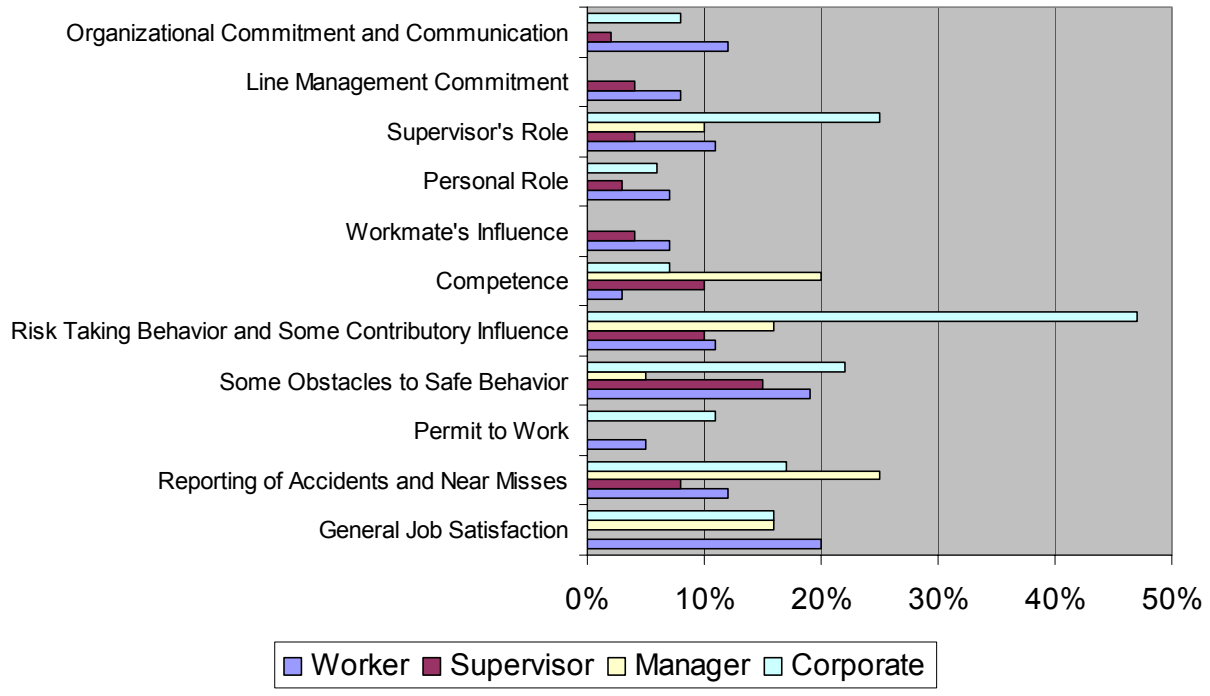


Figure 4 Safety Culture Survey - Unfavorable Responses



The safety culture survey identified some concerns about the supervisors' contribution to health and safety, both from the workers and management. Some managers perceived that supervisors do not devote sufficient effort to health and safety, and approximately only half of the workers think that supervisors are good at detecting unsafe behaviors. Some supervisors indicated their bosses do not often talk to them about safety. However, with such a small number of supervisors at the plant, there is insufficient evidence to make generic conclusions about these issues.

To date, most of the safety metrics that are formally tracked by management are the "lagging indicators," such as accident and injury statistics. Plant managers are aware of the importance and value of leading indicators and management does discuss leading indicators (such as incidents and incident investigations, overdue safety action items, and safety training accomplishments) at company managers meetings. However, as one manager put it, the process is "informal at best."

Communications

In general, it was evident that there were good interpersonal communications relating to safety at the GCRW facility. Safety issues are raised and addressed through the monthly Joint Health and Safety Committee Meetings, and these meetings are documented with detailed minutes. Issues are communicated to the workers through monthly safety meetings. The monthly union-management meetings provide an additional forum for workers to raise issues of concern.

In the safety culture survey, hourly workers reported favorably as follows:

- Communications with their immediate bosses were positive.
- The Health and Safety Committee is valued.
- They are kept informed of the outcomes of health and safety meetings.
- Health and Safety meetings are a good use of time.
- They are kept informed of incidents and the results of incident investigations.
- The Company generally shows interest in their views of health and safety.

However, some supervisors and managers were less satisfied with communications, and they reported that communications were not always favorable with their immediate bosses and/or their peers.

Based on observations at the site and employee interviews, it was apparent that there was no clear vision for safety at the plant, and there was no sense of personal identity within the program. There were no explicit company or facility goals for safety, and workers provided differing personal opinions of where the safety program was and where it was going. Some opinions were indicative of a general lack of motivation that appears to have developed at the plant. For example, while some workers indicated that "the plant just needs to stop the releases, or we could be shut down by the community," others were resigned to doing whatever they were told to do.

The General Chemical 3P Program was established in 2001 to improve safety performance. However, the full extent of the program and its value in terms of safety has not been well

communicated to workers at the GCRW facility. There was very little awareness of the program elements, other than the new incentive program (see the following section on Personal Involvement in Safety).

Safety slogans and safety messages (banners, signs, posters, etc.) were not being used in a coordinated way to convey greater awareness of safety. While there were some banners posted (for the 3P Program and for accident statistics), they were not integral to a consistent safety theme. The General Chemical Environmental Health and Safety (EHS) policy was not posted around the plant, and the copies of "EHS Matters" in front lobby were more than 3 years old. Safety performance metrics are not being shared widely and consistently with hourly workers, so there is a lost opportunity to show trends and recognize improvements in the activities which workers are directly involved in.

Regarding the communications among the work groups, several concerns were raised with regard to the communications within Operations. In general, there was little evidence of team-work amongst the Operators, and there seemed to be no sense of purpose as a group. Management style in the past has been authoritarian, and some workers are still apprehensive about making mistakes. Comments made by the workers suggested that they were afraid of being disciplined and/or ostracized by the other Operators if they make a mistake.

The shift structure is such that workers do not work as "crews" within Operations. There is a Lead Operator, an 'A' Operator, and a 'B' Operator for each shift, but the Lead and B Operators are on a twelve-hour shift cycle, and the A Operators are on an eight-hour shift cycle. This means that the workers are seldom together on the same shift for more than a few days at a time. The disadvantage of this approach is that Operators work as "individuals," it could lead to compartmentalized thinking because there is a lack of bonding among the Operators, and less inclination to care for each others' well-being. The idea of changing the shift structure has been discussed with the Operators, but some Operators have expressed resistance to this.

It was reported that, in the recent past, there were limited communications at shift change, and this may have contributed to some incidents. Recent changes have been made to encourage Operators to be more responsible about the hand-over process.

In the past, General Chemical, as a corporation, has not seen the need for an active public relations program and for communicating safety and environmental issues with the local communities. Within the Company, the GCRW facility has been acknowledged for its technical capabilities, but corporate managers now recognize the need for Plant Managers to be trained and prepared for community relations.

Personal Involvement in Safety

GCRW has a wide-ranging employee participation program for safety that is well summarized in their Injury and Illness Prevention Program. Some of the main activities involve participation in the PHAs, incident investigations, safety meetings, writing operating procedures, and conducting safety inspections.

The safety culture survey results indicated that, in general, the workers felt they were involved in the safety program, and they felt their immediate bosses were receptive to the health and safety

issues they raise. Workers indicated that the Company shows an interest in their safety opinions, and health and safety meetings were regarded as being a good use of time.

Despite these favorable indications, a number of important issues were raised in the survey responses and during the onsite evaluation which suggest that there are some limitations to the workers participation:

- While the Company encourages suggestions on safety, a relatively high percentage of workers considered that the suggestions were not acted on in a timely manner.
- Many workers indicated that there might be too many health and safety rules, given the real risks.
- More than half of the workers were neutral about their involvement in developing and reviewing procedures and rules. One hourly worker commented that "They tell us what to do, and we do it."

Similarly, hourly workers are asked to implement the safety mitigation measures that are developed by Company managers based on incidents that occur at other General Chemical plants, but hourly workers are rarely involved in reviewing the incidents.

The safety incentive programs (Corporate 3P Program and the GCRW Safety Bingo) do provide appropriate types of incentive for rewarding safety performance as a group, but individual workers are not recognized and celebrated for good safety performance. Also, there is no performance evaluation process for hourly workers that requires and recognizes good safety performance.

Workmates Influence

Survey results indicated that there is general agreement that all people "who work in my team" are fully committed to health and safety, and there is a need to work safely to keep the respect of others. Most workers indicated that workmates would react strongly against people who break the rules. Almost all workers indicated that they can trust most people to work safely, but not all workers were prepared to trust their own safety with their workmates.

The evaluation team found that some Operators were prepared to blame their peers when mistakes were made rather than helping to resolve the underlying issues. Some senior Operators questioned the capabilities of other Operators, and some were perceived as not having the skills to do their jobs effectively.

As discussed above, the "norm" at shift change has been to conduct the change over in the least time necessary. The culture (as influenced by Operators' workmates) does not seem to favor an Operator asking for help or for more information if he or she is uncertain of the status. There seemed to be a lack of caring for each other as a team. This may be attributable to the shift schedule structure, which allows some Operators to work in relative isolation, being removed to a large extent from other Operators and management supervision.

Training, Competence, and Awareness of Responsibilities

In the safety culture survey, a high percentage of workers indicated that they thought the training they were given covers all health and safety risks and they were certain of what to do to ensure health and safety in their work. Workers commented that they could request training whenever they feel the need, and no one commented that the training was denied when asked for. Almost all workers said they understand the safety rules and procedures, they are clear about what their responsibilities are for health and safety, and they say they understand the associated risks. However, responses from the managers and supervisors expressed some uncertainty about what to do to ensure safety and health.

GCRW devotes considerable effort to the regulatory health and safety training. Some workers and supervisors commented that in this area there is "training to a fault," and there may be "training overkill." Some workers referred to the training as being boring and repetitive.

As for the operating procedures, some Operators indicated that the training was too rigid and does not include simulations (for emergencies). Management also acknowledged that the workers were not very familiar with some important equipment items such as the Allen Bradley system and the steam driven turbine. Only after incidents have occurred has the importance of this kind of training been realized. No training is provided for those asked to be incident investigation team leaders.

Operators are not exposed to other ways of doing things (for example, things done at other General Chemical sites, other process facilities in the area, etc.), and the local operating experience appears to be very parochial. Exposure to other operations could help Operators to identify ways to improve performance. The new initiative for in Performance Products for sharing lessons learned at other plants does provide Operators with exposure to experience at other General Chemical plants, but this does not give the Operators any direct experience with other similar plants. The potential benefit of cross training among the Operators to work in other plant areas has been recognized by managers and workers, but it has not been given a high priority.

The maintenance team is very experienced, but most of the workers are not empowered to take more initiative for improving safety. The failure of General Chemical to allocate adequate resources for preventive maintenance in the recent past has likely contributed to the prevailing attitude which is to focus on corrective maintenance ("if it breaks, fix it") with much less attention paid to preventive and predictive maintenance. Maintenance workers have likely been "taught" over the years not to accept much responsibility. As one worker put it: "We are not paid to make decisions." Mechanics as a group also seemed resigned to the fact that some incidents were "out of our control." Workers do not appear to be challenged and motivated to work "out of the box."

In general, the Safety Evaluation Team noted a complacency amongst workers that was characterized by low overall performance standards, and a lack of cohesion amongst the workers as a group. As the emphasis on safety changes at GCRW, and workers are expected to contribute more and take on new responsibilities, they may require help to acquire the necessary skills and attitudes to successfully accomplish their new responsibilities.

Some deficiencies were noted with respect to the training on the Emergency Response Plan. The findings are included in the Management Systems section.

Risk-Taking Behavior

In the safety culture survey, a relatively high percentage of managers and workers indicated they do not agree that people have a good understanding of the risks associated with their jobs and how to identify them. The evaluation team found that most workers' were aware that they had authority (and responsibility) to stop unsafe work.

GCRW has found that there could be increased risk at the time of a shift change if the new shift Operators are not fully aware of the status of the processes. It would appear that workers do not knowingly take risks; rather they may not have the ability to recognize situations that could lead to risks, and they may not ask for help when needed.

Almost all workers indicated that they see the advantages of staying within the rules, and nearly all indicated that they need to follow the rules to get the job done safely. However, the evaluation team identified two areas of concern:

1. The first concern was in the workers' responses to questions about protective actions and rescue following an incident in that several workers said they would be prepared to break the rules to assist a man down.
2. Some of the standards on personal protective equipment (PPE) and clothing were perceived as being too stringent, and workers were not convinced that the rules are necessary. There was considerable disagreement amongst workers about the value of using goggles for acid jobs in situations where they can fog up.

As indicated above, most workers said they trust their workmates to work safely, but they are less confident about trusting their own safety and health to others. Some supervisors and managers are not convinced that people always work safely when not supervised. A relatively high percentage thinks that people often take risks. One of the biggest issues around risk-taking appears to be associated with PPE. A relatively high percentage of supervisors and managers consider that PPE is not always worn when required. The main issue was related to goggles, and the need to wear them for acid jobs.

Workers, supervisors and managers all indicated that not all health and safety procedures and rules are strictly followed. All three categories are neutral on management's attention to health and safety. Some supervisors may be turning a blind eye to people not following the rules, but generally, people were not pressured to work unsafely by their colleagues.

Management does appear to take action to discipline people who break the health and safety rules, and people who cause accidents do appear to be held accountable.

Some maintenance workers stated they were uneasy when they were asked to open a line against one active valve, and sometimes they were asked to work alone on acid jobs.

At the time of the safety evaluation, pressure for production did not appear to adversely affect workers' attention to safety. While this may have been true in the past, the Company is now communicating a consistent message that production pressures must not compromise safety, and the Company would stop work due to safety concerns even if it meant losing money. Today, managers appear to be as interested in safety as in production.

Obstacles to Safe Behavior

Less than half of the workers were certain that safety rules are really practical, while all managers and supervisors were. Some supervisors think some rules are hard to follow, and they sometimes think it is necessary to take risks to get the job done. Some workers, supervisors, and managers said that some jobs are difficult to do safely. Some workers indicated that the health and safety rules are there only to protect management.

There was no indication of any problems getting the equipment needed to operate safely, but there was a perception amongst workers that there were not always enough people available to get the job done according to the health and safety rules.

There was strong agreement by workers and supervisors that physical conditions sometimes restrict people's ability to work safely. The issue is more likely to be related to the limited expenditures in the past on preventive maintenance rather than to human factors issues. The plant has a lot of older technology including the process control and effluent control systems, but funds are now being made available for upgrading the mechanical integrity program.

Attitudes towards Reporting and Investigating Accidents and Near Misses

Most employees think that accidents and incidents are reported, but there was a wide disparity as to whether near misses are reported. All supervisors thought they were reported, but all managers and many of the workers were neutral or disagree. The incident log for 2001 included only four near misses out of a total number of 29 incidents, and this reporting is much lower than would normally be expected for this type of plant.

Workers are not trained to identify and report near misses, and there was a general lack of awareness about the types of incidents that could be considered as near misses. Having experienced a long period during which there was a punitive culture at the plant, workers may be afraid of reporting near misses for fear of being blamed. The survey indicated that there is a sentiment among some workers that investigations are still used mainly to identify blame (e.g., "When things go wrong it's our fault.").

Incidents and the results of incident investigations are disseminated through the Health and Safety Committee and the safety meetings. However, incidents at other General Chemical plants are not shared directly with the hourly workers. Corrective actions developed for specific incidents are not always applied systematically to other like-equipment at the plant.

In the analysis of causal factors, human factors and equipment issues were being addressed, but it was not clear that management and policy issues were also being considered.

Job Satisfaction and Job Security

Overall, a very large number of employees expressed concern over job security in the survey. Some employees expressed concern that the plant may cease to operate because of the financial status of the Company. This fear appears to be justified given that General Chemical has now filed for bankruptcy. Others thought that regulatory agencies could close the plant if offsite releases continue to occur. For some individuals, there could be a sense of insecurity because of previous mistakes they had made on the job. Overall the effect on worker morale and safety performance did not appear to be greatly influenced by the threat of job losses.

Regarding job satisfaction, a small number of workers indicated in the survey responses "that their jobs were boring and repetitive."

Safety Culture Findings

2.3.1 Managers and workers at GCRW do not have a clear vision for the facility health and safety program. Safety slogans and safety messages do not provide a persuasive and compelling vision of the safety objectives for the plant, and there is no consistent communication of a safety vision.

2.3.2 There is little awareness among workers of the full scope of the General Chemical 3P Program, and the importance of 3P participation has not been effectively conveyed to workers. Operators and maintenance personnel are aware that they can receive a $50 quarterly bonus if no recordable injuries occur during that time period, but are almost unanimously unaware of any other features of the program.

2.3.3 Management has not demonstrated to workers a convincing ability to act quickly over health and safety concerns and suggestions.

2.3.4 Workers perceive that some supervisors and managers appear to be uncertain as to what is needed to ensure safety and health.

2.3.5 Some managers perceive that supervisors may not be devoting sufficient effort to health and safety, and some workers think supervisors may not be good at detecting unsafe behaviors.

2.3.6 Among the workers, there appeared to be an attitude of "resigned acceptance" as to the level of safety performance that is possible at GCRW. Workmates' influence and peer pressure within the Operations Department do not appear to be conducive to team building and working as a group towards a shared vision of safety. The influence of fellow workers (including first line supervision) in the Maintenance Department appears to foster an attitude in which workers are reluctant to accept much responsibility for raising safety performance standards.

The changes at management level and the limited expenditures on preventive maintenance at GCRW in the past have likely contributed to this attitude among the workers.

(Note: the Safety Evaluation team was made aware of a program that is now being implemented to enhance preventative maintenance at this plant.)

2.3.7 Safety metrics have not been developed and adopted for leading indicators of safety performance. The lagging indicators used by management do not convey information to reflect recent progress being made with regard to the safety program.

2.3.8 Safety performance metrics and safety performance progress are not shared widely with hourly workers.

2.3.9 Some workers appeared to be apprehensive about making mistakes for fear of being disciplined by management or ostracized by their fellow workers.

2.3.10 Communication among the Operators as a group is probably less than optimal because of the shift structure being used at the plant. Also, it was commented that communications at shift change in the recent past have been brief, with only limited exchange of information regarding the status of plant operations.

2.3.11 Plant managers receive no formal training on community relations and public outreach to help with the communication of safety and environmental issues.

2.3.12 Participation in the safety program has not been fully embraced by workers, so the potential from employee involvement is not being fully realized.

2.3.13 Workers are not always involved in developing and reviewing safety rules that affect their work, especially with respect to personal protective equipment, clothing, and work permits.

2.3.14 Some workers perceive that the safety and health rules may be too extensive or prohibitive for the real risks involved.

2.3.15 There is no performance evaluation process for hourly workers that could be used to require and recognize good safety performance. Personal performance appraisals and associated safety evaluations for salaried people are sometimes delayed beyond the anniversary date.

2.3.16 The regulatory safety and health training program is not revised and upgraded on a routine basis to ensure it maintains participants' interest. The training is perceived by some to be boring, repetitive, and time-consuming. As such the training may not be very effective.

2.3.17 The need for cross-training Operators to work in other areas of the plant has been recognized by workers and management, but there has been no commitment to implement such a cross-training program.

2.3.18 Workers appear to have a parochial view of operating and maintenance practices. They have very limited exposure to operating and maintenance practices at other similar facilities within General Chemical and/or within the local area.

2.3.19 GCRW job descriptions do not explicitly address safety requirements.

2.3.20 Working safely is not yet internalized by the entire work force. There appears to be a limited understanding of the risks involved, and managers indicated that personal protective equipment is not always worn by workers, as required.

2.3.21 Worker's concerns about wearing eye goggles have not been adequately addressed. Workers argue that wearing eye goggles could introduce health and safety risks under certain circumstances.

2.3.22 It appears that some supervisors may take risks to get the job done, and risk-taking behaviors may be permitted or overlooked by some levels of management. Some workers indicated they might be willing to take some risks and break safety rules to rescue a man down.

2.3.23 The existing shift structure may result in Operators' taking undue risks because of an unwillingness to request help when it is needed. The short duration of shift changes may also present significant risk in some situations.

2.3.24 Some workers and supervisors consider that safety rules may not be practical for the "real" risks at this plant. They consider there may be too many rules, and some rules are difficult to follow.

2.3.25 At times, there may not be an adequate number of Operators at the plant to work safely. Some examples of times and work activities that could introduce risk with insufficient people are: (1) during upset conditions; (2) during plant start-up; and (3) when the Operations Department has unfilled positions.

2.3.26 Physical conditions at the plant may restrict peoples' ability to work safely. (This issue applies more to the condition of the limited expenditures in the past on preventive maintenance rather than to human factors issues involved in equipment operation.)

2.3.27 Workers are not trained to identify and report near misses, and there is a lack of awareness of what a near miss is. There are no incentives for reporting near misses. (See also 2.1.10)

2.3.28 There is a sense among many of the workers that accident investigations are used to identify who is to blame, rather than to address the underlying root causes.

2.3.29 Many of the workers, supervisors and managers are concerned over job security. The recent bankruptcy announcement by General Chemical could have an adverse impact on employee morale and motivation for working safely.

3.0 Recommendations

For each of the findings identified during the evaluation, a recommendation was developed by the evaluation team. To the extent possible, the recommendations were designed to improve the applicable safety management system, rather than to "fix" the specific issues identified. For example, the safety culture includes a recommendation to develop a new vision and strategy for the safety program that, if implemented, would serve to address many of the findings included in the safety culture section.

In all cases, the recommendations were intended to provide a way to achieve safety performance improvement. They are based on the experience of the team and the collective experience gained from working with similar facilities in the industry. The recommendations provided are not the only way to address the findings, and as such, in addressing each of the findings, GCRW may develop other recommendations that would serve to address the findings.

Recommendations were prioritized based on the degree of risk associated with the finding. This was a subjective process involving the expertise of the team, but the underlying concept was to consider the perceived risk to GCRW of not implementing the recommendations. The priority levels provide a basis for establishing a schedule to address the recommendations.

The remainder of this section presents a text table that lists each finding, the associated recommendation, and a projected priority.

#	Finding	Recommendation	Priority
Safety Management Systems			
2.1.1	The PHAs do not include sufficient documentation to show how past incidents were addressed in the PHA.	Modify the RMP/Cal ARP Procedures covering PHAs to include a requirement that each PHA contain a list of the past incidents addressed in the PHA, and that the PHA documentation specifically identify where each incident was addressed.	Medium
2.1.2	There is no written procedure that covers the development, revisions, and certification of operating procedures.	Develop a written procedure that covers the development, revisions, and certification of operating procedures. This procedure should address who is responsible for the development and revisions to operating procedures, who is responsible for approving any new or revised operating procedures, and who is responsible for the annual certification of the operating procedures.	Medium
2.1.3	A review of the Emergency Response Manual showed that the list of contacts was out of date.	Update the contact list in the Emergency Response Manual, and implement a policy that requires updating whenever there is a change in staff that affects the contact list.	High
2.1.4	The Emergency Response Manual does not contain a written procedure for reviewing and updating the manual, and for specifying how any changes are communicated to the employees.	Add a section to the Emergency Response Manual that details the procedures for reviewing and updating the Emergency Response Manual. The section should discuss the frequency of the review, the person who is responsible for reviewing and updating the manual, and the process that will be used to communicate the changes with the employees. It should be noted that certain changes to the Emergency Response Manual would also be required through the MOC process.	High
2.1.5	The Emergency Response Manual does not contain a written policy regarding the rescuing of workers.	Develop a written policy that covers the rescuing of workers. This policy should cover different scenarios such a fire, hazardous material release, chemical spills, etc.	High
2.1.6	Some of the Operators are unclear as to what is the proper procedure for agency notifications in the event of an emergency.	Develop a flowchart that shows the required notifications and the order of contact for various emergency situations such as fire, chemical release, man down, etc.	High
2.1.7	Evacuation drills have not been conducted to test the Emergency Action Plan.	Modify the Emergency Response Plan to include a requirement for evacuation drills. These drills should be conducted on an annual basis.	Low
2.1.8	Changes in policies and procedures that affect operations and	Add a section to the MOC procedure that clearly states that any changes in	Medium

#	Finding	Recommendation	Priority
	safety have not always been handled through the MOC process.	polices or procedures that affect operations must be handled through the MOC process.	
2.1.9	Changes in key personnel assignments or responsibilities have not gone through the MOC process as required by the facility's Management of Change Procedures dated June 7, 2002.	Assure that any changes to key personnel assignments or responsibilities are handled through the MOC process as required by the facility's MOC procedures dated June 7, 2002.	Medium
2.1.10	A review of incident and near-miss reports for the years 2000, 2001, and 2002 indicate that near misses are being under reported. For example in the year 2001, only 4 of the 29 reported incidents were near misses and this reporting is much lower than would normally be expected for this type of facility.	Provide additional training to the workers on the importance of reporting near misses. Develop a near-miss reporting program that provides incentives for staff to report near misses. See also 2.3.27 and 2.3.28.	High
2.1.11	Incident investigation recommendations do not appear to be closed out in a timely manner. A review of 2002 incident investigation recommendations showed that 18 of 53 have not been closed out by the target completion date. A number of these items showed target completion dates in March 2002.	Use the monthly safety meetings to review all outstanding recommendations, paying particular attention to progress on meeting the completion date. Assure that documentation is submitted in a timely manner when an action item is completed. Update the target completion dates as needed, based upon revised information, and assure that if target completion dates are changed, that the reason for the change is documented.	Medium
2.1.12	Documentation showing that recommendations from incident investigations had been closed out was not consistently tracked. Of the 32 closed incident recommendations reviewed for the period of 2001 and 2002, twelve did not have documentation verifying that the recommendation had been closed.	Develop a written procedure that details the required documentation process for closing out action items for incident investigations, audits, PHAs, etc.	Medium
2.1.13	There is no systematic application of incident investigation action items to like equipment/systems throughout the facility.	Revise the Incident Investigation procedure to include a requirement for the Health and Safety Committee to make recommendations for applying incident investigation action items across all like equipment/systems at the facility.	Medium
2.1.14	There is no documented training course for incident investigation team leaders.	Develop an incident investigator training course, and require that this be taken before an individual may conduct an incident investigation.	Medium
2.1.15	The incident investigation procedure does not indicate who is qualified to conduct incident investigations, and incident	Develop a training course for incident investigation team leaders with an emphasis on GCRW's procedure for root cause analysis. The training course	Low

#	Finding	Recommendation	Priority
	investigators do not receive training in the incident investigation technique and how to identify root causes.	should also cover who is responsible for developing recommendations for applying incident investigation action items across all like equipment/systems at the facility.	
2.1.16	The work order form generated by the Maximo system does not show who requested the work to be performed.	Modify the work order form generated by the Maximo system to include the person who requested the work be performed.	Low
2.1.17	In reviewing the Contractor Program documents, the following issues were identified: • The date of the job-specific training for each contract employee is not always the same as the date provided on the top of the sign-in form. • The job-specific training form includes a number of information items that are not required, and are often left blank on the completed forms. These items include the AR No., Job No., Req No., PO No., Owners Representative and Title.	Modify the job-specific training sign-in form to include a date for each signer, which would allow each contractor to sign the form and provide the date that they received the job specific training. Review the job specific training form to make sure that only the required fields are included in the form.	Low
2.1.18	Several safety management programs lack adequate document control to ensure that they are developed, implemented, revised and distributed in an effective manner.	Establish a Document Control Procedure for managing the development review certification and distribution of safety program documents including the plant rules, plant policies, training system, job descriptions, etc. This procedure should assure that all safety management system documents are current, consistent, and accurate.	Medium
	Human Factors		
2.2.1	The majority of displays in the control room are comprised of very old technology whose interpretability is non-intuitive, particularly for inexperienced Operators and for all Operators under upset or stressful conditions. There is a high degree of inconsistency among display formats, and a lack of displays that provide a quick, overall, "at-a-glance" summary of the state of plant processes. The mimic displays that are available for the CP plant are good, particularly at providing at-a-glance summaries of CP processes. However, similar displays are not available for other processes throughout the facility.	It is recommended that General Chemical hire a qualified human factors consultant to perform a cognitive task analysis (CTA) of control room functions as they relate to display design and use. The output of a CTA is important in identifying human performance bottlenecks (e.g., limits in the interpretability of displays under routine and/or upset conditions) that exist with the current system. Additionally, a CTA can provide general design and implementation guidelines for improved displays based on the results of the CTA itself, as well as general guidance from the human factors display knowledge base. The potential benefit of implementing a Distributed Control System (DCS) should also be considered in the CTA.	Medium
2.2.2	Senior management and training personnel have not had sufficient training or background in human factors and ergonomics. Their lack of training in these areas prevents	It is recommended that the new permanent Plant Manager, the Operations Superintendent, and the EHS Manager receive general background training in the areas of human factors engineering and ergonomics. Short courses on	Low

#	Finding	Recommendation	Priority
	them from being able to adequately train plant personnel in these areas and prevents them from being sufficiently aware of human factors and ergonomic safety issues throughout the facility.	these topics are generally offered by (1) human factors and ergonomics consultants, (2) local universities, and (3) workshop presenters at human factors and ergonomics conferences (e.g., National Ergonomics Conference).	
2.2.3	Human factors and human performance issues are not adequately covered as part of training for plant personnel. The majority of plant personnel have had no exposure to concepts related to causes of human error, human performance risk factors for injury, etc.	It is recommended that a segment on human factors and human performance be added to the safety training curriculum. Additionally, the safety walkthrough that accompanies safety training sessions should also incorporate the identification of human factors and human performance risk factors.	Low
2.2.4	Control room alarms lack sufficient discriminability and are not sufficiently prioritized. For instance, when Operators are outside the control room and hear an alarm it is generally not possible to identify its source without returning to the control room or communicating with someone in the control room. Additionally, once alarms are acknowledged they will not repeatedly sound even if Operators fail to address the underlying condition. This could cause an Operator to forget about an alarm condition should he/she become preoccupied with another existing situation.	As part of the CTA recommended in (2.2.1) above, an analysis of the current design and operation of control room alarms should be conducted. This analysis should address current problems with alarm discriminability and prioritization, and should result in a set of guidelines and recommendations for an improved, reconfigured alarm system.	High
2.2.5	The current approach to training relies heavily on classroom-style instruction and testing, as well as on-the-job training. However, simulations and drills are not used to full advantage as training methods. While minimal use of these techniques has recently been introduced in the facility, they are not sufficiently employed. Additionally, there appears to be a lack of awareness among managers of modern training technologies such as desktop computer-based simulation tools.	Simulations and drills should become a more central element of GCRW's approach to safety training. Drills should focus on emergency procedures and emergency response, enabling personnel to practice and refine essential skills and behaviors needed to adequately cope with emergency conditions. Drills often have the added benefit of illuminating shortcomings in current emergency procedures so that better procedures can then be adopted. Simulations (e.g., desktop, PC-based simulations) should be used to provide Operators with the opportunity to familiarize themselves with plant process characteristics as they vary due to the presence of various upset and non-routine conditions.	Medium
2.2.6	There is insufficient emphasis placed on reward and positive reinforcement as a means of increasing good safety behaviors and practices. While discipline for unsafe practices appears to be well enforced, there is no formal arrangement for plant personnel to be rewarded (e.g., with letters of commendation, awards, informal positive statements from management, etc.)	General Chemical should investigate methods for increasing the use of reward and positive reinforcement to promote effective safety behaviors among plant personnel. The reward does not necessarily need to be money (General Chemical already includes a monetary reward as part of its 3-P program), but could involve letters of recognition, "Safe Employee of the Month/Quarter/Year" awards, and even informal "attaboys" from plant	Medium

#	Finding	Recommendation	Priority
	for good safety decisions and practices.	management in the presence of other plant personnel.	
2.2.7	There is little or no "team concept" among plant Operators, perhaps primarily due to the fact that the current shift structure prevents the formation of cohesive teams (i.e., Operators do not work with the same individuals on a consistent basis). This prevents Operators from forming the type of teamwork bonds that promote a sense of caring and awareness of other team members' strengths, weaknesses, habits, etc.	As part of the next union collective bargaining effort, GCRW should seek a change in the current shift structure to enable the same people to work together on the same team more consistently. See also 2.3.6	High
		Safety Culture	
2.3.1	Managers and workers at GCRW do not have a clear vision for the facility health and safety program. Safety slogans and safety messages do not provide a persuasive and compelling vision of the safety objectives for the plant, and there is no consistent communication of a safety vision.	It is recommended that GCRW develop a new vision for the safety program and a strategy for attaining the vision. This visioning process should incorporate the following elements: • Establish a team to guide the initiative. The team should include: senior managers who are fully committed to implementing the vision with sufficient authority and influence to provide resources and develop policy; plant management; first line supervisors; representatives from GCRW Operations and Maintenance; and represented labor. All team members should be recognized as leaders, having respect from their colleagues and workers for their ability to successfully implement new ideas. • Develop a compelling safety vision statement, and a concise strategy for how the vision will be accomplished. The guiding team should consider existing programs within General Chemical and their potential for contributing towards the new vision, but the team should also have the freedom to develop completely new ideas that will likely appeal to the GCRW workers, and provide the inspiration for gaining broad-based support. The strategy should lay out a logic for achieving the vision, including preliminary plans, budgets and schedules. Offsite meetings could help to provide an environment conducive to this type of creative process. • Establish a framework for communicating the vision with all employees at GCRW. This framework needs to be simple, effective, and include strategies for addressing the resistance to change that is likely to be encountered. The new vision and strategy should address the risk-taking behaviors and "obstacles to safety" that are evident in the existing culture. Through the application of a clear vision statement and	High

#	Finding	Recommendation	Priority
		consistent communication of the values inherent in the vision, the new initiative should help the organization address these barriers, and to address the obstacles evident in the existing culture. This may be achieved using a wide range of communications approaches (persuasive communication, role modeling, expectancy, coercion, rewards, structural rearrangement, etc.). These "methods of influence" can be very effective in dealing with the "multiple realities" that exist in any organization, and recognizing that every person has a valid opinion that needs to be considered. • Identify needs for training and ways to empower the work force to increase performance standards and to allow them to actively participate in the new safety initiatives. During the change process, there is likely to be a need for training to provide workers with new skills and attitudes for assuming the responsibilities and behaviors that are called for in the new vision. Of particular importance with respect to GCRW is the need for workers to develop team skills, team goals and a sense of purpose as one unit. Managers and supervisors would likely benefit from leadership training and skills development. • Establish a sense of urgency by emphasizing the critical importance of this initiative for moving beyond the current realm of problem solving and "fire fighting," and establishing self-directed teams responsible for implementing broad-based safety programs. • Review human resource and financial systems and to make sure they are fully aligned with the new vision. This should involve goal setting for individuals and groups; review and revision of the performance appraisals, job descriptions, and how staff are being hired; review of how resources are allocated and what reward systems are in place. The required skill sets for new hires should be considered to be sure that attitude and leadership capabilities are considered as well as technical skills. As the safety initiative progresses, the intent is to establish a culture that is fully committed to safety at every level of the organization, with every participant working towards the same vision of safety. As peoples' level of trust grows over time, so also will the level of participation. This approach should allow employees to identify better ways for achieving superior safety performance.	
2.3.2	There is little awareness among workers of the full scope of	General Chemical should promote greater awareness of its 3-P safety	Medium

#	Finding	Recommendation	Priority
	the General Chemical 3P Program, and the importance of 3P participation has not been effectively conveyed to workers. Operators and maintenance personnel are aware that they can receive a $50 quarterly bonus if no recordable injuries occur during that time period, but are almost unanimously unaware of any other features of the program.	program. This can be accomplished by disseminating printed material to plant personnel describing the attributes of the program, and/or by featuring the program as a key element of monthly safety training sessions. See also See 2.3.1.	
2.3.3	Management has not demonstrated to workers a convincing ability to act quickly over health and safety concerns and suggestions.	See 2.3.1	High
2.3.4	Workers perceive that some supervisors and managers appear to be uncertain as to what is needed to ensure safety and health.	See 2.3.1	High
2.3.5	Some managers perceive that supervisors may not be devoting sufficient effort to health and safety, and some workers think supervisors may not be good at detecting unsafe behaviors.	See 2.3.1	High
2.3.6	Among the workers, there appeared to be an attitude of "resigned acceptance" as to the level of safety performance that is possible at GCRW. Workmates' influence and peer pressure within the Operations Department do not appear to be conducive to team building and working as a group towards a shared vision of safety. The influence of fellow workers (including first line supervision) in the Maintenance Department appears to foster an attitude in which workers are reluctant to accept much responsibility for raising safety performance standards. The changes at management level and the limited expenditures on preventive maintenance at GCRW in the past have likely contributed to this attitude among the workers. (Note: the Safety Evaluation team was made aware of a program that is now being implemented to enhance preventative maintenance at this plant.)	Consider giving workers training to help them learn the new behaviors, skills and attitudes needed to increase their personal effectiveness. Conduct leadership training for workers and line supervisors. See also 2.3.1 and 2.2.7	High

#	Finding	Recommendation	Priority
2.3.7	Safety metrics have not been developed and adopted for leading indicators of safety performance. The lagging indicators used by management do not convey information to reflect recent progress being made with regard to the safety program.	Develop a set of leading indicators for safety metrics to complement the lagging indicators currently used. Examples of leading metrics include safety and training activity hours per person; numbers of audits/inspections, safety meetings, training courses, tool-box meetings, safety suggestions, near misses reported, etc. Offsite injuries (of workers) are also used by some companies as an indicator of cultural attitudes to safety. Targets should be set for all of these metrics, and progress should be measured against the targets. At-risk behaviors can also be measured and tracked against targets.	High
2.3.8	Safety performance metrics and safety performance progress are not shared widely with hourly workers.	Develop a list of leading and lagging safety performance indicators that will be shared with employees on a regular basis (e.g., monthly). The statistics should be presented in a suitable format (e.g. using charts and graphs) to present trends and progress, and distributed to all GCRW employees. See also 2.3.7	High
2.3.9	Some workers appeared to be apprehensive about making mistakes for fear of being disciplined by management or ostracized by their fellow workers.	Develop a disciplinary policy and include this as an item for negotiation in the next union contract renewal. The policy development should have worker input, and all workers should be given an orientation of the new policy to make it clear when and how discipline will be used depending on the severity of the misdemeanor. Ensure that this procedure is coordinated with the existing grievance procedure in the union contract. See also 2.2.6.	Medium
2.3.10	Communication among the Operators as a group is probably less than optimal because of the shift structure being used at the plant. Also, it was commented that communications at shift change in the recent past have been brief, with only limited exchange of information regarding the status of plant operations.	See 2.3.1 and 2.2.7	High
2.3.11	Plant managers receive no formal training on community relations and public outreach to help with the communication of safety and environmental issues.	Develop a training program to provide the GCRW Plant Manager (and other key managers, as appropriate) with the skills necessary for effective communication on environmental and safety issues with outside parties, including the public.	Medium
2.3.12	Participation in the safety program has not been fully embraced by workers, so the potential from employee involvement is not being fully realized.	See 2.3.1	High
2.3.13	Workers are not always involved in developing and reviewing	See 2.3.1 and 2.3.21	High

#	Finding	Recommendation	Priority
	safety rules that affect their work, especially with respect to personal protective equipment, clothing, and work permits.		
2.3.14	Some workers perceive that the safety and health rules may be too extensive or prohibitive for the real risks involved.	See 2.3.1 and 2.3.21	
2.3.15	There is no performance evaluation process for hourly workers that could be used to require and recognize good safety performance. Personal performance appraisals and associated safety evaluations for salaried people are sometimes delayed beyond the anniversary date.	Consider developing an incentive-based system for providing hourly workers with rewards for positive contributions to safety (see Finding #2.2.6). For each salaried employee, ensure that the evaluation of safety performance (including a session to provide feedback to the employee) is conducted on the anniversary date to provide feedback on safety issues in a timely manner.	Low
2.3.16	The regulatory safety and health training program is not revised and upgraded on a routine basis to ensure it maintains participants' interest. The training is perceived by some to be boring, repetitive, and time-consuming. As such the training may not be very effective.	Conduct a training effectiveness review of the regulatory Health and Safety training courses using a team of workers and managers, and consider alternative approaches for providing this training, including "e-training" options (provided by a third party or through the Company intranet). Using e-training has the potential of increasing interest level. It would allow individuals to schedule training and to proceed with the training at their own pace. It also offers potential cost savings. (Note. This method may not be suitable for all training courses, especially if site-specific or Company-specific requirements apply. Also, it does not allow for employees to ask questions directly to an instructor.)	Low
2.3.17	The need for cross-training Operators in the procedures for operating other areas of the plant has been recognized by workers and management, but there has been no commitment to implement such a cross-training program.	GCRW management should develop a plan for Operator cross-training and review the plan with the union during the next round of contract negotiations. As soon as a mutually acceptable plan has been developed, it should be implemented within the Operations Department.	Medium
2.3.18	Workers appear to have a parochial view of operating and maintenance practices. They have very limited exposure to operating and maintenance practices at other similar facilities within General Chemical and/or within the local area.	GCRW should consider establishing relationships with other facilities within General Chemical and/or with companies in the local area that would allow GCRW plant workers to visit other plants to gain a perspective of how others conduct operations and maintenance. This may be offered as a rotation (e.g., one person per month) or as an incentive program based on individual contributions to the safety program. As workers identify best practices at other facilities, the best practices could be offered for consideration at GCRW.	Low
2.3.19	GCRW job descriptions do not explicitly address safety	See 2.3.1	High

#	Finding	Recommendation	Priority
	requirements.		
2.3.20	Working safely is not yet internalized by the entire work force. There appears to be a limited understanding of the risks involved, and managers indicated that personal protective equipment is not always worn by workers, as required.	See 2.3.1 and 2.3.21	High
2.3.21	Worker's concerns about wearing eye goggles have not been adequately addressed. Workers argue that wearing eye goggles could introduce health and safety risks under certain circumstances.	Conduct a round of safety meetings at GCRW specifically to address workers' concerns with Personal Protective Equipment (PPE) such as goggles and clothing. Following these meetings, revise the PPE policy, as necessary, to address legitimate concerns, and develop consensus among workers that the policy will be adhered to.	High
2.3.22	It appears that some supervisors may take risks to get the job done, and risk-taking behaviors may be permitted or overlooked by some levels of management. Some workers indicated they might be willing to take some risks and break safety rules to rescue a man down.	Conduct a meeting for all supervisors to emphasize the importance of strict adherence to safety and health policies, procedures, rules and instructions. Supervisors' ability to comply with this requirement should be included in the supervisors' job descriptions and as a safety performance objective in the annual performance reviews. Also see 2.3.24	High
2.3.23	The existing shift structure may result in Operators' taking undue risks because of an unwillingness to request help when it is needed. The short duration of shift changes may also present significant risk in some situations.	GCRW managers and supervisors should review the current policy requirements for shift change to verify the policies provide adequate coverage for the likely risks, especially when the plant is going through a startup. Also see 2.2.7 and 2.3.17.	Medium
2.3.24	Some workers and supervisors consider the safety rules may not be practical for the "real" risks at this plant. They consider there may be too many rules, and some rules are difficult to follow.	Use the Health and Safety Committee or a similar forum to conduct a review of the applicable safety rules and identify why workers may perceive they are not practical. For safety rules that are deemed to be overly restrictive, review the rules and the associated training to determine if there are ways to help workers comply with the rule requirements, and minimize the time needed to implement the rules.	Low
2.3.25	At times, there may not be an adequate number of Operators at the plant to work safely. Some examples of times and work activities that could introduce risk with insufficient people are: (1) during upset conditions; (2) during plant start-up; and (3) when the Operations Department has unfilled positions.	GCRW plant management should ensure that all open Operator positions are filled as quickly as possible with qualified individuals in order to avoid experiencing undue risks because of staff shortages. Also see 2.3.23	Low
2.3.26	Physical conditions at the plant may restrict peoples' ability to	GCRW is implementing improvements to the mechanical integrity program	High

#	Finding	Recommendation	Priority
	work safely. (This issue applies more to the limited expenditures in the past on preventive maintenance rather than to human factors issues involved in equipment operation.)	that should address the underlying issues associated with this finding.	
2.3.27	Workers are not trained to identify and report near misses, and there is a lack of awareness of what a near miss is. There are no incentives for reporting near misses. (See also 2.1.10)	Consider implementing a "near-miss campaign" that focuses attention on identifying near misses over a limited period of time. The campaign could include initial orientation for workers to help them identify near misses, a competitive element (e.g., reporting by groups, shifts, facility demographics, etc.), and a rewards component. After the campaign, analysis of the near misses could be used to highlight how the near misses helped to eliminate risks in the work place. The intent of the campaign would be to raise awareness of near misses, and help to increase the motivation of all workers to report near misses. Consider a follow-up program that provides incentives for reporting near misses on a routine basis.	High
2.3.28	There is a sense among many of the workers that accident investigations are used to identify who is to blame, rather than to address the underlying root causes.	Management should consider promoting a moratorium on near misses, making it clear to workers that there would be no retribution or discipline for workers who report near misses. Also see 2.3.1 and 2.3.27	Medium
2.3.29	Many of the workers, supervisors and managers are concerned over job security. The recent bankruptcy announcement by General Chemical could have an adverse impact on employee morale and motivation for working safely.	GCRW management should communicate routine updates to all employees on the financial status of the Company and the likely outcome as it pertains to GCRW. These communications should continue regularly until the General Chemical bankruptcy proceedings are resolved.	High

4.0 Conclusions

To achieve a high performance safety program, there needs to be a "culture of safety," and a commitment from upper management, with demonstrated and consistent leadership. Culture cuts across the management system elements, and without a positive safety culture, the management systems and the success of the program are vulnerable. There should be a formal management system, fully implemented and funded, and there should be operational discipline on the part of all employees to make it happen.

The Safety Evaluation Team observed many strengths at the GCRW facility. There appears to be a commitment from senior management, and many of the required systems are becoming more formalized. There also appears to be a willingness to implement the necessary discipline to make the safety program work. A number of safety management systems deficiencies were identified, but the findings are not unlike those found in other safety management systems audits for similar facilities. In general, the safety management systems were well documented and were being implemented.

A number of human factors issues were identified, notably with respect to the design of control room displays and alarm systems, the lack of familiarity among key plant personnel of human factors and ergonomic safety issues, and the insufficient use of drills and simulations for training. However, none of these issues were considered to be so serious that they warrant immediate, extreme measures.

Most of the immediate limitations appear to be attributable to the plant culture, which has built over time in response to fairly austere and authoritarian practices that were used by General Chemical in the recent past. At present there is a lack of vision for the safety program, and the evaluation team noted the need for improving teamwork and harnessing the full capabilities of the employees. Also noted were the need for improving attitudes and awareness to near-miss reporting, and to maintain a consistent and coherent management team, given the management changes that have taken place in recent years.

Recommendations have been included to address these important issues and the other findings included in this report. For these recommendations to be effective in improving safety performance, it will take a genuine commitment from all parties concerned. Changing a plant culture can be a slow process. It requires intelligent application of a "transformation process," and a strict adherence over time to implementing the necessary change strategies. There is often a great deal of inertia to prevent change and keep things the way they are. Only after years of constant reinforcement and clear commitment to the new vision can the workforce institutionalize the new programs. There is a need for ongoing commitment and determination by management to maintain the operational discipline necessary to "steer" the organization in line with the safety vision.

The Safety Evaluation Report does not provide a timetable for implementation, nor does it include specific details of what the implementation process should entail. GCRW will be required to develop an action plan that addresses how they will implement each of the

findings/recommendations. As part of this action plan, General Chemical will establish a timetable for implementation. However, the report does provide a ranking of the findings/recommendations, which serves to provide General Chemical with an indication of which findings/recommendations the evaluation team thinks are of high, medium, and low priority. General Chemical must develop the action plan based on their interpretation of how best to accomplish the desired change, and working within the constraints of available resources, workload at the facility, and facility procedures.

Some recommendations can be closed out quickly, but the ones needed to achieve lasting change will require ongoing attention and commitment. Over time, the ongoing implementation of recommendations applicable to safety culture and human factors will lead to a progressive integration of safety-related issues into the decision making processes and the day-to-day work practices.

Progress and improvement in these areas are hard to measure, but repeating the safety culture survey at 6-month or yearly intervals could provide some measure of progress. Contra Costa County and the City of Richmond will track the progress being made on implementing the findings and recommendations as part of their regular audits and inspections at the facility.

Appendix A Safety Evaluation Work Plan

Final Work Plan for the General Chemical Richmond Works Facility Safety Evaluation

Submitted to:

Contra Costa County Health Services
Hazardous Materials Program
4333 Pacheco Blvd.
Martinez, CA 94553

October 7, 2002

MRS
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Appendix A Scope of Work (prepared by Contra Costa County Health Care Services and the Oversite Committee

Appendix B Safety Management Systems Assessment Protocol

Appendix C Human Factors Assessment Checklist

1.0 Introduction

Because of incidents that have occurred at the General Chemical - Richmond Works (GCRW), the communities surrounding the facility, the Richmond City Council, the Contra Costa Board of Supervisors, and the County Health Services Department (CCHS) are concerned about safety at the facility.

In response to the most recent incidents, the Richmond City Council together with CCHS is arranging for a third party safety evaluation to be performed on this facility. This draft work plan summarizes the approach that the MRS team will take to conduct the safety evaluation. The remainder of the work plan is broken down into six major sections that cover (1) scope and objectives of the evaluation, (2) the approach that will be used to conduct the evaluation, (3) the schedule, (4) staffing, (5) the communications plan, which addresses interaction with the public, and (6) recordkeeping. The work plan also includes a number of Appendices that provide additional information on overall scope and approach to the safety evaluation.

The draft will be revised and finalized prior to the onsite evaluation to incorporate input from the Safety Evaluation Oversight Committee and the public.

This document presents the work plan that will be used to conduct the safety evaluation of the GCRW facility. The remainder of the work plan is broken down into six major sections that cover (1) scope and objectives of the evaluation, (2) the approach that will be used to conduct the evaluation, (3) the schedule, (4) staffing, (5) the communications plan, which addresses interaction with the public, and (6) recordkeeping. The work plan also includes a number of Appendices that provide additional information on overall scope and approach to the safety evaluation.

2.0 Scope and Objectives

The scope of work for this assignment, developed by CCHS and the Oversight Committee, is included with this work plan in Appendix A. The purpose of the safety evaluation is to look at safety management systems, human factors, and safety culture at the GCRW facility. The main objectives of this safety evaluation are:

- To evaluate safety management systems, human factors and safety culture.
- To identify safety concerns at the plant and to develop a list of findings.
- To develop and prioritize findings and recommendations in a way that allows for sound decision-making by City and County agencies.
- To conduct an evaluation that is trusted and considered credible by the public and other key stakeholders.

The evaluation is expected to receive intense scrutiny from a wide range of stakeholders including the Richmond City Council, Contra Costa County Board of Supervisors, County staff; the Hazardous Materials Commission; GCRW management, workers and union representatives;

the public; and environmental organizations. It is imperative that the evaluation be conducted in an impartial manner to ensure that all stakeholders' needs and concerns are represented.

3.0 Approach

There will be four main components in our approach to this evaluation:

- Safety Management Systems,
- Human Factors,
- Safety Culture, and
- Public Participation.

The first three components will be addressed primarily through the administration of a Safety Climate Survey, and an onsite evaluation using a team of safety professionals working at the plant over a period of about one week. The public participation component will occur in parallel with the onsite evaluation, and will continue until a final evaluation report is delivered to the Richmond City Council and the Contra Costa County Board of Supervisors.

3.1 Safety Climate Survey

We will conduct a Safety Climate Survey prior to the onsite evaluation. We will distribute the survey to all employees at the GCRW plant, to selected contractors, and to those managers at the corporate level with responsibilities for safety at the GCRW plant. The survey will be used to obtain an initial perspective of people's views and perceptions on some key aspects of health and safety in the GCRW organization as it exists today. The survey will include questions based on the Health and Safety Climate Survey Tool developed by the United Kingdom (UK) Health and Safety Executive (HSE)[1].

The survey will be administered in a way that protects the anonymity of the respondents and the confidentiality of the information provided. We will provide a stamped, addressed envelope with each form to allow the completed form to be sent directly to us (an independent consultant) in a sealed envelope. We will include a cover letter which emphasizes the importance of the survey, and we will coordinate the survey roll-out with GCRW management and the Oversight Committee.

The Safety Climate Survey will offer several advantages for the safety evaluation:

- The survey will provide a convenient way of soliciting input from a wider range of people (onsite and offsite) than could be achieved with interviews and focus groups alone.

[1] Available from Loughborough University Internet site, www.lboro.ac.uk/departments/bs/JIP/index.htm

- With the small number of employees at this plant, workers may be concerned about the evaluation team's ability to preserve anonymity with the interview process. The anonymity provided by the survey may help to alleviate this concern during the initial phase of the evaluation.
- The evaluation team will have an opportunity to review safety concerns and perceptions identified in the survey prior to the onsite work. This review will help the team to plan more effectively, and target key issues.
- The survey results will provide a tangible baseline which could be used as a benchmark for evaluating progress on safety issues during any subsequent assessments.

3.2 Onsite Evaluation Activities

The onsite evaluation is an important follow-up to the Safety Climate Survey to allow for thorough inquiry of safety issues. For the onsite work, we will use many of the same methods used in a traditional safety audit combined with other refined data-gathering techniques for investigating human factors and safety culture.

We will initiate our onsite activities with a brief opening meeting to be held with County representatives and key facility personnel. The purpose of this meeting is to review the objectives of the evaluation, to present an overview of the steps that we will be taking, and to explain how each step will be accomplished. We will request a description of plant operations and we will identify key facility contacts and their area(s) of responsibility. Following the opening meeting, we will conduct a short tour of the facility.

During the period of the evaluation, we will conduct interviews, hold focus groups and review documents to gain an understanding of safety issues and how they are managed. Physical inspections will also be conducted, especially to evaluate human factors issues. Verification testing will be conducted to confirm the functioning of the management systems. However, this evaluation is not intended to provide a detailed status of safety compliance.

We will hold daily debriefing sessions to provide the CCHS project manager and GCRW management with a summary of our daily activities and the issues that were identified. Findings will be developed and presented at the daily debriefing sessions as the evaluation proceeds. The meetings will provide GCRW personnel with an opportunity to present additional information, if available, and to ask questions about the findings. At the conclusion of the onsite activities, a close-out meeting will be held to verbally present the team's preliminary findings and observations. This onsite reporting process provides an opportunity for facility personnel and the CCHS project manager to understand the basis and underlying facts on which our findings and observations are formed.

The onsite interviews and observations will help us to substantiate or refute the issues initially raised in the Safety Climate Survey, to explore issues in more depth, and to identify other important issues. Interview technique is critical for exacting the right information from workers. Our team will use our experience with interviews and focus groups to establish a rapport with the workers, which will help them to be at ease and open with their comments.

3.3 Safety Management Systems

Our basic approach for evaluating safety management systems is presented below.

Management System Element	Key Questions
Assessing	Do they know what they need to know?"
Planning	"If they do what they say they do, will that be sufficient?"
Implementing	"Are they doing what they say they're doing, and is it effective?"
Reviewing	"Is the 'program' reviewed and its effectiveness improved over time?"

We will use a tailored protocol to conduct our evaluation of the following safety management systems:

- operating procedures,
- training,
- management of change,
- pre-start-up safety reviews,
- incident investigation,
- hot work, contractors,
- emergency response program,
- compliance audits, employee participation, and
- process hazard analysis.

For this component of the evaluation, we will focus on the effectiveness of program implementation, and we will explore our inquiry on issues that indicate potential failures of the management systems due to safety culture and/or human factors issues. We will review the reports from other audits conducted by GCRW and CCHS (as available), and we will explore issues associated with incidents, near misses, and any "latent conditions" review conduced as part of the Industrial Safety Ordinance compliance. This approach should help to avoid duplication of effort, but our review will be sufficiently rigorous to ensure that the audit findings are thoroughly defensible. A draft of our protocol for conducting the safety management systems evaluation is included in Appendix B. This protocol has been developed in a way that allows us to obtain a sound evaluation of the systems, without having to conduct a complete compliance audit.

3.4 Human Factors

For human factors, the goal of this assignment is to perform sufficient investigation and research on the human factors aspects of safety practices at the GCRW facility to provide adequate answers to the questions listed in Attachment A of the Statement of Scope provided by Contra Costa County Health Services. (See Appendix A to this work plan.) Other related human factors issues that arise during the course of the evaluation will also be examined if deemed appropriate by the team.

The specific methods to be used in performing the investigation and research are as follows:

1. Interviews with individuals from each significant level of management, including workers, shift supervisors, senior and middle management, safety management, administrative management, and contractors.
2. Focus group discussions comprised of individuals from the levels of management listed above.
3. Review of all relevant documentation including training materials, checklists, safety procedures, incident reports and documentation procedures etc.
4. Facility tours with individuals from each of the levels of management listed above.

The initial goal will be to obtain a general sense of the level of human factors awareness and concern at the plant. In doing so, the questions provided in Attachment A (with appropriate follow-on questions) will be addressed through the interview process and through one or two focus group sessions. In addition to the interviews, the human factors evaluation will examine the following:

- Documentation of operating procedures and safety practices,
- Training procedures and training program materials, and
- Incident reporting procedures.

Tours of the work areas will be conducted separately with various workers (including contractors if possible) in order to gain their perspective and/or awareness of human factors hazards and issues in the workplace.

A draft of the human factors protocol is included in Appendix C.

3.5 Safety Culture

Safety culture is the product of the individual and group values, attitudes, competencies, and patterns of behaviour that determine the commitment to and the style and proficiency of an organization's health and safety programs. Safety culture is, *"The way we do things around here".* Workers interpret safety culture through their work environment and individual experiences.

An organizational culture that supports safety is critical to the prevention of injuries and illness for employees, the economic viability of the organization, and preventing accidents that may affect the community. The purpose of this element is to evaluate the health of the existing organizational culture, and to identify gaps and "unwritten rules" that discourage safe behaviors and practices.

Critical aspects of the management practices and programs that influence the behavior of workers include:

- What is measured and rewarded
- How persuasion and coercion are exercised
- How leaders model behavior and telegraph expectations
- How workers are trained and supported
- How accidents and near misses causes are reported, investigated and resolved
- Where accountability for safety performance really resides

To evaluate safety culture onsite, we will use the questions included in the Safety Climate Survey. These questions and others will be used to discover the perceptions of employees and others directly involved in day to day operations. These perceptions are investigated through a defined interviewing technique on a sampling of several categories of employees. These categories include:

- Senior management
- Middle management
- Supervisors
- Workers
- Safety, health and environmental professionals
- Key contractor personnel (Managers, supervisors and workers)

Those to be interviewed will be selected based on a representative sampling of a cross section of employees within each category. These employees would represent senior management (e.g., most senior site manager, financial, production, etc.) staff positions (e.g., purchasing, legal, human resources, shipping, receiving, safety, etc.), supervision (production, maintenance, etc.) and workers. A sampling of contractors and others indirectly employed on a routine basis is important to determine their perceptions of the safety programs at GCRW.

We will aim to interview a high percentage of the employees during the one week we are onsite. These interviews would normally require approximately 30-45 minutes of time for each interview. Group interviews may be completed where feasible. All interviews would be held on a strictly confidential basis. Direct quotations may be taken for later use in our reports without identifying the contributor of the quotation. It is essential that we are trusted by those who we

interview, and this trust will be seriously compromised if we are unable to assure them that interviews are strictly confidential.

The interview process would consist of six parts. These parts are as follows:

- An introduction to include the confidentiality of the interview and the purpose for conducting the interview.
- A discussion of how the person interviewed perceives the current state of safety at the GCRW plant based on the safety culture protocol questions.
- A review of what they perceive their role to be in terms of the safety program.
- A review of why they think accidents, incidents and near misses occur.
- An open-ended opportunity to contribute views related to safety.
- A closing and opportunity to contribute later.

Within each part of the interview process, structured questions will be asked without implying any strong bias or direction. Direct quotations of significance will be recorded. These quotations will later be used to develop and support conclusions regarding the "unwritten rules" and the unwanted effects of such rules (e.g., it is stated that any worker can shut down an unsafe operation without reprimand; however, the unwritten rule is that the worker would be rigorously interrogated if their action resulted in lost production).

The results of the safety culture interviews will be combined with information gathered from the other aspects of the evaluation (i.e., review of the safety management system and human factors evaluation) to develop findings and to develop recommendations for improvement.

3.6 Evaluation Findings and Reports

While the onsite evaluation consists of three discrete components, as discussed above, there is considerable overlap among them. The evaluation team will work closely together to coordinate observations and findings. Using the information gathered through the survey and onsite evaluation process, we will identify weaknesses and deficiencies in the management system, and tie these weaknesses to human factors and cultural issues where appropriate. Additionally, the safety culture investigation process will be used to address the following issues:

- Identify the ***desired*** safety-related behaviors at each level of the organization
- Identify the ***current*** behaviors at each level
- Identify possible ways to change behaviors to close the gap
- Develop findings that support an action plan for making the shift

Following the onsite work, we will prepare a draft evaluation report. The report will provide a concisely description of the approach used to conduct the evaluation and a summary of the safety issues identified. The report will also include a detailed list of evaluation findings, and a set of recommendations for correcting the deficiencies. The findings will be ranked on the basis of risk

(high, medium, low), and the recommendations will be prioritized accordingly. These findings and recommendations will be based on our extensive experience with similar assessments at other facilities. However, the evaluation will not provide a formal benchmarking of safety at GCRW against other similar facilities.

The table of contents for the draft initial safety evaluation report will include the following:

- Executive Summary
- Introduction (objectives, background, report format)
- Evaluation Findings (Safety management Systems, Human Factors, Safety Culture)
- Recommendations
- Conclusions
- Appendices (Scope of Work, Written Comments, Glossary)

The final report for the initial evaluation will include the same sections as the draft with additional appendices for written comments on the draft report and comments and responses from the public meetings.

3.7 Public Participation

We will coordinate with the CCHS Project Manager on the public participation process for this evaluation. The coordination process will address the schedule for public meetings, the communication of comments to and from the public (written and spoken), and the way in which the public input is incorporated into the evaluation process.

The first public meeting will be held prior to the onsite evaluation, during which time the project team will present an overview of the evaluation process and the methodology to be used. The meeting will provide an opportunity to receive public comment on the evaluation process. The next public meetings will be held after the draft report is issued. The final evaluation report will be presented in separate meetings to the Richmond City Council and the County Board of Supervisors.

Dates for the public meetings are included in the schedule presented in the following section.

4.0 Schedule

The following schedule will apply to the evaluation:

Milestone	Dates
Submission of Draft Work Plan to County	Friday, August 30,2002
County Comments Back to MRS	Tuesday, September 10,2002
Submission of Draft Work Plan to Public	Wednesday, September 18, 2002
Pre-Assessment Site Visit	Tuesday, October 1, 2002
Public Workshop on Draft Work Plan	Tuesday, October 1, 2002

Milestone	Dates
Submit Final Work Plan	Monday, October 7, 2002
Submit Culture Survey	Thursday, September 5,2002
Culture Survey Response Period	Friday, September 6,2002 to Thursday, September 19, 2002
On-Site Evaluation	Monday October 7, 2002 to Friday, October 11, 2002
Submit Draft Report to County	Friday, October 25, 2002
County Comments Back to MRS	Friday, November 8, 2002
Submit Draft Report to Public	Friday, November 15, 2002
30-Day Public Comment Period	Monday, November 18, 2002 to Monday, December 16, 2002
Public Hearing on Draft Report	Wednesday, December 4, 2002
Submit Final Report to County	Friday, December 20, 2002
County Comments Back to MRS	Tuesday, December 31, 2003
Submit Final Report to Public	Monday, January 6, 2003

5.0 Staffing

The consultant team for this project includes Mr. John F. Peirson, Jr. (MRS, Inc.), Dr. J. Ivor John (Ryerson, Master and Associates, Inc.), and Dr. Laurence Hettinger (Nashoba Human Factors Associates, Inc.). Mr. Peirson of MRS will be the project manager. All three are former employees of Arthur D. Little Inc., and all three were involved in the Safety Evaluation of the Tosco Avon/Ultramar Golden Eagle refinery.

The team has a good understanding of the Contra Costa regulatory framework for safety and risk management at these types of facilities, and is familiar with the political and social issues that provide the community context for the GCRW project.

Resumes for all persons working on this project have been provided to the CCHS.

6.0 Communications Plan

The project team will meet daily to communicate issues and report on progress during the evaluation. Likewise, the team will hold a short debriefing with GCRW staff and CCHS on a daily basis to report on progress. All other communications with CCHS and the Oversight Committee will be through the MRS project manager.

The project team will not disclose any observations or findings to any party without the express permission from CCHS. Further, the team will not give any interviews to the media unless requested by CCHS.

Communications with the community will be channeled through CCHS and the public participation process outlined above. Project staff will be available at all public meetings to explain our approach, to convey our findings and recommendations, and to answer questions.

7.0 Recordkeeping

The evaluation team will use workbooks to make notes and record any observations and findings. The workbooks will be made available to CCHS at the end of the evaluation, if requested. The evaluation team will also keep private records of all documents reviewed and all persons interviewed.

Any public comments relevant to the evaluation will be recorded by CCHS or their designee. A draft report will be prepared at the end of the onsite evaluation and released for public review. Any comments on the draft report will be addressed and incorporated into the final report.

Appendix A Scope of Work (prepared by Contra Costa County Health Care Services and the Oversite Committee

General Chemical - Richmond Works
Management Systems and Safety Evaluation
Statement of Scope

Objective

The objectives of this Management Systems for Process Safety and Safety Evaluation are to complete a thorough evaluation of the current management practices and safety culture at the General Chemical - Richmond Works plant.

Background

Because of incidents that have occurred at the General Chemical - Richmond Works plant, communities adjacent to the plant, the Richmond City Council, the Contra Costa County Board of Supervisors, and Health Services are concerned about the safe operation of the plant. Among these incidents are a July 26, 1993 release of oleum, May 1, 2001 release of sulfur dioxide, and a November 29, 2001 release of sulfur trioxide and sulfur dioxide.

In response to the two 2001 incidents, the Richmond City Council together with Contra Costa Health Services is arranging for a third-party evaluation to be performed on this plant. This evaluation is not an investigation of the incidents, but an overall review of the Management Systems that are in place at the plant for process safety and a Safety Evaluation of the plant.

Requirements

The Management Systems and Safety Evaluation will evaluate the plant's human factors and systems concerning the management practices and safety culture at the plant.

Scope of Work

The evaluation will be conducted at the General Chemical - Richmond Works plant.

1 Evaluate how the plant's management safety systems, safety culture, and human factors are incorporated in the training of operating, maintenance, other staff, management personnel, and contractors. Address the management systems for: Operating Procedures, Training, Management of Change, Pre Start-Up Safety Reviews, Incident Investigation, Hot Work, Contractors, Emergency Response Program, Compliance Audits, Employee Participation, and Process Hazard Analysis. This evaluation should include, but not be limited by the list in Appendix A "Self-evaluation Questionnaire for Managers Considering Ways To Improve Human Performance[2]Policy Issues" and the items listed below:

[2] This a modified list from the Chemical Manufactures Association's (CMA) book titled A Manager's Guide to Reducing Human Errors Improving Human Performance in the Chemical Industry

a How is management intent, as expressed in internal policies, carried out at field level?

b How are procedures developed? What does General Chemical – Richmond Works plant do when work falls outside of the written procedures?

c How is bottom-up input provided for, and on what range of subject matter? How are disagreements resolved?

d What systems are in place to ensure that management policies and/or procedures are carried out? Do these systems include audits?

e What accountability exists at each level of the organization? Who is accountable for what and to whom?

2 Public Participation – the evaluation will include public participation. A public meeting will be held prior to the beginning of the onsite evaluation, in which the contractor will explain the plan on how the contractor will perform the evaluation. A second meeting will be held after the draft report is issued to explain the results of the evaluation. The meetings will be an opportunity for the contractor to listen to the public's concerns and consider incorporating them in the evaluation. The contractor shall attend and present reports at the following meetings:

a An initial meeting before starting the evaluation;

b A public meeting to discuss the draft findings of the evaluation;

c A meeting of the Richmond City Council;

d A meeting of the Board of Supervisors, to present the final report.

3 A follow-up evaluation will be done, if determined to be necessary by the successful bidder or the Oversight Committee, to include the following:

a Review the General Chemical – Richmond Works plant's action plan to help ensure that the action plan is addressing the recommendations and findings from the safety evaluation.

b Onsite follow-up evaluation to determine that the action plan implemented is actually addressing the recommendations from the safety evaluation. This evaluation is expected to occur approximately six months after the final report is completed.

c Follow-up evaluation may include a public meeting presenting the draft report of the follow-up onsite evaluation, a public comment period, and a final report to the Richmond City Council and the Board of Supervisors.

The contractor will prepare a plan for evaluation and will submit this plan to the Project Manager from Contra Costa Health Services for review. Included in Appendix A are examples of items to be considered in this evaluation. The contractor should use this list to assist in the evaluation of General Chemical – Richmond Works plant's current programs for addressing management systems, safety practices, and the safety culture of the General Chemical - Richmond Works plant.

Appendix A

Self-Evaluation Questionnaire for Managers Considering Ways To Improve Human Performance[3] Policy Issues

1. Is upper management's commitment to employee health and safety clear? What policy statements communicate this commitment to employees? Do workers understand these policies and are they convinced of upper management's sincerity?
2. Do supervisors and workers believe that safety has higher (or at least equal) status with other business objectives in the organization? How does the company promote a "safety first" approach?
3. Have supervisors and workers been specifically told to err on the safe side whenever they perceive a conflict between safety and production? Will such decisions be supported throughout the management chain?
4. Is management of worker health and safety an essential part of a manager's daily activities? How are managers held accountable for their health and safety record, and how do the rewards and penalties compare to those for production performance?
5. Is health and safety regularly discussed in management meetings at all levels? Do such discussions involve more than a review of injury statistics? What actions are taken if an injury occurs? Are near misses discussed, and is any action taken to prevent recurrence?
6. In the areas of design, construction, procurement, operations, maintenance, and management are there clearly defined procedures for evaluating the human factors aspects of:
    - New and modified processes?
    - New and modified equipment?
    - New and modified procedures?
    - Special, abnormal, and one-of-a-kind procedures?
8. Are human factors resources available in the organization, and are they readily available to help resolve procedural issues? Do they periodically review the adequacy of the standards in conjunction with other groups (engineering, operations, maintenance, etc.)?
9. Are adequate time and resources allocated to human factors? How is human factors integrated into the procedure writing process?
10. Do workers help identify error-likely situations in existing designs/procedures? Are they also involved in the review of new designs/procedures? How is worker input used? Are worker suggestions implemented?
11. Are workers encouraged to discuss potential human errors and near misses with their supervisors? Are such worker disclosures treated as evidence of worker incompetence, as unwarranted criticism of management, or as valuable lessons to be shared and acted upon? What criteria and procedures exist for reporting and investigating accidents and near misses? Are they followed consistently? Do the investigations go into enough depth to identify the root causes of worker errors? How are the human factors engineering deficiencies identified during the investigation of an incident corrected at: (1) the site of the original incident; (2) similar sites at the same facility; and (3) similar sites at other facilities?

[3] This a modified list from the Chemical Manufactures Association's (CMA) book titled A Manager's Guide to Reducing Human Errors Improving Human Performance in the Chemical Industry

12. Are supervisors trained and encouraged to identify error-likely situations, unsafe behaviors, and personal problems that may adversely affect a worker's performance? What actions are taken if a problem is identified?
13. Are data on human errors collected and made available to managers? Have the data been used as the basis for any management decisions? Are the data collected routinely or are they only collected after an accident?

Job and Task Issues

14. Have critical jobs and tasks been identified? Have the mental and physical aspects of such jobs been analyzed for both routine and emergency activities? What has been done to reduce the likelihood and/or consequences of potential human errors in the performance of these jobs?

15. Have jobs and tasks been designed to maintain worker interest and involvement? Are assignments rotated to even out workloads and increase worker experience? How have activities with safety implications been emphasized?

16. Are the worker's individual responsibilities clearly defined? How do these individual responsibilities relate to team responsibilities? How is worker performance monitored and measured?

Procedural Issues

17. Is a complete, current set of procedures available for workers to use? How are specific, up-to-date procedures maintained? Do the workers themselves help review/revise the procedures? How often? Are known errors allowed to remain uncorrected?

18. Are procedures written for the right level of knowledge and understanding by the workers, considering their education, background, experience, native language, etc.? Is a step-by-step format used? Are diagrams, photographs, drawings, etc. used to clarify the written text? Are cautions and warnings clearly stated in prominent locations? Does procedure nomenclature match equipment labels? Are there too many abbreviations and references to other procedures?
19. Do worker practices always comply with written procedures? How are differences detected and resolved? Who can authorize changes and deviations from the written procedures? Does such authorization include a review of the safety implications of the change or deviation? Do cautions always precede action steps in the procedures?
20. Are work permit systems correctly used? How are contractors included in such systems?
21. Are the emergency procedures clearly written? Are they practiced regularly? How many "immediate" actions are required? Are the procedures designed so workers can cross-check each other's performance of the necessary tasks?
22. Are checklists used for critical procedures? Is only one action specified per numbered step? Are any instructions embedded in explanatory notes? Are the steps in the correct sequence? Do steps requiring control actions also specify the correct system response?

Worker Issues

23. Did a human factors specialists help develop worker hiring and assignment policies? How are the results of job and task analyses converted into appropriate criteria for worker selection based on physical abilities, aptitudes, experience, etc.?

24. Is there a written training policy applicable to all workers? What safety objectives are established and how is attainment of such objectives monitored?

25. Are training records kept? How are retraining needs identified? How are workers trained on new processes, equipment, and procedures? What training is given to workers changing jobs or taking additional responsibilities? What training is given to new workers? How is training effectiveness assessed?

26. Are pre-employment and periodic health assessments performed for workers who must meet and maintain defined medical standards? Is a worker's health evaluated before he/she is allowed to return to work after an illness?

27. Are there programs for identifying and helping workers with substance abuse or mental health problems? What counseling, support, and professional advice is available to workers during periods of ill health or stress? What is the company policy on reassigning or terminating workers who are unable/unfit to perform their jobs?

Appendix B Safety Management Systems Assessment Protocol

Draft Protocol for Safety Management Systems

This appendix includes the evaluation protocols for safety management systems for the following elements:

a. Operating Procedures,
b. Training,
c. Management of Change,
d. Pre-Start-up Safety Reviews,
e. Incident Investigation,
f. Hot Work,
g. Contractors,
h. Emergency Response Program,
i. Compliance Audits,
j. Employee Participation, and
k. Process Hazard Analysis.

The protocol is based on the Contra Costa Health Services audit protocol for evaluating the prevention program elements of the California Accidental Release Prevention (Cal-ARP) Program and Chapter 450-8 of the Contra Costa County Industrial Safety Ordinance #98-48. Minor revisions have been made to the CCHS protocols to adapt them to the specific requirements of this evaluation. In particular, the "clarifications" column has been replaced with a column that provides guidance to help identify circumstances where human factors and/or culture issues may be contributing factors to system deficiencies.

MRS ID #	CCHS Question ID#	Question	Safety Culture Considerations	Human Factors Considerations
Operating Procedures				
A-1	A13-1	Did the stationary source prepare written operating procedures that provide clear instructions for safely conducting activities associated with each covered process? [§2760.3(a)& Section 450-8.016(A)(2)(a)]	Personal Involvement Commitment Procedures/Instructions	Procedures Workload
2	A13-2	Are the written operating procedures consistent with the safety information for the process?[§2760.3(a)& Section 450-8.016(A)(2)(a)]	Commitment Procedures/Instructions	Controls/Displays Alarms Procedures
3	A13-3	Do the procedures address initial startup? [§2760.3(a)(1)(A)& Section 450-8.016(A)(2)(a)]	Commitment Procedures/Instructions	Controls/Displays Alarms Procedures
4	A13-4	Do the procedures address normal operations? [§2760.3(a)(1)(B) & Section 450-8.016(A)(2)(a)]	Commitment Procedures/Instructions	Controls/Displays Alarms Procedures
5	A13-5	Do the procedures address temporary operations? [§2760.3(a)(1)(C) & Section 450-8.016(A)(2)(a)]	Commitment Procedures/Instructions	Controls/Displays Alarms Procedures
6	A13-6	Do the procedures address emergency shutdown, including conditions under which emergency shutdown is required, and the assignment of shutdown responsibility to qualified operators to ensure that emergency shutdown is executed in a safe and timely manner? [§2760.3(a)(1)(D) & Section 450-8.016(A)(2)(a)]	Commitment Procedures/Instructions	Controls/Displays Alarms Procedures
7	A13-7	Do the procedures address emergency operations? [§2760.3(a)(1)(E) & Section 450-8.016(A)(2)(a)]	Commitment Procedures/Instructions	Alarms Procedures
8	A13-8	Do the procedures address normal shutdown? [§2760.3(a)(1)(F) & Section 450-8.016(A)(2)(a)]	Commitment Procedures/Instructions	Controls/Displays Alarms Procedures
9	A13-9	Do the procedures address startup following a turnaround, or after emergency shutdown? [§2760.3(a)(1)(G) & Section 450-8.016(A)(2)(a)]	Commitment Procedures/Instructions	Controls/Displays Alarms Procedures
10	A13-10	Do the procedures address consequences of deviations and steps required to correct or avoid deviations? [§2755.3(a)(2)& Section 450-8.016(A)(2)(a)]	Commitment Procedures/Instructions	Controls/Displays Alarms Procedures
11	A13-11	Do the operating procedures include safety and health consideration such as properties of, and hazards presented by, the chemicals used in the process? [§2760.3(a)(3)(A)& Section 450-8.016(A)(2)(b)]	Commitment Procedures/Instructions	Work Environment Procedures
12	A13-12	Do the operating procedures include safety and health consideration such as precautions	Commitment Procedures/Instructions	Work Environment Protective Equipment

MRS ID #	CCHS Question ID#	Question	Safety Culture Considerations	Human Factors Considerations
		necessary to prevent exposure, including engineering controls, administrative controls, and personal protective equipment? [§2760.3(a)(3)(B)& Section 450-8.016(A)(2)(b)]		Procedures
13	A13-13	Do the operating procedures include safety and health consideration such as control measures to be taken if physical contact or airborne exposure occurs? [§2760.3(a)(3)(C) & Section 450-8.016(A)(2)(b)]	Commitment Procedures/Instructions	Work Environment Protective Equipment Procedures
14	A13-14	Do the operating procedures include safety and health consideration such as quality control for raw materials and control of hazardous chemical inventory levels? [§2760.3(a)(3)(D) & Section 450-8.016(A)(2)(b)]	Commitment Procedures/Instructions	Work Environment Procedures
15	A13-15	Do the operating procedures include safety and health consideration such as any special or unique hazards? [§2760.3(a)(3)(E) & Section 450-8.016(A)(2)(b)]	Commitment Procedures/Instructions	Work Environment Procedures
16	A13-16	Do the operating procedures include safety systems and their functions? [§2760.3(a)(4)& Section 450-8.016(A)(2)(c)]	Commitment Procedures/Instructions	Work Environment Procedures
17	A13-17	Are the operating procedures readily accessible to employees who work in or maintain a process? [§2760.3(b)& Section 450-8.016(A)(2)(d)]	Communications Personal Involvement Commitment Procedures/Instructions	Work Environment Controls/Displays Alarms Communications Equipment Procedures
18	A13-18	Are the operating procedures reviewed as often as necessary to ensure that they reflect current operating practice, including changes that result from changes in process chemicals, technology, and equipment, and changes to the stationary source?[§2760.3(c)& Section 450-8.016(A)(2)(e)]	Personal Involvement Accidents and Incidents Commitment Procedures/Instructions	Protective Equipment Procedures Training Workload
19	A13-19	Did/does the stationary source annually certify that the operating procedures are current and accurate? [§2760.3(c)& Section 450-8.016(A)(2)(e)]	Personal Involvement Commitment Procedures/Instructions	Workload
20	A13-20	Has the stationary source developed and implemented safe work practices to provide for the control of hazards during operations such as lockout/tagout; confined space entry; opening process equipment or piping; and control over entrance by maintenance, contractor, laboratory, or other support personnel? [§2760.3(d)Section 450-8.016(A)(2)(f)]	Pressure for Production Communications Personal Involvement Commitment Procedures/Instructions	Work Environment Protective Equipment Procedures
21	A13-21	Are these safe work practices applied to employees and contract employees? [§2760.3(d) Section 450-8.016(A)(2)(f)]	Communications Personal Involvement Commitment	Procedures

MRS ID #	CCHS Question ID#	Question	Safety Culture Considerations	Human Factors Considerations
Training				
1	A14-1	Has the stationary source ensured that each employee presently operating a process, and each employee newly assigned to a covered process has been trained in an overview of the process and in the operating procedures provided in Section 2760.3? [§2760.4(a)(1) & Section 450-8.016(A)(4)(a)]	Training and Competence Personal Involvement Commitment Procedures/Instructions	Training
2	A14-2	For those employees already operating a process on June 21, 1999, has the stationary source certified in writing that the employee has the required knowledge, skills, and abilities to safely carry out the duties and responsibilities as specified in the operating procedures?[§2760.4(a)(2)& Section 450-8.016(A)(4)(a)]	Training and Competence Commitment Procedures/Instructions	Training
3	A14-3	Has refresher training been provided at least every three years, and more often if necessary, to each employee operating a process to ensure that the employee understands and adheres to the current operating procedures of the process? [§2760.4(b)& Section 450-8.016(A)(4)(b)]	Training and Competence Personal Involvement Commitment Procedures/Instructions	Training
4	A14-4	Did/does the stationary source determine the appropriate frequency of refresher training in consultation with the employees operating the process?[§2760.4(b)& Section 450-8.016(A)(4)(b)]	Training and Competence Personal Involvement Commitment Procedures/Instructions	Training
5	A14-5	Has the stationary source ascertained that each employee involved in operating a process has received and understood the training required by this section?[§2760.4(c)& Section 450-8.016(A)(4)(c)]	Training and Competence Personal Involvement Commitment Procedures/Instructions	Training
6	A14-6	Does the stationary source prepare and maintain records which contain the identity of the employee, the date of training, and the means used to verify that the employee understood the training?[§2760.4(c)& Section 450-8.016(A)(4)(c)]	Commitment Procedures/Instructions	Training
Management of Change				
1	A16-1	Has the stationary source established and implemented written procedures to manage changes (except for “replacement in kind”) to process chemicals, technology, equipment, and procedures?[§2760.6(a)& Section 450-8.016(A)(6)(a)]	Commitment Procedures/Instructions	Procedures
2	A16-2	Has the stationary source established and implemented written procedures to manage changes to stationary sources that affect a covered process?[§2760.6(a)& Section 450-8.016(A)(6)(a)]	Commitment Procedures/Instructions	Procedures

MRS ID #	CCHS Question ID#	Question	Safety Culture Considerations	Human Factors Considerations
3	A16-3	Do the Management of Change procedures address the technical basis for the proposed change prior to any change? [§2760.6(b)(1)& Section 450-8.016(A)(6)(b)]	Commitment Procedures/Instructions	Procedures
4	A16-4	Do the Management of Change procedures address the impact of the change on safety and health prior to any change? [§2760.6(b)(2) & Section 450-8.016(A)(6)(b)]	Commitment Procedures/Instructions	Procedures
5	A16-5	Do the Management of Change procedures address modifications to operating procedures prior to any change? [§2760.6(b)(3)& Section 450-8.016(A)(6)(b)]	Commitment Procedures/Instructions	Procedures
6	A16-6	Do the Management of Change procedures address the necessary time period for the change prior to any change? [§2760.6(b)(4)& Section 450-8.016(A)(6)(b)]	Commitment Procedures/Instructions	Procedures
7	A16-7	Do the Management of Change procedures address authorization requirements for the proposed change prior to any change? [§2760.6(b)(5) & Section 450-8.016(A)(6)(b)]	Training and Competence Personal Involvement Procedures/Instructions	Procedures
8	A16-8	Are employees involved in operating a process informed of, and trained in, the change prior to start-up of the process or affected part of the process?[§2760.6(c) & Section 450-8.016(A)(6)(c)]	Training and Competence Personal Involvement Procedures/Instructions	Procedures Training
9	A16-9	Are maintenance employees whose job tasks will be affected by a change in the process informed of, and trained in, the change prior to start-up of the process or affected part of the process?[§2760.6(c)& Section 450-8.016(A)(6)(c)]	Training and Competence Personal Involvement Procedures/Instructions	Procedures Training
10	A16-10	Are contract employees whose job tasks will be affected by a change in the process informed of, and trained in, the change prior to start-up of the process or affected part of the process?[§2760.6(c)& Section 450-8.016(A)(6)(c)]	Training and Competence Communications Personal Involvement Procedures/Instructions	Procedures Training
11	A16-11	Does/did the stationary source ensure that if a change results in a change in the PSI (§2760.1 and Section 450-8.016(A)(1)), that this information will be updated accordingly? [§2760.6(d)& Section 450-8.016(A)(6)(d)]	Training and Competence Communications Personal Involvement Commitment Procedures/Instructions	Procedures Training
12	A16-12	Does/did the stationary source ensure that if a change results in a change in the operating procedures or practices (§2760.3and Section 450-8.016(A)(2)), that such procedures or practices will be updated accordingly? [§2760.6(e) & Section 450-8.016(A)(6)(e)]	Training and Competence Communications Personal Involvement Commitment Procedures/Instructions	Procedures Training
13	A16-13	Did the source notify CCHS that procedures to	Communications	Procedures

MRS ID #	CCHS Question ID#	Question	Safety Culture Considerations	Human Factors Considerations
		manage a covered process modification had been established? [§2745.11(a)(2)]		
Pre-Startup Safety Reviews				
1	A17-1	Does/did the stationary source perform pre-startup reviews for new stationary sources? [§2760.7(a) & Section 450-8.016(A)(7)(a)]	Training and Competence Communications Personal Involvement Commitment Procedures/Instructions	Work Environment Procedures Training
2	A17-2	Does/did the stationary source perform pre-startup reviews for modified stationary sources when the modification is significant enough to require a change in the process safety information?[§2760.7(a)& Section 450-8.016(A)(7)(a)]	Training and Competence Communications Personal Involvement Commitment Procedures/Instructions	Work Environment Procedures Training
3	A17-3	Does/did the stationary source confirm that prior to the introduction of regulated substances to a process that construction and equipment is in accordance with design specifications?[§2760.7(b)(1)& Section 450-8.016(A)(7)(b)]	Training and Competence Communications Personal Involvement Commitment Procedures/Instructions	Work Environment Procedures Training
4	A17-4	Does/did the stationary source confirm that prior to the introduction of regulated substances to a process that safety, operating, maintenance, and emergency procedures are in place and adequate?[§2760.7(b)(2) & Section 450-8.016(A)(7)(b)]	Training and Competence Communications Personal Involvement Commitment Procedures/Instructions	Work Environment Procedures Training
5	A17-5	Does/did the stationary source confirm that prior to the introduction of regulated substances to a process that a PHA has been performed and recommendations have been resolved or implemented before startup (for new stationary sources)? [§2760.7(b)(3)& Section 450-8.016(A)(7)(b)]	Training and Competence Communications Personal Involvement Commitment Procedures/Instructions	Work Environment Procedures Training
6	A17-6	Does/did the stationary source confirm that prior to the introduction of regulated substances to a process that modified stationary sources meet the requirements contained in the management of change program, §2760.6 or Section 450-8.016(A)(7)(b)? [§2760.7(b)(3)& Section 450-8.016(A)(7)(b)]	Training and Competence Communications Personal Involvement Commitment Procedures/Instructions	Work Environment Procedures Training
7	A17-7	Does/did the stationary source confirm that prior to the introduction of regulated substances to a process that training of each employee involved in operating a process has been completed? [§2760.7(b)]?[§2760.7(b)(4)& Section 450-8.016(A)(7)(b)]	Training and Competence Communications Personal Involvement Commitment Procedures/Instructions	Work Environment Procedures Training
8	A17-8	Did the source notify CCHS that procedures to manage a covered process modification had been established? [§2745.11(a)(2)]	Training and Competence Communications	Work Environment Procedures Training

MRS ID #	CCHS Question ID#	Question	Safety Culture Considerations	Human Factors Considerations
			Commitment Procedures/Instructions	
Incident Investigation				
1	A19-1	Has the stationary source investigated each incident which resulted in, or could reasonably have resulted in a catastrophic release? [§2760.9(a) & Section 450-8.016(A)(9)(a)]	Training and Competence Job Security Personal Involvement Accidents and Incidents Procedures/Instructions	Procedures Training Workload Problem Resolution
2	A19-2	Are incident investigations initiated as promptly as possible, but not later than 48 hours following the incident? [§2760.9(b)& Section 450-8.016(A)(9)(b)]	Training and Competence Job Security Pressure for Production Personal Involvement Accidents and Incidents Commitment	Procedures Training Workload Problem Resolution
3	A19-3	Was an incident investigation team established and did it consist of at least one person knowledgeable in the process involved, including a contract employee if the incident involved work of the contractor, and other persons with appropriate knowledge and experience to thoroughly investigate and analyze the incident? [§2760.9(c) & Section 450-8.016(A)(9)(c)]	Training and Competence Accidents and Incidents Commitment Procedures/Instructions	Training Workload
4	A19-4	Was a report prepared at the conclusion of every investigation? [§2760.9(d)& Section 450-8.016(A)(9)(d)]	Training and Competence Accidents and Incidents Procedures/Instructions	Procedures Training Workload
5	A19-5	Does the incident investigation report include the date of the incident? [§2760.9(e) & Section 450-8.016(A)(9)(d)]	Training and Competence Commitment Procedures/Instructions	Procedures Training
6	A19-6	Does the incident investigation report include the date the investigation began? [§2760.9(d) & Section 450-8.016(A)(9)(d)]	Training and Competence Commitment Procedures/Instructions	Procedures Training
7	A19-7	Does the incident investigation report include a description of the incident? [§2760.9(d)& Section 450-8.016(A)(9)(d)]	Training and Competence Commitment Procedures/Instructions	Procedures Training
8	A19-8	Does the incident investigation report include the factors that contributed to the incident? [§2760.9(d) & Section 450-8.016(A)(9)(d)]	Training and Competence Commitment Procedures/Instructions	Procedures Training
9	A19-9	Does the incident investigation report include any recommendations resulting from the investigation? [§2760.9(d)& Section 450-8.016(A)(9)(d)]	Training and Competence Commitment Procedures/Instructions	Procedures Training

MRS ID #	CCHS Question ID#	Question	Safety Culture Considerations	Human Factors Considerations
10	A19-10	Did/does the stationary source promptly address and resolve the incident report findings and recommendations? [§2760.9(e)& Section 450-8.016(A)(9)(e)]	Training and Competence Pressure for Production Communications Personal Involvement Accidents and Incidents	Procedures Training Workload Problem Resolution
11	A19-11	Have the resolutions and corrective actions been documented?[§2760.9(e) & Section 450-8.016(A)(9)(e)]	Training and Competence Procedures/Instructions	Procedures Workload
12	A19-12	Has the report been reviewed with all affected personnel whose job tasks are relevant to the incident findings including contract employees where applicable?[§2760.9(f)& Section 450-8.016(A)(9)(f)]	Training and Competence Pressure for Production Personal Involvement Commitment	Procedures Workload Problem Resolution
13	A19-13	Are investigation summaries retained for five years? [§2760.9(g)& Section 450-8.016(A)(9)(g)]	Training and Competence Procedures/Instructions	
14	A19-14	Are incidents “tracked” in any way to identify “trends” that may lead to prevention/risk reduction?	Personal Involvement Accidents and Incidents Commitment	Workload Problem Resolution
15	A19-15	What methodology was used to determine the root cause of each of the accidental release?	Accidents and Incidents Procedures/Instructions	Procedures
Hot Work Permit				
1	S1-1	Does/did the stationary source issue written and numbered hot work permits (issued and signed by the employer or authorized agent) for hot work operations conducted on or near a covered process before a source of ignition is used? [T19 CCR§2760.11(a)][T8 CCR §6777(a)]	Training and Competence Pressure for Production Communications Personal Involvement Commitment Procedures/Instructions	Procedures Training Workload
2	S1-2	Does the hot work permit contain the following information (a) the effective time and date (b) the place of use (c) the hours during which the source of ignition may be used, not to exceed 24 hours (d) the specific location or piece of equipment where the source of ignition will be used (e) the nature of the use of the source of ignition (f) any special precautions or limitations to be observed before, during, or after the use of the source of ignition, including the need for fire watch? [T8 CCR §6777(c) & T8 CCR §5189(k)]	Procedures/Instructions	Procedures
3	S1-3	Does/did the stationary source maintain copies of each permit issued for at least six months after date of issue? [T8 CCR §6777(g)]	Procedures/Instructions	Procedures
4	S1-4	Do the hot work permits document that when issued the following requirements (if applicable) are met: (a) oil accumulations or other combustible materials in exposed areas shall be removed or protected from ignition (b) gage glasses containing light oil or flammable gas	Training and Competence Rule Breaking Personal Involvement Commitment	Protective Equipment Procedures Workload

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		liquids, vapors or gases and exposed to spatter of molten metal shall have their valves closed and be drained, or the gage glasses shall be guarded? [[T8 CCR §6777(f)]		
5	S1-5	Has the stationary source determined and documented that the flammable gas or vapor content is less than 20% of the LEL before the hot work permit is issued? [T8 CCR §6777(e)]	Training and Competence Pressure for Production Personal Involvement Commitment	Procedures Training Workload
6	S1-6	Do the hot work permits require that suitable fire extinguishing equipment be maintained ready for use when working with a source of ignition? [T8 CCR §4848((a)(19) & [T8 CCR §6777(h)]	Procedures/Instructions	Procedures
7	S1-7	Do the hot work permits document that fire watchers are assigned whenever welding or cutting is performed in locations where other than a minor fire might develop or whenever appropriate? [T8 CCR §4848(a)(7)(Accidents and Incidents) & (a)(20)]	Training and Competence Personal Involvement Commitment Procedures/Instructions	Procedures Training Workload
8	S1-8	Do the hot work permits document that individuals responsible for authorizing cutting and welding inspect the area before cutting and welding is permitted? [T8 CCR §4848(a)(8)]	Training and Competence Pressure for Production Personal Involvement Commitment Procedures/Instructions	Procedures Training Workload
9	S1-9	Do the hot work permits document that the employer designate precautions to be followed in granting authorization to proceed? [T8 CCR §4848(a)(8)]	Training and Competence Personal Involvement Commitment Procedures/Instructions	Procedures Training Workload
10	S1-10	Do the hot work permits document that where combustible materials such as paper clippings, wood shavings, or textile fibers are on the floor, the floor is swept clean for a radius of 35 feet? [T8 CCR §4848(a)(11)]	Training and Competence Pressure for Production Personal Involvement Commitment Procedures/Instructions	Work Environment Procedures Training Workload
11	S1-11	Do the hot work permits document that combustible floors were kept wet, covered with damp sand, or protected by fire-resistant shields? [T8 CCR §4848(a)(11)]	Training and Competence Pressure for Production Personal Involvement Commitment Procedures/Instructions	Work Environment Procedures Training Workload
12	S1-12	Do the hot work permits document that all combustibles are relocated at least 35 feet from the work site? [T8 CCR §4848(a)(12)]	Training and Competence Pressure for Production Personal Involvement Commitment Procedures/Instructions	Work Environment Procedures Training Workload
13	S1-13	Do the hot work permits document that if the object to be welded or cut cannot readily be	Training and Competence	Work Environment Procedures

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		moved, all movable fire hazards in the vicinity are taken to a safe place? [T8 CCR §4848(a)(13)]	Pressure for Production Personal Involvement Commitment Procedures/Instructions	Training Workload
14	S1-14	Do the hot work permits document that, where objects to be welded or cut are not movable and where fire hazards cannot be removed, then guards are used to confine the heat, sparks, and slag, and to protect the immovable fire hazards and nearby personnel? [T8 CCR §4848(a)(14)]	Training and Competence Pressure for Production Personal Involvement Commitment Procedures/Instructions	Work Environment Procedures Training Workload
15	S1-15	Do the hot work permits document that wherever there are cracks or openings in the floor that cannot be closed or covered, precautions are taken so that no readily combustible materials on the floor below will be exposed to sparks which might drop through the floor. [T8 CCR §4848(a)(15)]	Training and Competence Pressure for Production Personal Involvement Commitment Procedures/Instructions	Work Environment Procedures Training Workload
16	S1-16	Do the hot work permits document that ducts and conveyor systems that might carry sparks to distant combustibles are suitably protected or shut down? [T8 CCR §4848(a)(16)]	Training and Competence Pressure for Production Personal Involvement Commitment Procedures/Instructions	Work Environment Procedures Training Workload
17	S1-17	Do the hot work permits document that where cutting or welding is done near walls, partitions, ceiling or roof of combustible construction, fire-resistant shields or guards are provided to prevent ignition? [T8 CCR §4848(a)(17)]	Training and Competence Pressure for Production Personal Involvement Commitment Procedures/Instructions	Procedures Work Environment Training Workload
18	S1-18	Do the hot work permits document that if welding is to be done on a metal wall, partition, ceiling or roof, precautions are taken to prevent ignition of combustibles on the other side, due to conduction or radiation, preferably by relocating combustibles? [T8 CCR §4848(a)(17)]	Training and Competence Pressure for Production Personal Involvement Commitment Procedures/Instructions	Work Environment Procedures Training Workload
19	S1-19	Has management established approved areas for cutting and welding, and established procedures for approving cutting and welding in other areas? [T8 CCR §4848(a)(1)]	Commitment	Work Environment Protective Equipment
20	S1-20	Has management designated an individual responsible for authorizing cutting and welding operations in areas not specifically designed or approved for such processes? [T8 CCR §4848(a)(2)]	Training and Competence Commitment	Procedures Training
21	S1-21	Does management insist that only approved apparatus, such as torches, manifolds, regulators, or pressure acetylene generators be used? [T8 CCR §4848(a)(3)]	Communications Commitment	Protective Equipment Procedures Training
22	S1-22	Does management insist that cutters or welders and their supervisors are suitably trained in the	Training and Competence	Procedures Training

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		safe operation of their equipment and the safe use of the process? [T8 CCR §4848(a)(4)]	Commitment	
23	S1-23	Does management select contractors to perform hot work involving cutting or welding who have suitably trained personnel and who have an awareness of the magnitude of the risks involved? [T8 CCR §4848(a)(5)]	Training and Competence Commitment	Procedures Training
24	S1-24	Does the hot work permit require that, in locations where flammable vapors may be present, precautions be taken to prevent ignition by eliminating or controlling sources of ignition. [T8 CCR § 6777(i)]	Training and Competence Pressure for Production Personal Involvement Commitment Procedures/Instructions	Protective Equipment Procedures Training
25	S1-25	Does management require that a supervisor or contractor supervisor is responsible for ensuring that cutting and welding are so scheduled that plant operations that might expose combustibles to ignition are not started during cutting or welding [T8 CCR §4848(a) and 29 CFR §1910.252(a)(xiv)]	Training and Competence Personal Involvement Commitment	Procedures Training Workload
26	S1-26	Does the stationary source prohibit cutting or welding in sprinklered buildings while such protection is impaired [29 CFR §1910.252(a)(2)(vi)(B)]	Training and Competence Pressure for Production Rule Breaking Communications Personal Involvement Commitment	Protective Equipment Procedures Training Workload
Emergency Response				
1	A22-1	If the stationary source elects not to respond to accidental releases of regulated substances, have they developed and implemented an Emergency Action Plan as specified in T8 CCR §3220? [T8 CCR §5192(q) & Section 450-8.016(12)(d)]	Procedures/Instructions	Procedures
2	A22-2	If the stationary source elects not to respond to accidental releases of regulated substances, is the stationary source included in the community emergency response plan (Area Plan) developed under T42 USC §11003 (regulated toxic substances held above TQ in a covered process)?[§2765.1(b)(1)& Section 450-8.016(12)(d)]	Communications Procedures/Instructions	Procedures
3	A22-3	If the stationary source elects not to respond to accidental releases of regulated substances, has the stationary source coordinated response actions with the local fire department (regulated flammable substances held above TQ in a covered process)? [§2765.1(b)(2) & Section 450-8.016(12)(d)]	Communications Procedures/Instructions	Procedures
4	A22-4	If the stationary source elects not to respond to accidental releases of regulated substances, are	Communications Procedures/Instructions	Procedures Communications

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		appropriate mechanisms in place to notify emergency responders when there is a need for a response? [§2765.1(b)(3)& Section 450-8.016(12)(d)]		Equipment
5	A22-5	Has the stationary source developed and implemented an emergency response program for the purpose of protecting public health and the environment? [§2765.2(a)& Section 450-8.016(12)(a)]	Procedures/Instructions	Procedures
6	A22-6	Does the emergency response program meet the requirements of T8 CCR § 5192? [§2765.2(a)& Section 450-8.016(12)(a)]	Procedures/Instructions	Procedures
7	A22-7	Does the emergency response program include an emergency response plan which is maintained at the stationary source? [§2765.2(a)(1)Section 450-8.016(12)(a)]	Procedures/Instructions Commitment	Procedures
8	A22-8	Does the emergency response plan include procedures for informing and interfacing with the public and local emergency response agencies about accidental releases, emergency planning, and emergency responses? [§2765.2(a)(1)(A) Section 450-8.016(12)(a)]	Procedures/Instructions	Procedures
9	A22-9	Does the emergency response plan include documentation of proper first-aid and emergency medical treatment necessary to treat accidental human exposures? [§2765.2(a)(1)(B) Section 450-8.016(12)(a)]	Procedures/Instructions	Procedures
10	A22-10	Does the emergency response plan include procedures and measures for emergency response after an accidental release of a regulated substance? [§2765.2(a)(1)(C) Section 450-8.016(12)(a)]	Procedures/Instructions	Procedures
11	A22-11	Does the emergency response program include procedures for the use of emergency response equipment and for its inspection, testing, and maintenance? [§2765.2(a)(2)Section 450-8.016(12)(a)]	Procedures/Instructions	Procedures
12	A22-12	Does the emergency response program include training for all employees in relevant procedures and relevant aspects of the Incident Command System? [§2765.2(a)(3) Section 450-8.016(12)(a)]	Training and Competence Procedures/Instructions	Procedures Training
13	A22-13	Does the emergency response program include procedures to review and update, as appropriate, the emergency response plan to reflect changes at the stationary source and ensure that employees are informed of changes? [§2765.2(a)(4) Section 450-8.016(12)(a)]	Training and Competence Commitment Procedures/Instructions	Procedures Training
14	A22-14	Has the stationary source developed a written plan, complying with the California	Commitment Procedures/Instructions	Procedures Workload

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		Consolidated Contingency Plan? [§2765.2(b) Section 450-8.016(12)(b)]		
15	A22-15	Has the stationary source coordinated the emergency response plan with the community emergency response plan (Area Plan) developed under T42 USC §11003? [§2765.2(c)Section 450-8.016(12)(c)]	Communications Commitment Procedures/Instructions	Procedures Workload
16	A22-16	Has the stationary source provided to the LEPC or emergency response officials, information necessary for developing and implementing the community emergency response plan (Area Plan), when requested? [§2765.2(c)Section 450-8.016(12)(c)]	Communications Commitment Procedures/Instructions	Procedures Workload
18	A22-18	Has the source consulted with CCHS and identified CAN zones?	Communications Personal Involvement Commitment Procedures/Instructions	Procedures Workload
Employee Participation				
1	A20-1	Has the stationary source developed a written plan of action regarding the implementation of the employee participation required by this section? [§2760.10(a)& Section 450-8.016(A)(3)]	Commitment Procedures/Instructions	Procedures
2	A20-2	Has the stationary source consulted with employees and their representatives on the conduct and development of PHA's? [§2760.10(b)& Section 450-8.016(A)(3)]	Communications Personal Involvement Commitment	Procedures Workload
3	A20-3	Has the stationary source consulted with employees and their representatives on the development of the other (other than PHA's) element of process safety management in this rule? [§2760.10(b)& Section 450-8.016(A)(3)]	Communications Personal Involvement Commitment	Procedures Workload
4	A20-4	Has the stationary source provided employees and their representatives with access to PHA's? [§2760.10(c)& Section 450-8.016(A)(3)]	Training and Competence Communications Personal Involvement Commitment Procedures/Instructions	Procedures
5	A20-5	Has the stationary source provided employees and their representatives with access to all other (other than PHA's) information required to be developed under this rule? [§2760.10(c)& Section 450-8.016(A)(3)]	Training and Competence Communications Personal Involvement Commitment Procedures/Instructions	Procedures
Compliance Audits				
1	A9-1	Has the stationary source certified that they have evaluated compliance with the provisions of the Program 2 prevention program requirements at least every three years to verify that the	Personal Involvement Commitment	Procedures Training Workload

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		procedures and practices are developed under the rule are adequate and are being followed? [§2755.6(a)]		
2	A9-2	Was the compliance audit conducted by at least one person knowledgeable in the process? [§2755.6(b)]	Training and Competence Pressure for Production Commitment	Procedures Workload
3	A9-3	Has the stationary source developed a report of the audit findings?[§2755.6(c)]	Commitment Procedures/Instructions	Procedures Workload
4	A9-4	Has the stationary source promptly determined and documented an appropriate response for each of the findings of the compliance audit and documented that the deficiencies have been corrected? [§2755.6(d)]	Commitment Procedures/Instructions	Procedures Workload
5	A9-5	Does the stationary source retain the two (2) most recent compliance audit reports? [§2755.6(e)]	Commitment Procedures/Instructions	Procedures
Process Hazards Analysis				
1	A12-1	Did the stationary source perform an initial process hazard analysis (PHA) as soon as possible, but no later than the RMP submittal date (June 21, 1999)?[§2760.2(a)]	Personal Involvement Commitment Procedures/Instructions	Procedures Workload
2	A12-2	Did the stationary source perform an initial process hazard analysis (PHA) by January 15, 2000 for all ISO covered processes? [Section 450-8.016(D)(2)]	Commitment Procedures/Instructions	Procedures Workload
3	A12-3	Has the stationary source determined and documented the priority order for conducing PHAs based on a rationale which includes such considerations as extent of the process hazards, number of potentially affected employees, age of the process, and operating history of the process?[§2760.2(a)]	Personal Involvement Commitment Procedures/Instructions	Procedures Workload
4	A12-4	Did the stationary source work closely with CCHS in deciding which PHA methodology is best suited to determine the hazards of the process being analyzed?[§2760.2(b)]	Communications Personal Involvement Commitment Procedures/Instructions	Procedures Workload
5	A12-5	Did the stationary source use one or more of the following methodologies that are appropriate to determine and evaluate the hazards of the process being analyzed: (a) What-If (b) Checklist (c) What-If/Checklist (d) Hazard and Operability Study (HAZOP) (d) Failure Modes and Effects Analysis (FEMA) (e) Fault Tree Analysis (f) An appropriate equivalent methodology? [§2760.2(b)& Section 450-8.016(D)(1)]	Commitment Procedures/Instructions	Procedures
6	A12-6	Was the PHA appropriate to the complexity of the process and did it identify, evaluate, and	Training and Competence	Procedures Training

MRS ID #	CCHS Question ID#	Question	Safety Culture Considerations	Human Factors Considerations
		control the hazards involved in the process? [§2760.2(a)& Section 450-8.016(D)(1)]	Commitment Procedures/Instructions	
7	A12-7	Do the PHA(s) address the hazards of the process? [§2760.2(c)(1)& Section 450-8.016(D)(1)]	Training and Competence Commitment Procedures/Instructions	Procedures Training Workload
8	A12-8	Do the PHA(s) address the identification of any previous incident which had a likely potential for catastrophic consequences? [§2760.2(c)(2)& Section 450-8.016(D)(1)]	Training and Competence Commitment Procedures/Instructions	Procedures Training Workload
9	A12-9	Do the PHA(s) address engineering and administrative controls applicable to the hazards and their interrelationships such as appropriate application of detection methodologies to provide early warning of releases? [§2760.2(c)(3)& Section 450-8.016(D)(1)]	Training and Competence Commitment Procedures/Instructions	S Communications Equipment Procedures
10	A12-10	Do the PHA(s) address the consequences of failure of engineering and administrative controls? [§2760.2(c)(4)& Section 450-8.016(D)(1)]	Training and Competence Commitment Procedures/Instructions	Controls/Displays S Procedures Workload
11	A12-11	Do the PHA(s) address covered process and stationary source siting? [§2760.2(c)(5)& Section 450-8.016(D)(1)]	Training and Competence Commitment Procedures/Instructions	Procedures Workload
12	A12-12	Do the PHA(s) address human factors? [§2760.2(c)(6)& Section 450-8.016(D)(1)]	Training and Competence Procedures/Instructions	Procedures Workload
13	A12-13	Do the PHA(s) include a qualitative evaluation of a range of the possible safety and health effects of failure of controls? [§2760.2(c)(7)& Section 450-8.016(D)(1)]	Training and Competence Commitment Procedures/Instructions	Procedures Workload
14	A12-14	Do the PHA(s) include consideration of external events, including seismic events, as applicable? [§2760.2(c)(8) & Section 450-8.016(D)(1)]	Training and Competence Commitment Procedures/Instructions	Procedures Workload
15	A12-15	Do the PHA(s) include consideration of external events, including seismic events, as applicable? [Section 450-8.016(D)(2)]	Training and Competence Commitment Procedures/Instructions	Procedures Workload
16	A12-16	Have PHAs completed to comply with T8 CCR§5189, including revalidations of the PSM PHAs, been used to satisfy the previous requirements? [§2760.2(a)]	Training and Competence Commitment Procedures/Instructions	Procedures Workload
17	A12-17	Did at least one member of the PHA team have experience and knowledge specific to the process being evaluated?[§2760.2(d)& Section 450-8.016(D)(1)]	Training and Competence Personal Involvement Procedures/Instructions	Procedures Training
18	A12-18	Was the PHA performed by a team with expertise in engineering and process operations?	Training and Competence	Procedures Training

MRS ID #	CCHS Question ID#	Question	Safety Culture Considerations	Human Factors Considerations
		[§2760.2(d)& Section 450-8.016(D)(1)]	Personal Involvement Procedures/Instructions	
19	A12-19	Did at least one member of the PHA team have knowledge in the specific PHA methodology used? [§2760.2(d)& Section 450-8.016(D)(1)]	Training and Competence Personal Involvement Procedures/Instructions	Procedures Training
20	A12-20	Has the stationary source established a system to promptly address the PHA team's findings and recommendations? [§2760.2(e)]	Commitment Procedures/Instructions	Procedures
21	A12-21	Has the stationary source established a system to ensure that the recommendations are resolved in a timely manner and that the resolution is documented? [§2760.2(e)]	Personal Involvement Commitment Procedures/Instructions	Procedures Workload
22	A12-22	Has the stationary source established a system to document what actions are to be taken? [§2760.2(e)]	Commitment Procedures/Instructions	Procedures Workload
23	A12-23	Has the stationary source established a system to complete actions as soon as possible? [§2760.2(e)]	Commitment Procedures/Instructions	Procedures Workload
24	A12-24	Has the stationary source established a system to communicate the actions to operating, maintenance, and other employees whose work assignments are in the process and who may be affected by the recommendations or actions? [§2760.2(e) & Section 450-8.016(D)(4)]	Commitment Procedures/Instructions	Procedures Workload
25	A12-25	Has the stationary source established a system to develop a written schedule of when these actions are to be completed? [§2760.2(e)]	Commitment Procedures/Instructions	Procedures Workload
26	A12-26	Were recommended actions selected for implementation completed within one year if shutdown was not required or during next scheduled turnaround if shutdown was required [Section 450-8.016(D)(4)]	Personal Involvement Commitment	Procedures Workload
27	A12-27	Does the source retain documentation of: a) decision made to implement or not implement all PHA recommended action items; b) results of recommendations for additional study; c) justification for not implementing any of the recommended actions? [Section 450-8.016(D)(4)]	Commitment Procedures/Instructions	Procedures
28	A12-28	Did the source consider the use of Inherently Safer Systems in the development and analysis of mitigation items resulting from a) the PHA b) the design and review of new processes and facilities? [Section 450-8.016(D)(3)]	Commitment Procedures/Instructions	Procedures Workload
29	A12-29	Did the source document the basis in meaningful detail for concluding that an inherently safer system was not feasible? [Section 450-8.016(D)(3)]	Commitment Procedures/Instructions	Procedures Workload

MRS ID #	CCHS Question ID#	Question	Safety Culture Considerations	Human Factors Considerations
30	A12-30	Has the PHA been updated and revalidated by a team meeting the requirements of §2760.2(d) at least every five years after the completion of the initial PHA to ensure that the PHA is consistent with the current process? [§2760.2(f)& Section 450-8.016(D)(2)]	Training and Competence Personal Involvement Commitment	Procedures Workload
31	A12-31	Has the stationary source retained copies of the PHA's and updates or revalidations for each covered process for the life of the process? [§2760.2(g)]	Commitment Procedures/Instructions	Procedures
32	A12-32	Has the stationary source retained copies of the documented resolution of the recommendations described in §2760.2(e) for the life of the process? [§2760.2(g) & Section 450-8.016(D)(4)]	Commitment Procedures/Instructions	Procedures

Appendix C Human Factors Assessment Checklist

Human Factors Checklist

Section 1 – General Work Environment

Question 1: Is the work area clean and free of debris?
A safe work area should be relatively clean and as free of unnecessary debris as possible. A sloppy workplace can make it difficult to locate key information and/or equipment in emergencies, and can encourage a general sense of apathy among workers regarding the importance of attention to detail and performance.

Question 2: Is the work area free of tripping and slipping hazards?
A safe work area should be as free as possible of objects and substances that might cause workers to either trip or slip as they move around the workplace. Note any hazards that are present, and ask workers if other similar hazards are ever present.

Question 3: Is the work area free of noxious and/or annoying fumes and odors?
To the greatest extent possible, the workplace should be free of fumes and odors whose presence can either present a direct hazard to the health of the worker and/or be a significant source of distraction when performing tasks.

Question 4: Is the work area temperature and humidity within an acceptable range?
Extremes of temperature and humidity are significant factors impacting human performance, either through direct physiological effects or by adversely affecting attention to task performance. To the greatest extent possible, both should be kept in ranges that do not produce worker discomfort.

Question 5: Is work area noise within an acceptable level?
Excessive background noise and the periodic occurrence of distinct, loud noises (e.g., routine auditory alerts, noises related to mechanical or system events, etc.) are known to adversely affect human performance. To the greatest extent possible, the sound levels associated with such noises should be minimized.

Question 6: Is the work area lighting within an acceptable range?
Sufficient lighting is obviously an important factor in supporting safe work performance. Direct observation of the workplace, combined with soliciting the opinions of workers, is generally sufficient to establish the acceptability of lighting levels.

Question 7: Is the general environment conducive to safe work performance?
This question asks you to form a general impression of the overall impact of the types of issues examined in Questions 1-6 on safe work performance. In general, is the overall work environment likely to promote safe or unsafe work performance? Bear in mind that the answer may not clearly be one or the other, but might be somewhere in between.

Question 8: Are workers provided with the proper tools to perform routine and emergency manual tasks? Do workers have sufficient quantities of the correct tools for performing necessary manual tasks? In many cases, you may not be sufficiently familiar with the specific type of work

being performed to make an independent determination, in which case it will be necessary to solicit inputs from workers and management.

Question 9: Has the work area ever been subjected to a general ergonomics or human factors analysis? If an ergonomic or human factors analysis has been previously conducted, it is important to follow up (either with further questions or by requesting any documentation that might exist) to find out what recommendations were made at that time, if any. Also, were the recommendations followed? If so, what is the general impression among workers and management of their helpfulness in increasing safety?

Section 2 – Control and Displays

Question 1: Are controls and displays arranged logically (i.e., do they meet the expectations of the user)?

The term "logically" in this context means that controls and displays are laid out in a way that makes sense to the users, that meets their expectations of how the system should operate, and that clearly maps onto the nature of the systems or processes being controlled. In practice, this means that related controls and displays (e.g., those that are involved in the operation of the same system/process) are located closely together, that all displays related to an individual system/process are grouped together, and that different displays present similar information using similar formats.

Most of the remaining questions in this section are designed to examine specific elements of this rather general, introductory question. In other words, each of these questions will examine specific aspects of the "logic" of the design and layout of the controls and displays in more detail.

Question 2: Are related controls and displays grouped together?

Controls and displays that are related to the same underlying system or process should be located closely together. In other words, a worker should be able to operate a control (e.g., push a button, turn a dial, etc.) and easily see (or, in some cases, hear) the results of that activity as specified on a related display. Similarly, if there is more than one display and/or more than one control that are related to the operation of a particular system and process, these should also be grouped together.

Question 3: Are all necessary controls readily accessible for routine and emergency operations?

Controls that are most critical to successful routine and emergency operations should all be easily accessible from the worker's primary location. Specifically, controls should be easily operable from that distance.

Question 4: Are necessary controls readily accessible from all relevant work positions?

Workers must quite often perform tasks from a variety of different locations. It is important to determine whether there are locations in which access to and accurate operation of important controls is difficult. Which controls, if any, are difficult to access?

Question 5: Do separate controls operate in a logically consistent manner?
Controls are said to "map" onto the underlying systems or processes they control. For instance, turning a dial to the right might *increase* the level of activity in a process while turning it to the left might decrease the level of activity. It is important that all of these "mappings" be consistent in order to avoid confusion, particularly during upset conditions.

Question 6: Does the sequential layout of the controls follow the normal sequence of operations?
If a particular set of controls is intended to activate, control, and/or deactivate a specific, sequential process (as in "First do Step A, then do Step B, then Step C, etc.") then the physical layout of the controls should match the normal sequential pattern of operations.

Question 7: Are all controls distinguishable and easy to use?
It is important that all controls be easily distinguishable from each other in order to prevent a worker from mistakenly using the wrong control simply because it feels or looks the same as a control that does something completely different. However, if the spatial separation between controls with very different functions is such that workers are very unlikely to mistakenly use one when they mean to use they other, then similarity in appearance is less of a problem.

Question 8: Are all controls appropriately clearly identified and/or labeled?
All controls should have some sort of clearly perceivable and understandable identification or labeling (either alphanumeric or symbolic). This is particularly important in preventing errors by inexperienced workers.

Question 9: Do any controls violate strong expectations (color, direction of movement, etc.)
In our society some colors have very strong symbolic associations. For example, green signifies "go," red signifies "stop" or "danger," and yellow signifies "caution." It would be unwise to use the color red to identify a control that starts a process, just as it would be unwise to use the color green to label a control that stops a process. Similarly, turning a control to the right or pushing it forward or up should signify an increase in the underlying process, while the opposite motions should correspond to a decrease.

Question 10: Are there any controls that are confusing or in any way difficult to operate?
Workers will often point to one or two specific controls as being particularly problematic. The difficulty may be related to issues addressed in the preceding questions, or there may be some other underlying problem. In any event, it is important to note which controls are difficult or confusing to operate as well as the frequency and the severity of the problem. As with all other questions in this checklist, it is important to obtain input from workers regarding what they perceive as the source of the problem.

Question 11: Have operators made any "quick fixes" to controls to make them more suitable to their needs?
Have workers done anything on their own to enhance the usability of any controls such as adding labeling, directions, warnings, etc.? This is a sign that the original design *may* be insufficient. However, it is important to verify that the modifications have not violated any of the control principles alluded to in previous questions.

Question 12: Is there a dedicated emergency shutdown panel? Is it easily accessible?
An emergency shutdown panel should be located in an easily accessible location. It should be designed in such a way that malfunctioning systems and processes can be quickly and effectively shut down.

Question 13: Are all necessary displays clearly visible from all relevant work positions?
Information contained within visual displays should be clearly visible by operators with normal (20/20) or corrected-to-normal vision from their work stations. It is not necessary to be able to see information on displays that are not relevant to work performed at a given work station.

Question 14: Do any displays violate strong expectations (color, direction of movement, etc.)
As with controls (see Question 9), the design of displays should also not violate strong expectations derived from societal norms about the meanings of color and direction. For instance, the use of green or blue to specify an emergency or unsafe condition violates normal human associations, at least in our society. The color red is much more effective for specifying emergency situations, yellow for specifying conditions approaching an emergency situation, etc. Similarly, dials or other indicators within displays should move to the right or up in order to specify increases in underlying systems or processes, and to the left or down to specify decreases.

Question 15: Are symbols and terminology consistent across displays?
A consistent set of symbols and terminology should be used across all displays in order to avoid possible confusion, particularly with inexperienced workers. Similarly, displays should use the same scales and metrics to the greatest extent possible. For example, unless there is a compelling reason for doing so, specifying temperature on one display in Fahrenheit and on another in Celsius is a bad idea as it adds a needless layer of complication that could result in an error.

Question 16: Is information about normal and upset process conditions displayed in a clear and understandable fashion?
Workers should be able to quickly and accurately extract necessary information under routine and upset conditions. They should be able to quickly and accurately obtain and update their "mental model" of the system on the basis of the information provided by the available displays.

Question 17: Do separate displays present information in a logically consistent manner?
To the extent possible, displays should present information using the same color coding and directional schemes, as well as the same scales and metrics. *Standardized* methods of presenting information facilitate safe work performance and help prevent errors.

Question 18: Are all displays appropriately labeled and identified?
All displays should be labeled and identified in such a way that workers can quickly and accurately determine the source and nature of the information being presented. This is particularly critical in preventing errors by inexperienced workers.

Question 19: Are operators required to perform calculations on information read from displays and are these calculations checked?

To the greatest extent possible, workers should not have to perform calculations on information read from displays. In other words, the information needed to understand what is happening with an underlying system or process or to know what to do next in a sequence of operations should be directly specified on the available displays. However, if calculations are required in some instances, some means should exist for verifying their accuracy, particularly if there could be high safety costs associated with errors.

Question 20: Do the displays provide an easily understandable overview or "big picture" of the entire process under operation?
It should be possible for workers to quickly obtain an accurate mental model of the current status of all key systems and processes by means of the displays.

Question 21: Do the displays provide information regarding all essential details of individual systems?
Workers should be able to quickly and accurately access display information regarding the status and/or activity of all essential elements of individual systems or processes. In some cases this information may not be immediately evident on individual displays and may require that workers "drill down" into existing displays to locate it. However, the information should still be easy to locate and interpret.

Question 22: Do the displays provide timely and accurate feedback about the results of operators' actions?
It is important that workers be provided with accurate and timely feedback about the results of their control activities. This information should be easy to locate and interpret.

Question 23: Do all mimic displays match the actual equipment and/or process configuration?
Mimic displays provide information in a specific way – they do so by providing a pictorial or schematic depiction of the system or process about which information is being conveyed. If mimic displays are used, it is important that they accurately depict the structure and dynamics of the actual equipment and/or process configuration.

Question 24: Is critical "historical" data presented on relevant displays?
It should be easy for workers to quickly and accurately obtain information about the past status of individual systems and processes for which such information is potentially relevant.

Question 25: Do displays provide adequate information regarding processes that are approaching or have already entered potentially dangerous conditions?
Displays should provide "out-of-tolerance" information in a manner that is easily perceived and interpreted by workers. In many cases, an alarm may be employed to further ensure that workers are aware of the situation, particularly if the safety costs associated with a continued out-of-tolerance condition are high.

Question 26: Are there any other displays that are confusing, provide misleading information, or that are in any way difficult to interpret?

The preceding questions have addressed the major ways in which displays can interfere with workers' performance and/or lead to errors. This question is meant to capture problems with other displays that might not have been addressed in previous questions.

Question 27: Have operators made any "quick fixes" to displays to make them more suitable for their purposes?
Have workers done anything to enhance the legibility, interpretability, or meaningfulness of any of the displays in their work area? If so, this is a critical indication that the original design *may* be insufficient. However, it is important to ensure that the modification has not violated any of the display principles alluded to in previous questions.

Section 3 – Alarms
Question 1: Are there a sufficient number of alarms, and are they operational?
Each system or process which, if malfunctioning, could present a significant safety risk should have an alarm associated with it. All alarms should be in good working order.

Question 2: Are the alarms sufficiently diagnostic of problems, emergencies, and upset conditions?
Workers should not be confused by the meaning of alarms. That is, they should be able to quickly and accurately determine the location and cause of each alarm when it occurs. The use of spatially distinct or perceptually distinct alarm sources can significantly aid this process.

Question 3: Is it easy to discriminate between alarms, or are they easily confused?
It should be easy for operators to discriminate between alarms when more than one is activated at the same time. Making separate alarms spatially and/or perceptually distinct can help.

Question 4: Do operators complain of "alarm flooding?" If so, under what circumstances.
"Alarm flooding" refers to a condition in which so many alarms are activated at once that operators find it difficult, if not impossible, to discriminate between them and to determine which, if any, have the highest priorities. It is important to determine whether or not workers have experienced alarm flooding, and under what conditions.
Question 5: Are workers provided with enough information to diagnose a problem when an alarm sounds?
The primary function of an alarm is to draw the worker's attention to the fact that an unsafe situation exists. However, it should also help draw the worker's attention to information that helps him determine the nature of the problem as well as what to do about it. Therefore, alarms need to be appropriately coupled with displays that provide this type of information.

Question 6: Are alarms activated according to priority?
When multiple alarms are activated, those which signal problems with the greatest urgency should be the most noticeable. This can be accomplished by automated suppression of less urgent alarms and/or invoking means to make the most urgent alarms more perceptually salient (e.g., louder, brighter), or by listing alarm conditions in order of priority on a central visual display.

Question 7: Do workers have the ability to silence low priority alarms?
In order to avoid problems with alarm flooding, workers should have the ability to manually silence or otherwise temporarily deactivate low priority alarms. However, it is critical that the systems or processes associated with these alarms continue to be automatically monitored and for associated alarms to periodically activate until the underlying problem is resolved.

Question 8: Is an alarm summary permanently on display?
An alarm summary is a visual display that provides a quick, at-a-glance summary of the status of alarms in a particular work environment. For example, a green light next to a symbol or other indication for a system or process might indicate an alarm-free condition (known as a "green board"). A red light associated with any system or process would indicate the presence of an alarm condition.

Section 4 – Signs and Labels
Question 1: Is all essential equipment clearly and unambiguously labeled?
All essential equipment (tools, operating and emergency manuals, safety equipment, etc.) should be labeled in a legible and clearly understood manner.

Question 2: Are the labels accurate and up-to-date?
All labels should be accurate both in terms of and identifying the equipment as well as reflecting any substantive, recent changes in the nature or status of the equipment.

Question 3: Are emergency exit signs clearly visible?
Emergency exit signs should be clearly visible under all appropriate lighting conditions. They should unambiguously and clearly indicate the location of each emergency exit.

Question 4: Are emergency response signs clearly visible, understandable, and accurate?
Signs that provide emergency procedure and response information should be legible and easily located when needed. They should convey emergency information in a clearly understandable fashion, and the information they convey must accurately reflect the emergency actions that need to be taken in the facility in which they are located.

Section 5 – Communications Equipment
Question 1: Is communication equipment easily accessible?
Workers should have ready access to communications equipment when it is needed. They should not have to spend time searching for it, and there should be enough equipment so that all workers who need it have it. These issues are important in the smooth functioning of routine operations, and essential for the successful resolution of emergency situations.

Question 2: Is communication equipment routinely kept in good working order?
Communications equipment cannot be effective if it is not kept in good working order. The equipment should be durable and reliable, and should be maintained in good working order. Battery life in the use of wireless equipment should be such that it does not routinely present any problems.

Question 3: Is the communications equipment easy to use?
Operators should find that the communications equipment is easy to use. Specifically, all features of the equipment important to use in routine and emergency situations should be well understood, enabling relatively error-free use. Any features that are not easy to use or which cause frequent errors should be identified.

Question 4: Does the communications equipment afford reliable, clear communication in routine and upset conditions?
To the greatest extent possible, the equipment should enable communication that is free of mechanical or electromagnetic interference (i.e., static), is not susceptible to interference caused by "competing" communications, and which does not disconnect or otherwise interrupt communications.

Question 5: Is there a sufficient number of communication channels to permit effective communications in routine and upset conditions?
Communication should not be limited by an absence of sufficient communication channels. The number of channels that are needed depends on the number of people using the system and the number of parallel conversations that might need to occur in routine or emergency conditions.

Question 6: Is there a method for assuring that low priority communications do not interfere with high priority communications during upset conditions?
If possible, operating procedures should be devised to ensure that low priority communications do not occur during upset or emergency conditions, or at least do not interfere with high priority communications.

Section 6 – Protective Equipment
Question 1: Are adequate supplies of protective equipment available for routine and emergency use?
It is obviously important that protective equipment be available to support all workers during routine conditions, and in case of emergencies. Are there sufficient quantities available? Do workers know where the equipment is located?

Question 2: Is all protective equipment easy to use?
With the understanding that some equipment may require training in order to use properly, it is nevertheless important that workers fully understand how to operate all protective equipment. It is important to identify any protective equipment that workers perceive as difficult to use and take steps (either through training and/or purchase of better designed equipment) to alleviate the situation.

Question 3: Is all protective equipment effectively and appropriately labeled?
All protective equipment should be identified with legible and appropriate labeling. If specific types of protective equipment require periodic inspection, the date and result of the most recent inspection should be posted near the equipment.

Question 4: Is emergency protective equipment available near locations where it is likely to be needed?
To the greatest extent possible, emergency protective equipment should be physically located near work locations where it is most likely to be needed.

Question 5: Is sufficient training provided in the use of protective equipment?
It is important to determine whether or not workers have received training in the use of protective equipment, and whether or not that training has enabled them to be proficient in its use. This information can be obtained by examining formal training records for a sample of workers and by interviewing workers and asking them to demonstrate the use of the equipment (when practical).

Section 7 – Operations and Emergency Procedures Information
Question 1: Is a complete set of operations manuals (hard copy and/or online) available and easily accessible?
Workers should be able to quickly identify the location of all operations manuals related to their job assignment.

Question 2: Is a complete set of emergency procedures manuals (hard copy and/or online) available and easily accessible?
Workers should be able to quickly identify the location of all emergency procedures manuals related to their job assignment.

Question 3: Are the operations manuals clear, concise, and understandable?
Operations manuals, whether in hard copy or online, should be easy to use and easy to understand. Operators should be able to quickly locate the information they are searching for, and should be able to understand the information provided once they have located it. The information should be complete without being needlessly complex or wordy. In short, workers should not view the use of operations manual as a source of frustration and/or a needlessly complex operation.

Question 4: Are the emergency procedures manuals clear, concise, and understandable?
The comments above regarding operations manuals also apply to emergency procedures manuals. However, it is *especially* important that workers be able to quickly and accurately locate emergency procedures information.

Question 5: Are operations manuals used on a regular basis? If yes, why? If no, why not?
The frequency with which operations manuals are used can be due to any number of different factors. Perhaps they are needlessly confusing and difficult to use, so that while workers would like to have something useful to refer to they do not use the existing manuals. Perhaps the technology, tools, and procedures used in this particular workplace are sufficiently clear and usable that confusion and/or errors seldom arise, and reference information is rarely needed. Perhaps operations manuals are frequently used by less experienced workers, but not by more experienced workers – or perhaps vice versa. In any event, the reasons that underlie the

frequency with which operations manuals are used can provide useful clues into their usability, as well as the overall usability of the technology, tools, and procedures of the workplace.

Question 6: Are emergency procedures manuals used during upset or emergency conditions? If yes, why? If no, why not?
As with operations manuals, the underlying reasons for why emergency procedures manuals are used or not used are also important to determine. The issues cited in Question 5 are also important to examine in this case.

Question 7: Are there administrative controls in place to ensure that documentation is current and correct?
Is there a formal method in place to ensure that information contained in the operations and emergency procedures manuals is correct and up-to-date? Do the manuals contain any sort of "verification" that the information has been recently reviewed for currency and accuracy? Are workers able to recommend revisions? If so, are the recommendations taken seriously and how are they processed?

Question 8: Are there procedures to ensure that a change to one type of documentation will lead to changes in other types of documentation that are related to it?
It is often the case that when normal or emergency procedures related to a specific task, sub-system, or device within a particular workplace are modified, then procedures with related tasks, sub-systems, or devices are also impacted. Is there a method for assuring that when changes are made to particular elements within the procedures that the impact on all related elements is taken into account?

Question 9: Is there a procedure to notify operators of updates and revisions?
Are workers given effective notice of changes to operations and emergency procedures manuals? If they have questions about the changes, are the able to get satisfactory answers?

Section 8 – Training
Question 1: What training do new workers receive before beginning full-time work responsibilities? Do workers view this training as sufficient?
It is important to get an accurate sense of *all* training that workers received prior to starting the job – not simply training related to safety. Do workers feel relatively confident as a result of this training? Do they feel well-prepared?

Question 2: Of the above training, how much is devoted to safety? Do workers view this as sufficient?
How much and what type of safety training do new workers receive before they assume their normal work duties? Do workers feel that this training adequately prepared them to deal with safety risks on the job?

Question 3: What additional training do new workers receive after starting work? Do workers view this additional training as sufficient?

Once workers have completed initial training and assumed full-time work duties, what additional training do they receive. This question refers to *all* training, and not just safety training. Is formal or informal on-the-job training made available?

Question 4: Of the above training, how much is devoted to safety? Do workers view this additional training as sufficient?
How much and what type of safety training do new workers receive *after* they have assumed full-time work duties. Is formal or informal on-the-job training made available?

Question 5: How frequently do experienced workers receive refresher training? Do workers view this training as sufficient?
Besides examining the frequency of refresher training, it is also important to determine what types of periodic training experienced workers receive, either in the form of classroom or on-the-job training. What portions of this training are mandatory, and what portions are optional? Do workers regard this training as effective? This question refers to *all* training, and not just that related to safety.

Question 6: Of the above training, how much is devoted to safety? Do operators view this training as sufficient?
How much and what type of safety refresher training is provided to experienced workers? How frequently does it take place? What portions are mandatory and what portions are optional? Do workers regard this training as effective?

Question 7: Does operational and/or safety training make use of "lessons learned" from actual previous emergency or upset conditions?
Does any part of the training curriculum involve discussions, simulations, problem-solving exercises, etc. of actual emergencies, accidents, incidents from the actual worksite, or one very similar to it? Do workers view these exercises as instructive? Why or why not?

Question 8: As part of training, are workers given the opportunity to perform work-related procedural or safety tasks and/or solve work-related procedural or safety problems under simulated emergency conditions?
Does training afford workers the opportunity to perform tasks and/or solve problems under simulated emergency or upset conditions? Is this training viewed as valuable? Why or why not?

Question 9: Is there a formal means for providing feedback on the adequacy /quality of operational and safety training?
Are workers provided with a means to provide feedback to management and training personnel on the adequacy and quality of the training they have received? Are there methods for making suggestions to improve training and/or add new training units?

Question 10: Are operators encouraged to request additional operational and/or safety training? Are workers encouraged to receive optional training? Are there methods in place for workers to request optional training, and how are such requests processed?

Question 11: In general, is training viewed as a positive, valuable use of time, or is it viewed negatively? What improvements would workers like to see, if any?
Do workers view the training they receive (or have available to them) in a generally positive or negative way? Do they feel that quality training is a high priority within the organization? How would they like to see training improved?

Section 9 – Workload, Situation Awareness, Stress, and Fatigue
The human factors engineer is interested in workload, situation awareness, stress, and fatigue for three major reasons:

(1) To what extent do the design and implementation of job-related technologies, tools, and work procedures contribute to excessive and unsafe levels of these factors,
(2) How do excessive levels of these factors adversely influence safe work performance, and
(3) How can technology, tools, and work procedures be designed (or re-designed) to help manage levels of these factors?

Many of the questions in preceding sections have addressed issues directly relevant to workload, situation awareness, stress, and fatigue. This section contains others that touch on issues that have not been addressed.

Question 1: Are there any specific tasks that are particularly difficult to carry out with existing equipment and/or work procedures? Why?
It is often the case that one or more tasks in a given workplace are more difficult to carry out than others. This may be due to a number of factors, including the inherent difficulty of the task (e.g., it involves more physical and/or mental effort than other tasks just by its very nature). However, in other cases the level of difficulty may be unnecessarily increased by poor design of the human-machine interface, the specific work procedures involved, and/or other related factors. Whatever the cause, it is important to identify the tasks that are the most challenging to perform, and to understand *why* they are difficult. With this knowledge we can begin to examine possible ways of making task performance less difficult.
As always, we are most interested in identifying tasks which would pose the most significant safety risks if an error occurred during their performance.

Question 2: Is sufficient information available to inform operators of the status of automated processes?
Automation is often described as a "double-edged sword." On the positive side, the ability of machines to handle the drudgery of continually monitoring the status and activity of largely repetitive processes and systems frees the worker from having to perform these monotonous tasks. However, automation can also induce a false sense of security in workers, and may also cause them to lose the sort of situation awareness which can spell the difference between success and failure in quickly and effectively responding to an emergency.
Effectively dealing with these risks of automation requires that workers be presented with information that allows them to maintain a consistent and accurate mental model of the activity of all relevant systems and processes (see Section 2 – Controls and Displays) It is important to

ask workers if they are provided with the right information to maintain this functional state of awareness.

Question 3: Would others always know that a worker is incapacitated or otherwise in trouble in the work area?
In most work areas it is not always possible to maintain direct line-of-sight contact with one's fellow workers. Some work areas may have areas (towers, loading docks, etc.) that are located a significant distance from the "main" work or control area. What methods exist to enable workers to become aware that a co-worker is incapacitated or otherwise in need of assistance? Are workers satisfied with these methods?

Question 4: Under routine conditions, are workers required to perform tasks in different locations? Does this present any problems related to effective or safe job performance?
Workers commonly perform different tasks in different locations. However, if this presents problems during routine operations (e.g., in terms of getting work done safely and effectively) then this is a sign that the workplace, work procedures, or both are not well designed.

Question 5: Under upset or emergency conditions, are workers required to perform tasks in different locations? Does this present any problems related to effective or safe job performance?
As in the previous question, it is not unusual for workers to have to perform tasks in different locations even under upset or emergency conditions. However, if too little time is allotted to perform too many tasks in too many different places, this could result in an unsafe situation.

Question 6: Under routine conditions, are workers required to perform multiple tasks within a short time span? Does this present any problems related to effective or safe job performance?
It is not unusual for workers to have to perform multiple individual tasks within short periods of time as a routine part of their job. However, it is important to determine if this ever presents problems in terms of effective and safe job performance.

Question 7: Under upset or emergency conditions, are workers required to perform multiple tasks within a short period of time? Does this present any problems related to effective or safe job performance?
As in the previous question, it is not unusual for workers to have to perform multiple individual tasks within very short periods of time in upset or emergency conditions. However, it is important to determine if there are situations in which too many tasks may be required to be performed in too short a time.

Question 8: How frequently are rest breaks taken (including lunch, coffee breaks, and informal rest breaks)? On average, how long are these breaks? Are there ever days when workers take few or no breaks?
It is important to determine if workers are taking regular breaks, and if there are ever circumstances under which breaks are missed.

Question 9: How many days per week and hours per day do workers normally work?
The amount of days normally worked per week, and hours normally worked per day, are obvious factors that can impact worker fatigue and safe work performance. When asking this question, it

is best to ask the worker being interviewed to report on their own habits, but also to report on their observation of what is typical with other workers in their unit or workplace.

Question 10: Is there adequate coverage available if one or more workers fail to come to work?
"Short staffing" can lead to increased safety problems associated with workload, situation awareness, stress, and fatigue. It is important to determine if adequate coverage is routinely available if one or more workers calls in sick or otherwise does not come in to work.

Question 11: On average, how much overtime do workers put in?
The amount of overtime that workers routinely put in can be a leading cause of on-the-job fatigue. When asking this question, it is best to ask the worker being interviewed to report on their own habits, but also to report on their observation of what is typical with other workers in their unit or workplace.

Question 12: Do workers always work within the same unit/site or do they rotate between units/sites? Has this ever caused problems with effective or safe job performance?
Depending on the nature of the job, an occasional "change of scenery" can be a positive thing with little or no impact on safe job performance. In other cases, however, it might lead to confusion or disruption in normal patterns of task performance. Does job site rotation ever occur? If so, does it ever interfere with effective or safe job performance?

Question 13: Are there any aspects of work that result in feelings of excessive physical or mental workload?
"Excessive physical or mental workload" can be interpreted as meaning that at a given moment on the job the worker feels so completely overwhelmed that if one or two additional tasks or problems were to arise he/she would not be able to perform tasks accurately or well. It is particularly important to identify situations in which this routinely occurs as there may be underlying design or procedural issues contributing to the problem.

Question 14: Has excessive workload ever caused you or others to "cut corners" or commit an error? Has it led to any other problems?
When workload reaches unacceptably high levels, workers will often compensate by cutting corners or skipping steps in procedures. In some cases this may be relatively unimportant, but it other situations it may lead to significant safety problems.

Question 15: Are there aspects of work that result in a potentially dangerous loss of situation awareness?
"A potentially dangerous loss of situation awareness" can be interpreted as meaning that the worker temporarily loses a sense of what is going on around him in the workplace *and* that this loss of awareness presents a problem in terms of his ability to work safely and effectively. Loss of situation awareness, if it occurs routinely or in particularly critical situations, can be a key indication that there may be underlying design or procedural issues contributing to the problem.

Question 16: Has loss of situation awareness ever caused you or others to "cut corners" or commit an error? Has it led to any other problems?

Loss of situation awareness is a common cause of human error. If it occurs routinely or under critical conditions, it is important to understand the underlying circumstances so that they can be addressed.

Question 17: Are there aspects of work that produce potentially dangerous feelings of fatigue?
Fatigue is now understood to be one of the leading causes of accidents in and out of the workplace. While the causes of fatigue may arise from conditions outside the workplace, it may also be the case that conditions within the workplace are leading to potentially dangerous levels of fatigue. If this is the case, there many be underlying design or procedural issues that are contributing to the problem.

Question 18: Has excessive fatigue ever caused you or others to "cut corners" or commit an error? Has it led to any other problems?
As anyone who has ever come close to falling asleep at the wheel of a car knows, excessive fatigue can quickly lead to very dangerous conditions. It is important to get an accurate sense of the extent to which fatigue is a safety problem in the workplace, and the specific types of problems it has caused.

Question 19: Are there aspects of work that produce potentially dangerous levels of stress?
While in many circumstances a moderate level of stress can actually promote safe and effective on-the-job behavior, too much stress can lead to a significant deterioration. Stress can arise from a variety of work-related and non-work-related causes. It is important to identify any work-related design or procedural issues that might be contributing to excessive levels of stress among workers.

Question 20: Has excessive stress ever caused you or others to "cut corners" or commit errors? Has it led to any other problems?
"Stressed out" workers frequently behave differently on the job than they would under normal emotional conditions. Examining the types of instances in which excessive stress has led to potential safety problems is an important first step in exploring potential design or procedural solutions.

Section 10 – Problem Reporting and Resolution

Question 1: Do formal methods exist for reporting and addressing problems with the usability of controls, displays, manuals, protective equipment, alarms and other technology, tools, and procedures?
Every workplace should have an established procedure that allows workers to express concerns about the above issues. These procedures should take into account the need to keep workers informed about the status of their issues/suggestions, the steps that were taken in considering them, and their eventual disposition.

Question 2: Are workers generally satisfied with these methods (i.e., are issues taken seriously, resolved satisfactorily, etc.)?
Workers should feel that their opinions and inputs are taken seriously, and that an effective system exists for considering them. "Resolved satisfactorily" does not mean that all opinions and

inputs are accepted or adopted – however, it does mean that workers are given a satisfactory explanation of the eventual outcome.

Question 3: Do formal methods exist for reporting and addressing potential safety problems related to workload, situation awareness, fatigue, and stress?
As with question 1, every workplace should have an established procedure that allows workers to express concerns about the above issues. These procedures should take into account the need to keep workers informed about the status of their issues/suggestions, the steps that were taken in considering them, and their eventual disposition

Question 4: Are workers generally satisfied with these methods (i.e., are issues taken seriously, treated confidentially, resolved satisfactorily, etc.)
As with question 3, it is important that workers feel that the methods that are in place for dealing with these occasionally sensitive issues are effective. Maintenance of confidentiality is an especially key consideration in this respect as workers may not come forward with concerns of this sort if they feel their privacy may not be protected.

Appendix B Comments and Responses from the Public Workshop on the Safety Evaluation Scope of Work

A public workshop was held on October 2, 2002, at the Richmond City Hall to present the scope of work of the Safety Evaluation, and to take comments on the scope of work. Listed below are the comments received on the scope of work and written responses to each of the comments.

1. Will the evaluation address the compatibility of the facility with the surrounding land use?

Compatibility of the facility with the surrounding land use was not part of the scope of the evaluation. Section 2.0 of this report discussed the scope of the study. Additional information on the scope of the evaluation can be found in Appendix A.

2. Will the evaluation identify issues that are so large that the recommendation would be to shut the facility down?

The purpose of the evaluation was to evaluate GCRW's safety management systems, human factors issues, and the safety culture at the facility, and to identify areas where there were deficiencies. It would be up to the local decision makers to determine if the identified deficiencies were significant enough to warrant shutting the facility down.

3. What other facilities have the evaluation team looked at in a similar manner?

The evaluation team conducted a similar study of the Tosco Avon Refinery, which also included a sulfuric acid plant. All of the audit team members have over 10 years of experience conducting process safety management and human factor audits and evaluations, which have included refineries, chemical plants, semi-conductor plants, government facilities, oil and gas production facilities, hazardous material pipelines, etc.

4. You can see material coming from the tall stack. What systems are in place to assure that the plant is in compliance with its air permits?

While the scope of work for the safety evaluation did not include a review of air permits, the evaluation team did a review of the air permit for the main stack. The facility is regulated by the Bay Area Air Quality Management District (BAAQMD), under Regulation 9-Sulfur Dioxide (SO_2) Rule. Sulfur Dioxide from the main stack can not exceed 300 ppm @ 12% O_2 over a one hour period. Monthly stack monitoring reports are submitted to the BAAQMD which provide average 24-hr and peak 1-hr SO_2 readings from the stack. The evaluation team reviewed the monthly reports to the BAAQMD for the years 1999, 2000, 2001 and 2002, and found no exceedences of the 300 ppm limit. The stack is equipped with a continuous emission monitor, which measures the SO_2 concentration in the gas leaving the stack. This monitor is source tested annually by a contractor certified by the BAAQMD. The last source test was on May 31, 2001.

The controls at the facility are set-up such that if the SO_2 concentration leaving the stack is greater then 300 ppm for 15 minutes then the facility automatically shuts down. This

control system prevents the facility from exceeding the threshold for SO_2 established by the air permit.

5. The evaluation should look at the agency notification procedure in the event of an emergency and the method of how this is implemented.

The evaluation did look at the agency notification procedure used by the facility. In March of 2002 the facility revised the Agency notification procedure. The written procedure is for is an Operator to notify the EHS Manager first, who will then notify the agencies. If the Operator can not reach the EHS Manager, then they are to contract the Plant Manager, who will make the notifications. If the Operator can not reach the EHS Manager or the Plant Manager within 10 minutes then the Operator is to make the calls to the agencies. The assessment team found that there was confusion among the Operators as to what the procedure is for making notifications in the event of an emergency (see Finding #2.1.6).

Appendix C Comments and Responses Received on the Draft Safety Evaluation Report

General Chemical Corporation

525 Castro Street

Richmond, CA 94801

(510) 232-7193

December 17, 2002

Mr. Ivor John
MRS Consulting
3140 Telegraph Road, Suite A
Ventura, California 93003

Subject: Comments on Draft Safety Evaluation Report

Dear Mr. John:

The following letter summarizes General Chemical's comments on the draft report dated November 15, 2002. These comments are from the salaried supervisors, as no written comments were received from the hourly personnel.

1. On page ES-1, under Scope and Approach – The first sentence of the third paragraph reads "…developed by CCHS staff with input from an ad hoc safety evaluation committee, the City of Richmond, the public, and General Chemical." The sentence should read "…developed by an ad hoc safety evaluation committee consisting of the City of Richmond, the public and General Chemical."
2. On page ES-2, under Strengths – The second bullet still references oleum. The sentence should just say "…potential releases."
3. On page ES-3, under Weaknesses – The last bullet states that safety program documents are generally complete, but there is no well-defined document control system. During the evaluation, I do not recall MRS finding any documents that were inconsistent. Therefore, the documents reviewed were more than "generally complete" and the value of a document control system is negligible. This bullet should be deleted, along with Finding 2.1.8 and the recommendation.
4. On page 1, under Scope – The first and second sentence do not agree. The first sentence states that the scope of work was prepared by CCHS staff. The second sentence states that it was developed by the oversight committee. The second sentence is more appropriate.
5. On page 8, under Safety Management Systems – The second sentence of the third paragraph states that a considerable amount of work has been done in the "past year or so." Earlier the report says two years. Two years is more appropriate.
6. On page 11, under Human Factors Findings – 2.2.3 states that human factors and ergonomic issues are not adequately addressed. Ergonomics is an annual training topic. The basis of this finding needs to be clarified.
7. On page 19, under Communications – The Lead and "B" Operators are on a 12-hour shift schedule and the "A" Operator is on an 8-hour shift schedule.

General Chemical Corporation

525 Castro Street

Richmond, CA 94801

(510) 232-7193

Thank you for the opportunity to comment on the draft report. Please contact me at (510) 237-3869 or on my cell phone to discuss these issues.

Sincerely,

Jeff W. Jakonczuk
Manager of Environmental, Health and Safety
Western Region

Responses to General Chemical Comments on the Public Draft Safety Evaluation Report

Comment #	Response
1	The text on page ES-1 has been modified to reflect the comment.
2	The reference to oleum has been removed from the text on page ES-2.
3	The Safety EvaluationRreport includes a strength that recognizes the work that has been accomplished by GCRW during the last 2 years in formalizing the safety program documents (page ES-2, third bullet). The need for a Document Control System is identified to provide further improvement to the process. While onsite, the evaluation team identified a number of areas where there was a lack of formality in the Document Control System. For example: (1) There did not appear to be a formal process for incorporating the "yellow bulletins" from the Plant Manager into the site policies and procedures manuals; and (2) Job Descriptions for the Lead Operator, 'A' Operator, and 'B' Operator were undated, and the Job Descriptions for Engineer-Project and Senior Chemist included unsigned, hand-written revisions.
4	The first two sentences under "Scope" on page 1 have been modified to make them consistent.
5	The text under "Safety Management Systems" has been modified to make it clear that the work was done during the past 2 years.
6	The Safety Evaluation Team is aware that GCRW does conduct ergonomics training. The main intent of this finding is to address human performance issues (e.g., cognitive, perceptual, problem solving), particularly those factors that can lead to human error in the work place. These topics are not normally covered in an ergonomics curriculum The human factors training would include topics such as equipment design principles, human error prevention, consequences of high workloads, and pre-occupation with issues other than the work in hand, fatigue, stress, etc. The training would be a high-level discussion intended to provide workers with an awareness of these issues, and could probably be covered in a class of 2 hours. The findings and recommendations have been modified to clarify this.
7	The text under "Communications" has been modified to reflect the comment.

General Chemical Safety Evaluation
Public Meeting on the Draft Report
Richmond City Council Chambers
December 2, 2002
7 pm to 9 pm

Comments Received at the Public Meeting

Comment #	Comment
PM-1	What is the normal expectation of cultural change or shift as far as timing, expectations, and completion/implementation?
PM-2	It appears that the study was objective and that there are helpful recommendations. Some of the findings are not surprising. The implementation of the recommendations is key. There needs to be feedback and a time table developed for implementation of the recommendations.
PM-3	In the recommendation for Finding 2.3.6, there is reference to training for workers to help them increase their personal effectiveness. What specific training are you recommending? What specific training is suggested as part of one of the recommendations?
PM-4	What is a near miss?
PM-5	Sometimes there's smoke coming out of the tall stack. Is that a near miss?
PM-6	Is the high personnel turnover due to illness?
PM-7	Over half of the workers don't feel the safety rules are practical; will workers be involved in creating safety rules?
PM-8	If General Chemical does not implement the recommendations in the final report, then the recommendations are useless. Does the Safety Evaluation Report provide a timetable for implementing the recommended?
PM-9	General Chemical has been cooperative in the past, so they probably won't drag their feet in this case. If an accident does occur, the public will be very upset, so it is in General Chemical's best interest to address all of the recommendations as soon as possible.
PM-10	What was recent work seen from the road at the facility?
PM-11	The report says the equipment is old.
PM-12	How can you show improvement without follow-up?
PM-13	Is recording all near misses an improvement?
PM-14	When is the Safety Evaluation Report schedule to go in front of the Contra Costa County Board of Supervisors and the Richmond City Council?

Responses to Public Meeting Comments on the Draft Safety Evaluation Report

Comment #	Response
PM-1	Typically, it can take years to accomplish a lasting change to the culture of an organization. It takes leadership to drive and motivate change; there needs to be a clear plan of what changes are being sought, and there needs to be broad support for the change to be sustainable. Also, for smaller facilities like GCRW, cultural change can occur more quickly. In the last 2 years there has been a positive change in the corporate level at General Chemical, and there is a new management team in place at GCRW. With a commitment to change, considerable progress could be achieved within one to 2 years.
PM-2	The Oversight Committee has discussed the possible need for a follow-up evaluation, but no firm decision has been made to date. The conclusion section of the final report includes a new paragraph that emphasizes the importance of GCRW's commitment to the implementation process, and the potential benefits of redoing the safety culture survey in about 6 months time.
PM-3	This recommendation presupposes that there will be an effort at GCRW to accomplish some degree of cultural change among the workers. For these workers, the cultural change is expected to change the "norm" as to what the day-to-day work experience will entail. It is unreasonable to expect that workers will adapt to this without help. The training may involve a formal meeting to outline the new standards and expectations, to promote the merits of teamwork, and to develop strong leadership skills.
PM-4	The American Institute of Chemical Engineers defines a near miss as "an extraordinary event that could have resulted reasonably in a negative consequence (harm to people, damage to property or the environment, or production loss) under slightly different circumstances, but actually did not." Typically, there are a lot more near misses than actual accidents/incidents based on statistics, but often the near misses go unreported because there have been no adverse consequences.
PM-5	Under normal operations at the facility there is always material being released from the tall stack. The facility has a permit from the BAAQMD that regulates the sulfur dioxide emissions that are released from the tall stack. The gas released from the stack is hot, and under certain meteorological conditions the material being release from the stack will appear as a white smoke. This typically will occur when the air temperature is cold, and water vapor in the gas is condensed by the cold air, resulting in a gas having an appearance of white smoke. This white smoke would not be considered a near miss since it is part of normal operations and results from specific meteorological conditions.
PM-6	The high turnover referred to in the report is in the management staff. Many of the workers at GCRW have been there a very long time. There was no unusual indication of worker health problems. The turnover at management levels is more likely attributable to the past corporate culture. Also, at GCRW, two management positions were left unfilled for an extended time period after a

	disgruntled employee shot a supervisor and a superintendent.
PM-7	Based on the interviews we conducted, it is likely that this survey score was due, at least in part, to concerns over the practicality of wearing goggles for certain maintenance procedures involving sulfuric acid. One of the recommendations in the report is to ensure that employees are more actively involved in developing safety rules and safe work practices that affect their work assignments. (See Finding 2.3.21).
PM-8	GCRW will be required to develop an action plan that addresses how they will implement each of the findings/recommendations. As part of this action plan GCRW will establish a timetable for implementation. The Safety Evaluation Report does not provide a timetable for implementation. However, the report does provide a ranking of the findings/recommendations, which provide GCRW with an indication of which findings/recommendations the evaluation team thinks are of high, medium and low priority. GCRW must develop the action plan based on their workload at the facility, and their facility procedures. Contra Costa County and the City of Richmond will track the progress being made on implementing the findings and recommendations as part of their regular audits and inspections at the facility. The type and extent of the follow-up will be determined by the Contra Costa County Board of Supervisors and the Richmond City Council as part of the presentations to these elected bodies on the Safety Evaluation. These presentations are expected to occur in January 2003.
PM-9	Comment Noted. See Response to Comment PM-8.
PM-10	The recent work being done at the facility was for a “turnaround”. A “turnaround” is a schedule activity where the facility is shutdown and maintenance activities that cannot be done when the plant is operating are done of various parts of the facility.
PM-11	The report notes this, but a review of mechanical integrity was not part of the scope. GCRW is making substantial investments in mechanical integrity, and they are transitioning from a reactive to a proactive approach.
PM-12	A follow-up will show progress, but not necessarily improvement. (See response to PW-2 regarding follow-up.)
PM-13	There are many advantages to reporting and recording near misses. This raises awareness of identifying unsafe conditions and unsafe work practices, and it can foster a level of trust among workers that they will not be disciplined for bringing these conditions to the attention of management. It can also help to prevent major accidents. We believe that this would be an improvement for GCRW. However, there is no intention for having the near misses reported to CCHS. (See also the response to PW-4).
PM-14	A public presentation is schedule for the Contra Costa County Board of Supervisors for January 14, 2003 to present the results of the Final Safety Evaluation. The tentative plan is to hold a public presentation with the Richmond City Council on January 14, 2003.