

PrimaTech Consulting Services

Specialists in Safety, Security and Risk



PrimaTech

PREFACE

Primatech offers consulting services, training courses, and computer software in Safety, Security and Risk Management. This brochure describes our consulting services. If you would like copies of brochures that describe our training courses or computer software please request them (see below).

Each consulting service described in this brochure begins with a description of why you need the service. We describe how Primatech can help you, what we do to help you and why you should choose Primatech. Further information about Primatech is provided on the back cover of this brochure.

Primatech Inc.

**50 Northwoods Boulevard
Columbus, OH 43235 USA**

Telephone: 614-841-9800

Fax: 614-841-9805

www.primatech.com

Check out our website for technical papers, guides and resource materials on a variety of risk, safety, and security topics.

www.primatech.com

*"Nothing great was ever achieved
without enthusiasm."*

Ralph Waldo Emerson



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“Knowing is not enough; we must apply. Willing is not enough; we must do.”

Johann von Goethe

PROCESS SAFETY MANAGEMENT

developing and implementing new programs and enhancing existing programs

Companies that handle certain highly hazardous chemicals in excess of threshold quantities must comply with OSHA's Process Safety Management (PSM) standard, 29 CFR 1910.119 and EPA's Risk Management (RM) Program rule, 40 CFR Part 68.

These regulations are performance-based and compliance with them is quite different from specification-based regulations that spell out requirements. For PSM and RMP many decisions must be made by companies on how to meet the regulatory requirements and what levels of performance are appropriate. As technical improvements are made, OSHA's and EPA's expectations for performance increase. Companies must stay abreast of these developments and adjust their programs accordingly. Many companies find it is more cost effective to seek outside expertise when doing so.

Services Offered:

Primatech develops complete PSM and Prevention Programs for clients covering all elements of the regulations. Typically, this is done for new facilities or expanded facilities that come under coverage by PSM and/or RMP.

Primatech also assists companies in improving their existing programs. This work usually involves an initial assessment of the existing program to identify areas for improvement. Sometimes companies may have a sound PSM program design, but may be struggling with implementing it. Primatech's extensive PSM experience enables us to provide implementation guidance to clients in such situations.

Primatech also helps clients improve specific elements of their PSM programs. For example, we help clients fine tune mechanical integrity, management of change, and other programs that are part of PSM.

Primatech has developed guidelines for all PSM elements:

- Employee Participation
- Process Safety Information
- Process Hazard Analysis
- Operating Procedures
- Training
- Compliance Audits
- Trade Secrets
- Mechanical Integrity
- Hot Work Permits
- Management of Change
- Incident Investigation
- Contractors
- Pre-Startup Safety Review
- Emergency Planning and Response

Primatech works with clients to apply these guidelines to specific facilities. The guidelines take into account clarifications and interpretations of the regulations that have been issued by OSHA and EPA and thus help ensure regulatory compliance.

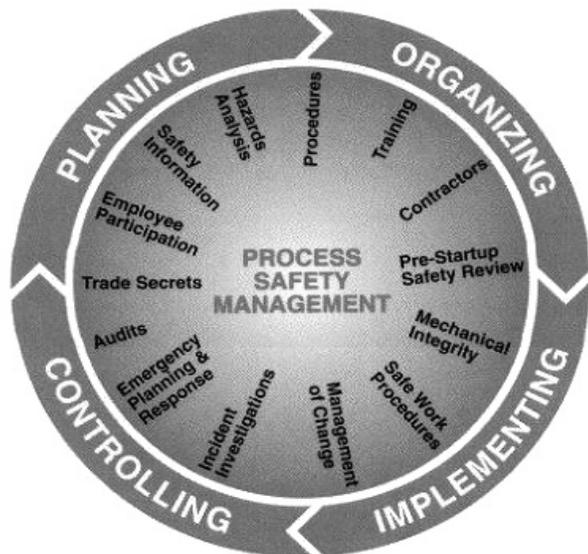
Primatech has developed many PSM programs for clients in a variety of industries. Unlike programs that merely re-state the PSM regulation, Primatech-developed programs reflect current regulatory expectations and match the requirements of the facility and company. They are designed to be put into practice immediately.

Primatech provides extensive knowledge of technical developments in PSM and regulatory expectations for compliance with the regulations. Primatech developed a Training Material Reference Manual for OSHA to elaborate on PSM regulatory requirements to help train OSHA inspectors.

Primatech offers over 30 training courses in various safety, security and risk topics and licenses computer software for PHA, Audits, Security and PSM.

"The best way to escape from a problem is to solve it."

Alan Saporta



Management system for process safety

- R** – Responsibility
- A** – Authority
- S** – Supervision
- R** – Resources
- A** – Accountability

Key issues in management

RISK MANAGEMENT

developing, updating and implementing RM programs

Companies that handle certain highly hazardous chemicals in excess of threshold quantities must comply with EPA's Risk Management Program (RMP) rule, 40 CFR Part 68.

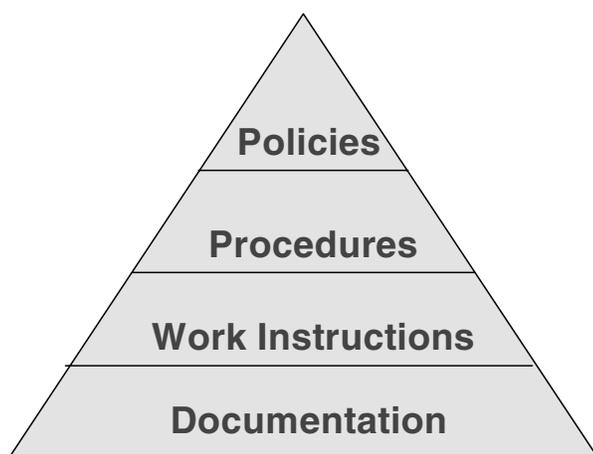
EPA's RMP rule embraces OSHA's PSM standard but applies it to protection of the public and the environment rather than employees as is the case with OSHA. However, the RMP rule goes beyond PSM in its requirements. For example, it requires the determination of impact distances for a worst-case accident and at least one alternative release scenario. These additional aspects of the RMP regulation require technical expertise beyond that required for PSM.

As with PSM, the RMP regulation is performance-based and compliance with it is quite different from specification-based regulations that spell out requirements. Decisions must be made by companies on how to meet the regulatory requirements and what levels of performance are appropriate. As technical improvements are made, EPA's expectations for performance increase. Companies must stay abreast of these developments and adjust their programs accordingly.

For these reasons, many companies find it is more cost effective to seek outside expertise in developing and maintaining their RMPs.

"There are no shortcuts to any place worth going."

Anon



The building blocks of a management system

Services Offered:

Primatech works with clients to cover the RMP requirements to:

- Develop and implement a Management System
- Conduct a Hazard Assessment
- Develop and implement a Prevention Program
- Develop and implement an Emergency Response Plan
- Submit a Risk Management Plan

We also assist clients in preparing updates to RMPs and risk management plans. These are required within five years of their previous submission, for new processes, or whenever a process becomes covered under the regulations, and when certain types of process changes are made.

We develop a Management System by working with our clients to assign responsibilities for the overall program and individual program elements, and by defining lines of authority. The Hazard Assessment involves an Offsite Consequence Analysis (OCA) and the compilation of a five-year accident history for the process. The OCA considers worst-case and alternative release scenarios so that impacts on the population and the environment can be determined.

The Prevention Program is EPA's equivalent of OSHA's PSM Program and the Emergency Response Plan is similar to the Emergency Planning and Response element of OSHA's PSM standard. We follow guidelines similar to PSM for their development.

The Risk Management Plan is used to notify EPA that a facility is covered under the regulations and provides summary information about the RMP. It must be certified by signature of a company representative.

Primatech has developed RMPs for a variety of facilities. We provide extensive knowledge of technical developments in RMP and expectations for compliance with the regulations.

Primatech offers the training courses:

- *"Developing and Implementing an EPA Risk Management Program" (2 days)*
- *"Updating Risk Management Plans (RMPs)" (1 day)*



PROCESS SECURITY MANAGEMENT

developing and implementing programs to protect facilities from terrorism and other criminal acts

Process security management addresses threats from terrorist and criminal acts against plants that may deliberately cause such harm as shutting processes down or the diversion or release of hazardous materials. Both physical and cyber attacks are possible. These risks are real and recent events have emphasized the need for such programs. Both government and industry are acting to remedy current shortfalls in process security. Improvement in security and immediate action is needed at many plants. Facilities must ensure they are secure from attack by adversaries.

Primatech has developed a comprehensive process security management program that parallels management systems used for process safety management (PSM) which address accidental releases of hazardous materials, and information security (BS 7799:2) which includes the protection of electronic information from cyber attack. Modeling process security management on these management systems offers numerous benefits. A considerable amount of development work has been performed and experience accumulated with these other programs. Most process companies invest significant resources in them and value them highly. Modification of an existing program to address process security is easier and more efficient than developing a completely new program. Furthermore, many companies already have in place elements of process security that can be integrated readily into an overall program.

"To the man who only has a hammer in the toolkit, every problem looks like a nail."

Abraham Maslow

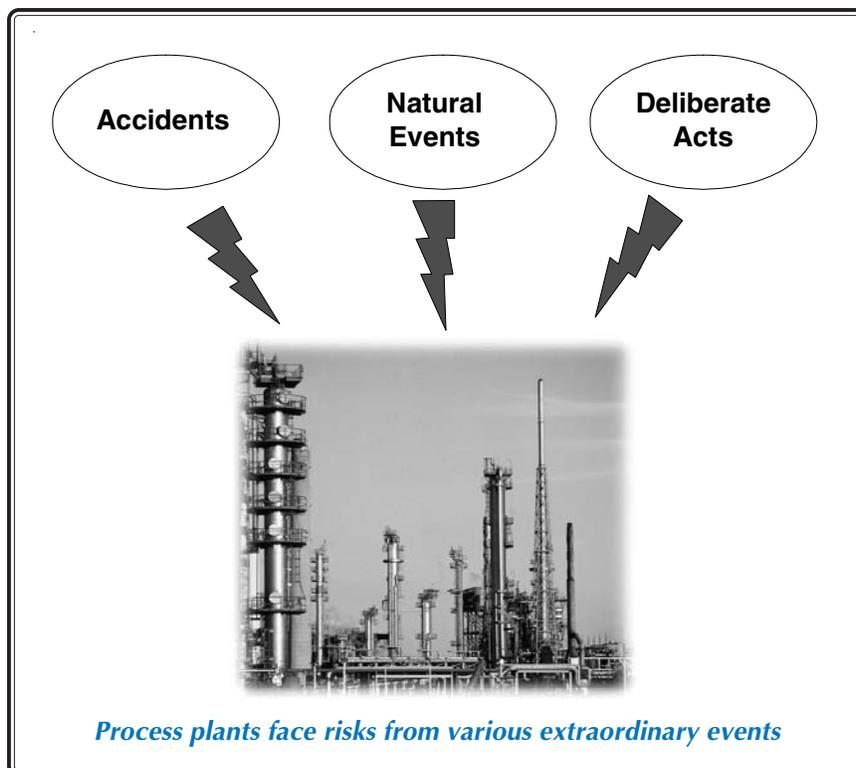
Services Offered:

Primatech assists clients in designing and implementing process security management programs. Such programs help reduce the likelihood and severity of terrorist and criminal acts. Primatech can also lead or assist with reviews and audits of facilities to assess the current state of protection against threats of terrorism and criminal acts.

Primatech has developed approaches for threat and vulnerability analysis and guidelines for the use of inherent security measures. We have formulated model process security programs for various threat levels that can be used as reference points for developing new programs or improving existing ones. These approaches have been published in periodicals and presented at conferences.

Primatech offers the training courses:

- "Process Security Management" (2 days)
- "Security Vulnerability Analysis" (2 days)
- "Countermeasures for Process Security" (1 day)
- "Understanding and Applying Cyber Security for Manufacturing and Computer Control Systems" (2 days)
- "Cyber Security Vulnerability Analysis" (2 days)



CYBER SECURITY MANAGEMENT

risk assessments and systems development to thwart cyber attacks

Cyber security is an established discipline for business computer system and typically has focused on the protection of information so it cannot be read, compromised or destroyed. Cyber security for process plants needs to be defined more broadly to include a range of malicious acts that could be perpetrated through access to the computer control systems within these plants. Cyber attacks can be mounted with very few resources and have the potential to cause impacts as tragic as those of September 11, 2001. Responsible risk management mandates that this threat be managed to protect the interest of employees, the public, the company, shareholders, customers, vendors, and our society.

Industrial cyber security can be defined as the protection of manufacturing and process control computer systems, and their support systems, from threats of:

- Cyber or physical attack by adversaries who wish to disable or manipulate them.
- Access by adversaries who want to obtain, corrupt, damage, destroy or prohibit access to valuable information. Note that a cyber attack may also be mounted to obtain sensitive information to plan a future physical or cyber attack.

Industrial cyber security has become an issue owing to the connections that are now often made between manufacturing and process control computer systems and business and enterprise networks that in turn are connected to the Internet. Process control systems may also contain computers with Internet connections, or modems for remote access. These connections with the outside world provide the means for attackers to penetrate the systems and cause harm. The potential also exists for cyber manipulation of control systems by people acting from inside a company. Current control systems were not designed with public access in mind, often have poor security, and are vulnerable to attack.

Services Offered:

Cyber Security Vulnerability and Risk Analysis:

Many companies have performed physical security vulnerability analyses (SVAs) for their facilities. The American Chemistry Council announced in November, 2003 that their member companies must perform cyber SVAs for the facilities on which physical SVAs have been performed by June, 2005. Such studies are new and have never been performed before. Primatech has developed three alternative methods for performing cyber SVAs (CSVAs): scenario-based, asset-based and sneak path analysis. They can be used to perform stand-alone CSVAs, adjuncts to physical SVAs already performed, or integrated cyber and physical SVAs. The methods are applicable to manufacturing processes as well as their value chains including transportation and distribution. Primatech provides facilitators for CSVAs.

"The difference between fiction and reality? Fiction has to make sense."

Tom Clancy

Cyber Security Assessments:

Primatech has formulated a cyber security assessment protocol that is appropriate not just for IT cyber security but also cyber security for process control systems and the value chain. This protocol can be used to assess the current state of cyber security practices for a company. Primatech assists companies in conducting assessments and audits.

Cyber Security Programs and Management Systems:

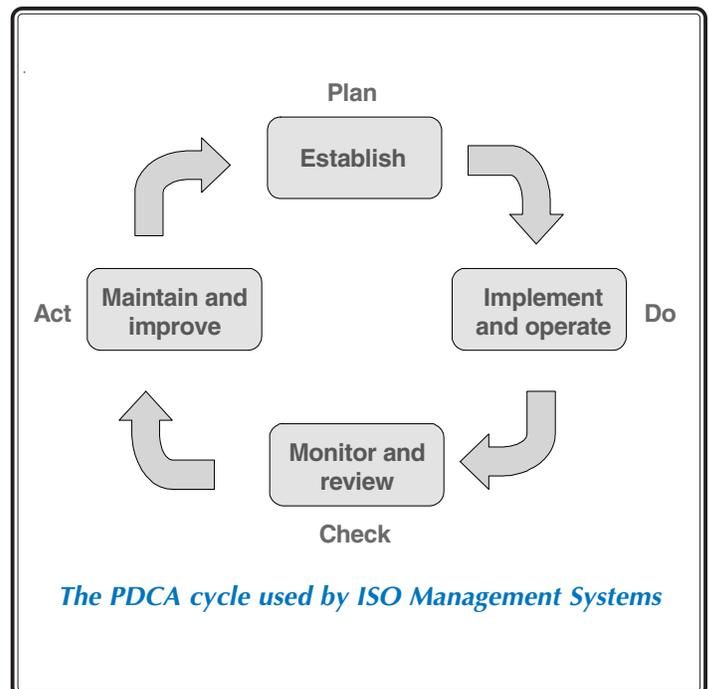
Primatech has developed a specification for cyber security management based on the internationally recognized ISO management system model. We can help you implement a management system for cyber security that will integrate with your existing management systems.

Primatech provides:

- Active participation in CIDX's cyber security initiative and the ISA SP 99 committee for Cyber Security of Manufacturing and Control Systems.
- Novel physical and cyber security methods that have been published in peer-reviewed journals. The methods were evaluated by CIDX and they have also been tested and refined in actual CSVAs.
- Expertise in chemical processes, control systems, cyber security, risk analysis, SVA, auditing and working with IT personnel and plant personnel to help both groups communicate with each other.
- Software including SVAWorks™ that is used for performing physical or cyber SVAs and AUDITWorks® that is used for performing audits and reviews.

Primatech offers the following training courses:

- "Understanding and Applying Cyber Security for Manufacturing and Computer Control Systems" (2 days)
- "Cyber Security Vulnerability Analysis" (2 days)
- "Process Security Management" (2 days)
- "Security Vulnerability Analysis" (2 days)



MANAGEMENT SYSTEMS

developing integrated management systems for sureties

Many companies have created separate management systems for different sureties such as quality, safety and environmental protection. These separate management systems lead to duplication of effort, additional costs, and possibly conflicts with requirements of one another. These conflicts are addressed after the systems have been implemented. It often leads to ongoing unresolved conflicts between the teams responsible for each surety.

The content and format of the ISO family of management system standards is being evolved to facilitate the integration of the management of different sureties. The American Chemistry Council (ACC) has also recently launched an initiative to combine its seven Codes of Management Practices in pollution prevention, distribution, product stewardship, process safety, employee health and safety, security, and community awareness and emergency response into a Responsible Care® Management System (RCMS).

An integrated management system (IMS) provides the opportunity to identify both commonalities in systems and conflicts in managing different sureties. Advantage can be taken of the many commonalities and conflicts can be managed rather than allowed to continue and interfere with performance. An IMS identifies potential conflicts as part of the design process. Solutions and appropriate compromises are built into the IMS so they do not recur on a continuing basis. For these reasons, an IMS is the most logical and cost-effective approach.

Services Offered:

Primatech has developed an integrated management system (PIMS) based on the ISO model that also addresses regulatory requirements and industry guidelines. Thus it can be used to integrate management systems that use such specifications as ISO 9001 (quality), ISO 14001 (environmental protection), OHSAS 18001 (occupational health and safety), OSHA PSM and EPA RMP (process safety), BS 7799:2 (information security), etc.

PIMS offers a number of features:

- Structures the client IMS with regard to facilitating its design, implementation, operation, maintenance, and improvement.
- Recognizes and takes advantage of the commonality of administrative controls for different sureties and places them in a separate section of the client IMS.
- Provides a section for surety-specific controls.
- Clearly and logically presents objectives, requirements, documents and records needed for each IMS element in a standard format.
- Incorporates some important IMS elements not yet included in the ISO standards.
- Allows each surety to benefit from experiences in designing and implementing management systems for other sureties.

Through its PIMS approach, Primatech assists organizations to integrate their management of process safety, occupational health and safety, security, environmental protection, quality, etc. We also help companies design new management systems or modify existing ones.

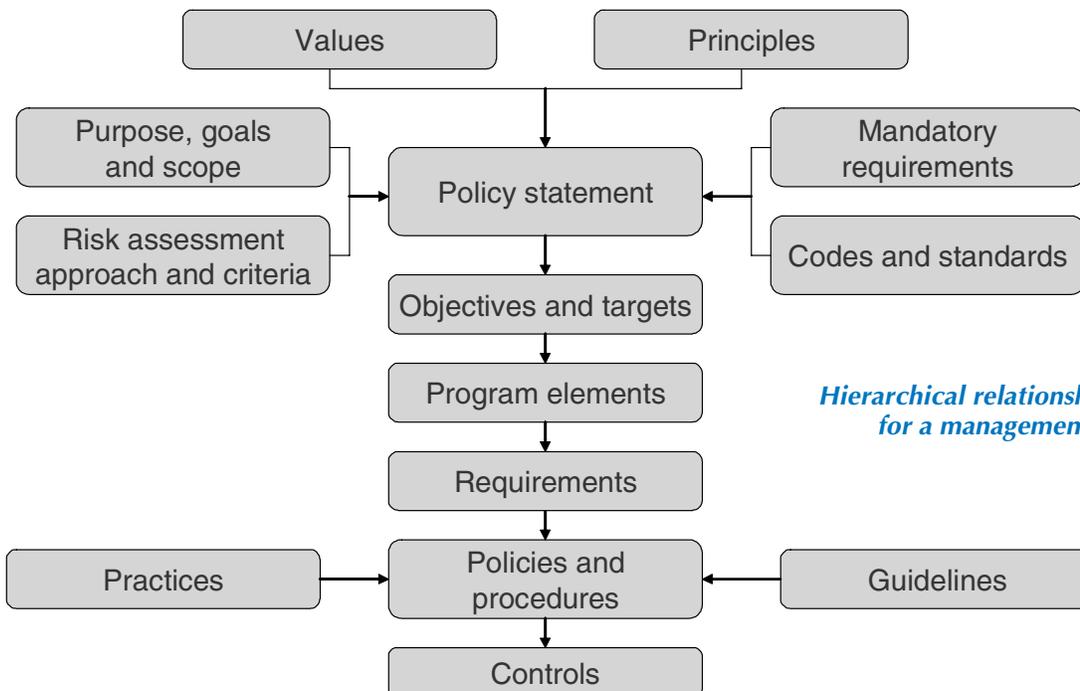
Primatech offers the training courses:

- "Understanding and Developing Management Systems" (1 day)
- "Designing and Implementing a PSM Program" (2 days)
- "Process Security Management" (2 days)
- "Developing and Implementing an EPA Risk Management Program" (2 days)
- "Designing and Implementing an Occupational Health and Safety Management System (OHSMS) for the Workplace" (2 days)

"Advice, when most needed, is least heeded"

Chinese proverb

Hierarchical relationship of entities for a management system



AUDITS AND ASSESSMENTS

evaluating process safety, security and risk management programs against regulatory and industrial standards

Audits and assessments provide a vital management control for Process Safety Management (PSM), Security Management, and Risk Management (RM) Programs. They help ensure programs are properly designed and implemented. Audits identify program deficiencies so that recommendations can be developed for corrective action. Without regular audits, programs will not stay current and will deteriorate, causing companies to face regulatory and legal liabilities.

OSHA's PSM Standard and EPA's RMP rule both require companies to conduct compliance audits of their prevention programs at least every three years.

Services Offered:

Primatch provides one or more auditors to conduct an on-site PSM, RMP, security or other type of audit. Primatch auditors employ protocols with Primatch's software package, AUDITWorks®, to conduct and document the audit.

Primatch also conducts simpler reviews of your programs to help determine whether they have gaps or deficiencies.

Primatch's audit approach focuses on the policies and procedures that make up the program being audited. We address each element of the program and also include the management systems that are used to implement the program.

There are three main phases of the audit:

- Pre-Audit: planning and organizing the audit; establishing the audit objectives, scope and protocol; and reviewing the design of the program by examining documentation;
- On-site Audit: conducting personnel interviews, reviewing records, and making observations to assess program implementation;
- Post-Audit: preparing a report.

Primatch is internationally recognized for its work in process safety, security and risk management. This provides a stamp of credibility for the audits we conduct.

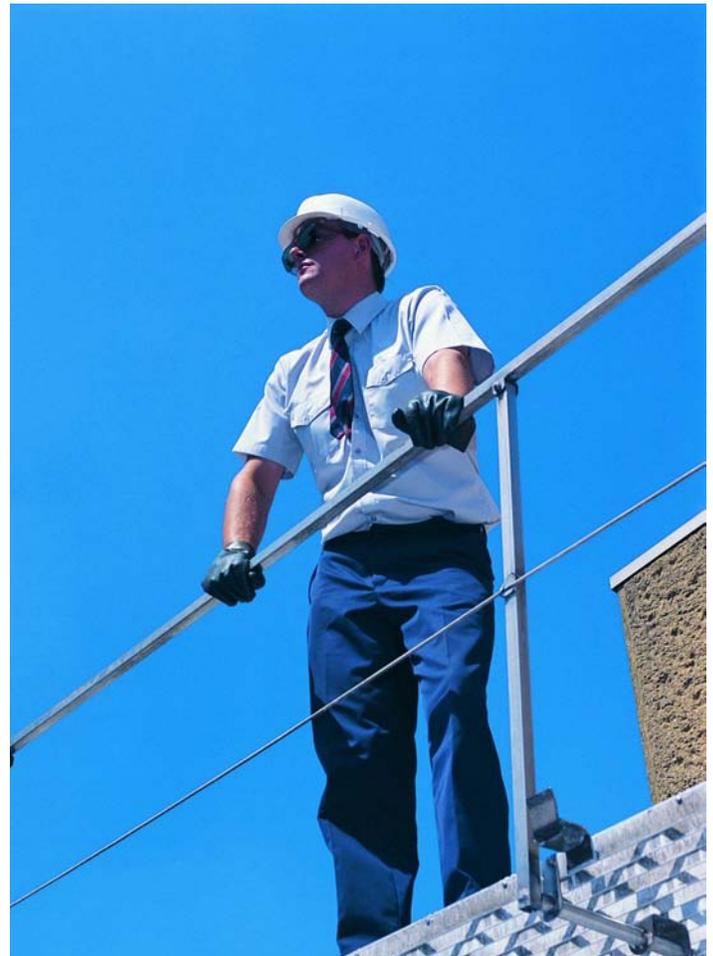
Primatch provides:

- Knowledge of the PSM and RM regulatory requirements and security standards that is unsurpassed in the industry. This helps in identifying program deficiencies.
- Extensive experience in auditing PSM programs, having audited literally hundreds of PSM programs. This helps ensure an efficient audit.
- Staff experienced in developing and implementing PSM and RM programs. This provides insights into what is required for a successful program.
- Audit checklists that reflect the expectations of the regulators. This is vital for performance-based standards such as PSM and RMP which do not specify explicit requirements for compliance. These checklists facilitate the performance of audits and help ensure audits cover the intent of the regulations.
- Insights into what inspectors may look for during audits based on our work preparing process safety and risk management guides for industry and government.

Primatch has developed the software package, AUDITWorks®. It provides audit protocols and facilitates documentation of the audit. It incorporates compliance checklists for process safety and other prevention programs. These checklists can be customized to meet site or company-specific requirements. AUDITWorks® facilitates the performance of an audit and helps ensure proper documentation of findings.

Primatch can help train company personnel to participate in and conduct audits through the training courses:

- "Designing and Implementing a PSM Program" (1 day)
- "Auditing PSM Programs" (2 days)
- "Developing and Implementing an EPA Risk Management Program" (2 days)
- "Process Security Management" (2 days)
- "Understanding and Applying Cyber Security for Manufacturing and Computer Control Systems" (2 days)
- "Using AUDITWorks® Software" (1 day)



"You can tell whether a man is clever by his answers. You can tell whether a man is wise by his questions."

Naguib Mahfouz

PROCESS HAZARD ANALYSIS

facilitating, scribing,
documenting, and reporting

Process Hazard Analysis (PHA) studies are the foundation for process safety and risk management of highly hazardous process systems. They help companies identify hazard scenarios that could adversely affect people, property, or the environment. Companies that handle or process hazardous chemicals have a responsibility to protect employees, the public and the environment from exposure to accidental releases.

Considering the complexity of today's chemical processes, the challenges involved in facilitating a PHA study, and the potential liabilities from an incident, your best option for completing PHAs may be to seek the assistance of expert specialists.

Services Offered:

Primatech uses predictive PHA techniques and methodologies such as Hazard and Operability Studies (HAZOP), What-If Studies, and Failure Modes and Effects Analysis (FMEA) and Major Hazard Analysis (MHA). Primatech provides a team leader or facilitator to work with a group of people from the facility to conduct the PHA. We document the PHA study findings and prepare a report on the study. We can also provide a scribe to assist with study documentation, if desired by the client.

We facilitate both initial PHAs and revalidations of existing PHAs.

Primatech's PHA Team Leader:

- prepares for the study
- advises on the selection of team members and methodology and the definition of study scope
- oversees the team's brainstorming of causes and consequences of possible accidents and the formulation of recommendations for appropriate corrective actions.

We utilize Primatch's software product PHAWorks® in conducting and documenting studies. Hazard scenarios caused by equipment failures, human errors and external events are considered. Safeguards, facility siting and human factors issues are discussed and their impact on safety identified.

Primatech has conducted PHAs for a wide variety of facilities, and has completed literally thousands of PHAs using such techniques as HAZOP, What-If, What-If Checklists, FMEA, Fault Tree Analysis, etc.

Primatech has also trained thousands of people in PHA including regulators from OSHA, EPA and state agencies.

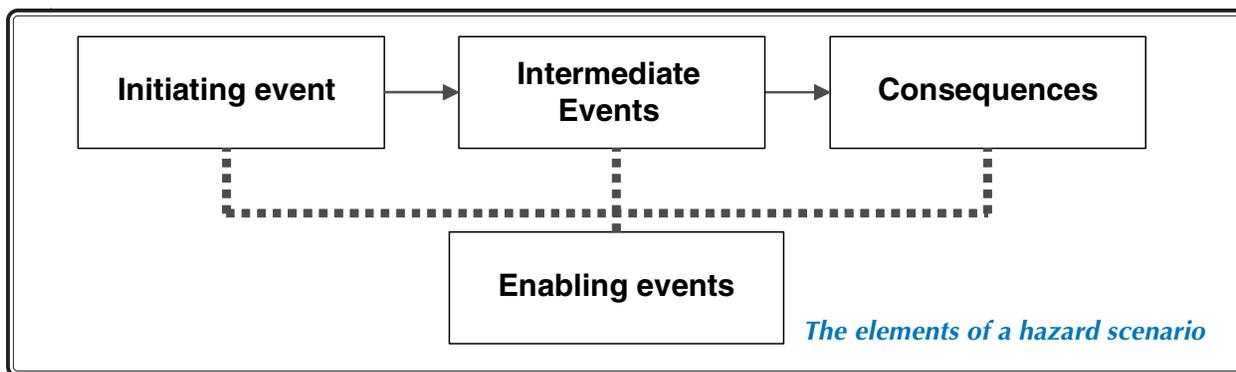
Primatech develops and markets the world's leading PHA software, PHAWorks®. The use of this program enhances the team leader's ability to conduct the analysis efficiently. The software is designed to allow the team leader to function as both facilitator and scribe, thereby eliminating the need for a separate scribe and reducing the cost of the study.

Primatech provides the following training courses on PHA:

- "Principles of Process Hazard Analysis (PHA)" (1 day)
- "PHA for Team Leaders" (5 days)
- "PHA Revalidation" (1 day)
- "Advanced PHA for Team Leaders" (2 days)
- "Layers of Protection Analysis (LOPA)" (2 days)
- "Re-certification for PHA Team Leaders" (1 day)
- "Using PHAWorks® Software" (2 days)
- "Using Tracker™ Software" (2 days)

"Common sense is not as common as it should be"

Anon



SECURITY VULNERABILITY ANALYSIS

determining the risk to facilities from deliberate acts including terrorism

The risk of deliberate acts - such as terrorism, sabotage, vandalism and theft - that may cause harm such as shutting down processes, and diverting or releasing hazardous materials from a process facility, may dominate the risk from accidental releases unless it is properly managed. The risk from such acts must be assessed for manufacturing facilities and their value chains including transportation and distribution to determine if existing security measures and safeguards are adequate or need improvement. Risk assessment is the heart of a process security program.

Threat analysis is the first step in risk assessment for deliberate acts. It is used to identify the sources and types of threats and their likelihood. Once specific threats have been identified, vulnerability analysis is used to identify threat scenarios, i.e. how threats could be realized. The results of the analyses are used to assist in making decisions on the levels of safeguards and secureguards that are needed.

This includes consideration of:

- prevention
- inherent safety/security
- process design
- site security
- controls
- engineered safeguards
- mitigation
- emergency response
- buffer zones

Threat analysis considers the motivations and capabilities of adversaries and facility security factors are rated to develop a threat profile. Plants and processes are divided into sectors and each credible threat within each sector is considered. Vulnerabilities are identified by brainstorming ways barriers can be penetrated.

Services Offered:

Primatech provides facilitators to lead a team of facility personnel in performing threat and vulnerability analysis. Primatech has developed and published approaches for physical and cyber threat and vulnerability analysis. We have developed templates for use with Primatech's software PHAWorks® to perform vulnerability analyses.

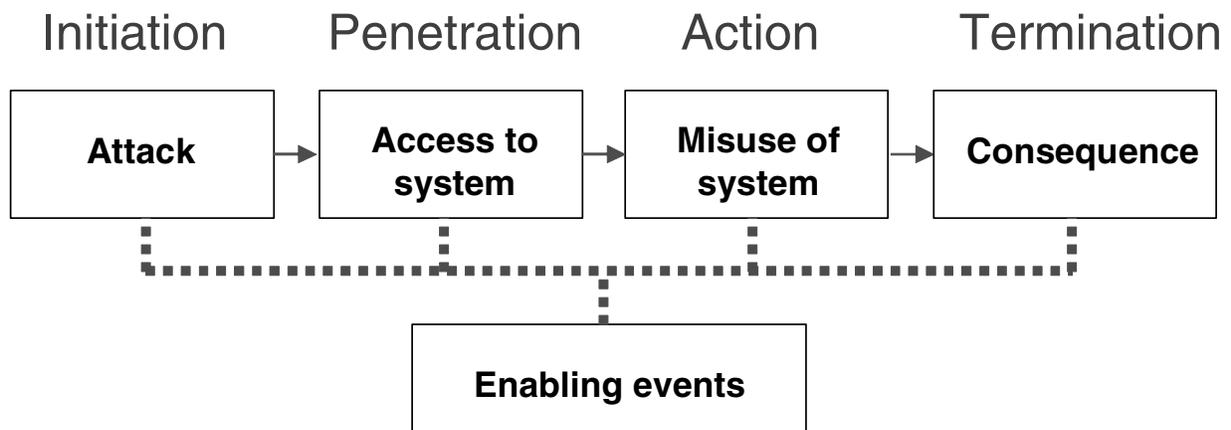
Primatech offers the training courses:

- "Process Security Management" (2 days)
- "Security Vulnerability Analysis" (2 days)
- "Countermeasures for Process Security" (1 day)
- "Understanding and Applying Cyber Security for Manufacturing and Computer Control Systems" (2 days)
- "Cyber Security Vulnerability Analysis" (2 days)



"Real knowledge is to know the extent of one's ignorance."

Confucius



The elements of a threat scenario

SAFETY INSTRUMENTED SYSTEMS

**modifying PSM programs to address SIS;
developing Safety Requirements Specifications
and procedures for SIS**

ANSI/ISA S84.00.01-2003, Application of Safety Instrumented Systems for the Process Industries, 2003, (called S84 here) addresses the application of Safety Instrumented Systems (SIS) to take a process to a safe state when predetermined conditions are violated, such as set points for pressure, temperature, level, etc. Its objective is to define requirements for SIS. SIS are also called Emergency Shutdown Systems, Safety Shutdown Systems, and Safety Interlock Systems. SIS provide safety control functions and complement the Basic Process Control System (BPCS) which provides normal process control.

OSHA has endorsed S84 as a "national consensus standard" in a March 23, 2000 OSHA letter to ISA. This letter states that S84 is considered "a recognized and generally accepted good engineering practice" for SIS. Paragraph (d)(3)(ii) of the Process Safety Management (PSM) standard specifies: "The employer shall document that equipment complies with recognized and generally accepted good engineering practices." The letter states that in evaluating whether an employer's engineering practices with respect to SIS comply with PSM, OSHA would consider, among other factors, whether the employer meets the requirements of S84.

In the letter, OSHA states that it is also important to note that there is a large percentage of processes which are not covered by PSM which may include SIS covered by S84. OSHA states that the employer may be in violation of the General Duty Clause, Section 5(a)(1) of the OSH Act, if SIS are utilized which do not conform with S84, and hazards exist related to the SIS which could seriously harm

employees. Consequently, this means that companies must comply with S84, not only for PSM-covered processes, but also for other processes that use SIS where hazards to personnel may be present.

Services Offered:

Primatech helps clients modify their PSM programs to address SIS, such as additions to process safety information, PHA, operating procedures, and mechanical integrity. We also help to establish SIS Safety Requirements Specifications and assist in developing procedures for SIS installation, commissioning, testing, operation, maintenance and change reviews. Primatech also facilitates the performance of LOPA studies by a team of facility personnel to help determine what safety integrity levels (SIL) are needed for SIS.

Primatech offers the training courses:

- "Complying with the S84 Standard for Safety Instrumented Systems" (1 day)
- "Layers of Protection Analysis (LOPA)" (2 days)



LAYERS OF PROTECTION ANALYSIS

**determining if process safeguards are adequate
and evaluating the adequacy of SIS**

Process hazard analysis (PHA) teams use engineering judgment to decide if additional safeguards are needed to protect against accident scenarios they identify. This subjective approach can lead to disagreements and possibly inappropriate measures to reduce risk. A more rational and objective approach is needed, at least when considering risk remediation measures for high risk scenarios or those that are expensive to implement. Layers of Protection Analysis (LOPA) was developed for this purpose.

LOPA is a simplified risk assessment method. It provides an objective, rational and reproducible method of evaluating scenario risk and comparing it with risk tolerance criteria to decide if existing safeguards are adequate, and if additional safeguards are needed. LOPA can be viewed as an extension of PHA.

Services Offered:

Primatech facilitates LOPA studies for clients. We also help decide which safeguards can be considered by LOPA and we help determine their failure probabilities.

Primatech applies LOPA after a PHA has been performed. Typically, high risk scenarios are first identified for consideration. Individual hazard scenarios, defined by cause-consequence pairs, are analyzed. LOPA considers safeguards that are Independent Protection Layers (IPLs), defined as those whose failure is independent of any other failures involved in the scenario.

A key part of LOPA is the determination of the Safety Integrity Level (SIL) provided by the IPLs involved in the scenario. The SIL is usually defined as a Probability of Failure on Demand (PFD). These SILs are used in LOPA to assess scenario risk and compare it with risk tolerance criteria to decide if existing safeguards are adequate, and if additional safeguards are needed.

Primatech has performed a variety of LOPA studies. We have produced templates for use with Primatech's software package, PHAWorks®, to conduct these studies. We have also developed extensions of LOPA to address human factors and process security.

Primatech offers the training courses:

- "Complying with the S84 Standard for Safety Instrumented Systems" (1 day)
- "Layers of Protection Analysis (LOPA)" (2 days)



FACILITY SITING

analyzing the impact on safety of the proximity of people to hazards

OSHA's PSM regulations require that "facility siting" be addressed in a Process Hazard Analysis (PHA). Facility siting involves the assessment of the possible impacts of fire and explosion on life safety, structures, and equipment as well as the effects of releases of toxic substances and their ingress into buildings. OSHA is particularly concerned that facility siting address the spatial relationship between the hazards of the covered process and the location(s) of people, especially in occupied buildings.

Services Offered:

Primatech can help ensure your PHAs address facility siting to meet OSHA's expectations and requirements. We can also conduct a stand-alone Facility Siting Analysis (FSA) for your facility or individual process areas to provide a more thorough analysis. Such a study focuses on facility siting issues alone, which helps ensure that facility siting issues are addressed properly and are not overlooked. Results of a stand-alone FSA can be referenced during a subsequent PHA study.

Facility siting analysis performed during a PHA uses simple checklists to identify issues. A separate FSA involves identifying issues using detailed checklists and evaluating them using consequence analysis. Toxic release, blast overpressure and thermal radiation footprints are overlaid on the facility plot plan and an occupied building analysis performed using API RP 752 good engineering practice guidelines.

Issues covered in a Facility Siting Analysis include:

- Identifying hazard scenarios that could have significant effects on occupied buildings
- Identifying vulnerable locations of control rooms, and other buildings that may be occupied by people
- Spacing of process units
- Spacing between equipment and employees in occupied buildings, and equipment and potential ignition sources
- Domino effects, i.e.: the potential for an incident to propagate from one process area to another separate area
- Analysis of the ability for an occupied building to provide sheltering-in-place
- Emergency response issues such as availability of emergency equipment, and the location of fire suppression systems

Primatech presents the findings of the FSA and facilitates a client team in the generation of recommendations for corrective actions. A written report is issued after these team sessions that documents the FSA results and the recommendations generated by the team.

Primatech consultants are experienced in performing FSAs and can assist clients in choosing the best consequence analysis software modeling tools to meet the unique requirements of each project. They understand how to meet applicable good engineering practices (such as API RP 752) and comply with regulatory requirements.



"The important thing is not to stop questioning."

Albert Einstein

NODE: (5) GLOBAL					
PARAMETER: Facility Siting					
DEVIATION	CAUSES	CONSEQUENCES	SAFEGUARDS	RECOMMENDATIONS	BY
Part Of Facility Siting	1. Chlorine cylinders situated behind control room building six feet from air intake	1.1. Possible exposure of control room personnel to chlorine	1.1.1. Chlorine release kit	1.1.1. Consider relocating chlorine cylinders from behind control room to location away from personnel	OPS
	2. Floor drains from control room building connect directly to sewer system	2.1. Possible exposure of control room personnel to materials released to sewer	2.1.1. PPE	2.1.1. Consider separate drains for occupied buildings	UTL
	3. Control room air intakes face discharges from reactor building relief valves	3.1. Possible exposure of control room personnel to reactor discharges	3.1.1. PPE	3.1.1. Consider re-routing reactor relief valve discharges away from air intakes on other buildings	ENG

HUMAN FACTORS AND HUMAN ERROR ANALYSIS

identifying human errors and the factors that affect their likelihood

Government regulations and industry-recommended practices have focused attention on human factors. OSHA's PSM standard, EPA's RMP rule and API's recommended practice for Safety Environmental Management Programs (SEMP), RP75, all address this topic. Human error as a cause of hazard scenarios must be identified and the factors that influence human errors must be considered. This latter topic falls within the field of human factors engineering. It deals with the person-process interface and how it influences the performance of people.

People are key components of industrial processes. They are involved in process design, operation, maintenance, etc. No step in the process life cycle is without some human involvement. Based on human nature, human error is a given and will arise in all parts of the process life cycle. Also, processes are generally not well-protected from human errors since many safeguards are focused on equipment failure. Consequently, human error is an important contributor to risk for most processes. This is evidenced by the number of major accidents that have been attributed to this cause. It is vital that the factors influencing the likelihood of errors be identified and assessed to determine if improvements in the human factors design of a process are needed.

Surprisingly, human factors is perhaps the most poorly understood aspect of process safety management. However, the standards from regulatory agencies and industry groups have underscored the importance of addressing human factors in process safety and risk management programs. This is motivating more companies to evaluate and address human factors issues in their facilities. Improving the human factors design of a process can produce not only improvements in safety and health but also gains in quality, productivity and employee job satisfaction.



"Man is a creature made at the end of the week when God was tired"

Mark Twain

Services Offered:

Primatech assists clients in identifying human errors and addressing human factors during the performance of process hazard analyses. We also perform specific human error or human factors studies to provide a more thorough assessment that is warranted by the human contribution to process risk. Such specific studies can be conducted before a PHA is performed so the results can be utilized in the PHA.

Human error analysis involves the systematic identification and evaluation of the possible errors that may be made by operators, maintenance engineers, technicians, and other personnel in the plant. Various analysis methods are used such as task analysis and job safety analysis.

Human factors engineering studies focus on the interface of people with the process and its impact on system operation. Detailed checklists are used with a people-process interface model to identify factors that increase the likelihood of human errors.

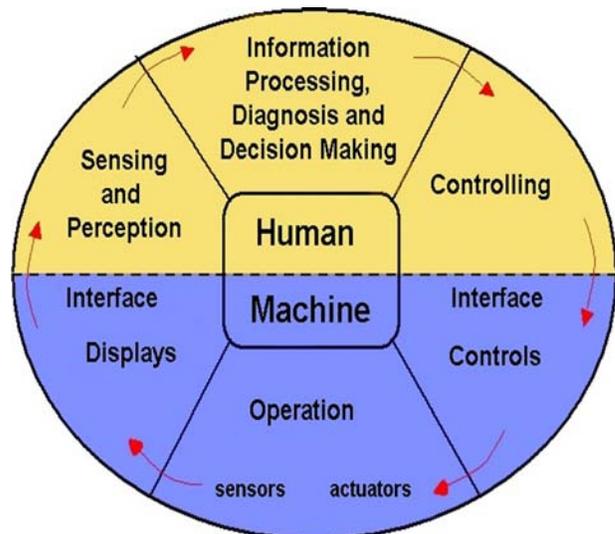
Primatech has developed improved approaches for considering both human errors and human factors in process safety.

Primatech provides:

- An understanding of human error contributions to risk
- Knowledge of human factors that affect performance
- Expertise with human error and human factors analysis techniques
- Analysis tools and checklists to aid studies

Primatech offers the training courses:

- "Understanding and Applying Human Factors for Process Safety" (1 day)
- "Human Error and Reliability Analysis" (2 days)



The human-machine model used to help identify human errors and the factors that influence them

PROCEDURES DEVELOPMENT

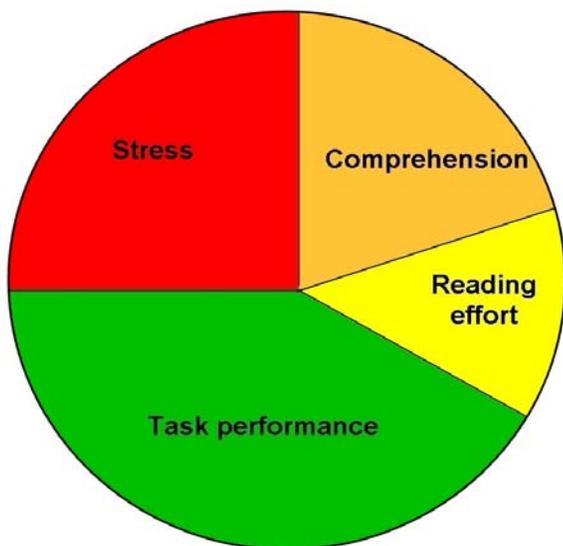
designing and developing procedures according to best practices and for regulatory compliance

Written procedures are required by OSHA's Process Safety Management Standard, CFR 1910.119. Contemporary engineering standards also place a heavy emphasis on having comprehensive, up-to-date procedures and training the employees who use them. Indeed, the development and use of effective and user-friendly operating and maintenance procedures in process facilities is essential for safe and efficient operations.

Procedures can have as much impact on process safety as the process equipment. The Operating Procedures element of the Process Safety Management Standard is one of the most frequently cited elements by OSHA year-after-year and therefore deserves special attention to ensure compliance.

Many companies assume their employees can write procedures simply by documenting what they do. However, this approach often produces ineffective procedures. There are much better approaches that can be used to write procedures that do not require any more work than the traditional "write what you do" approach. These new methods produce procedures that are much more effective and usable.

Procedures that are properly written, documented and followed help to ensure that the knowledge required to safely operate processes and equipment is made available to the appropriate operating and maintenance personnel, management, emergency response and preparedness teams, safety personnel and others.



This cognitive model shows that the reading effort and comprehension level for procedures and operator stress can all detract from task performance

Services Offered:

Primatech helps clients decide when and where procedures are needed. We help design and develop procedures according to established principles and best practices to ensure they are written for their users. We also help ensure regulatory requirements for procedures are met. While much of our work focuses on operating and maintenance procedures, we also help clients develop other facility procedures such as Safe Work Practices, Emergency Procedures, and Safety Procedures.

Primatech helps clients develop new procedures as well as revise existing procedures to meet current standards. We also advise clients on procedure maintenance, control and training.

Primatech works with clients interactively to develop procedures. We encourage the active participation of those who will use the procedures. Procedure users provide information on the actions required in the procedures and Primatech casts this information into a format that helps ensure usability.

Guidelines for drafting, evaluating and validating procedures are used. We also follow guidelines to ensure the appropriate use of language, numerical information, graphics, and lists and tables. Special types of procedural steps such as non-sequential, continuous or time-dependent are properly formulated.

Primatech is experienced in both developing procedures and assessing existing procedures. We understand the regulatory requirements for procedures and current industry standards for procedures development.

Primatech offers the training courses:

- "Principles of Procedure Writing" (2 days)
- "Advanced Procedure Writing" (2 days)
- "Understanding and Applying Human Factors for Process Safety" (1 day)



MECHANICAL INTEGRITY

developing, implementing and improving programs to help ensure there are no hazardous material releases from equipment failures

OSHA issues the most PSM citations for the Mechanical Integrity (MI) element of PSM. This is undoubtedly due to its complexity. Many companies find it the most difficult of the fourteen PSM elements to address.

The objective of Mechanical Integrity is to ensure equipment does not fail in a way that causes or affects a release of covered chemicals. Equipment means hardware that helps contain the chemicals in the process. MI covers the proper design, fabrication, construction/ installation and operation of equipment throughout the entire process life cycle.

MI is not just maintenance, although maintenance is a major part of an MI program. Other activities are involved such as training and quality assurance.

MI programs typically cover these areas:

1. Management system
2. Identification and categorization of covered equipment
3. Applicable codes and standards
4. Maintenance tasks
5. MI procedures
6. MI training
7. Inspection and testing (Preventive/Predictive Maintenance (PM))
8. Correction of deficiencies in equipment
9. Quality Assurance (QA) program

Services Offered:

Primatch helps companies establish new MI programs and refine existing programs to make them more effective and help ensure regulatory requirements are met.

Our work covers:

Management System – Any activity important to an organization must be managed. This requires policies, procedures, work instructions and documentation. Primatch works with clients to ensure responsibilities are assigned, authority is given, supervision is provided, resources are made available, and people are held accountable for MI activities.

Covered Equipment – OSHA defines specific types of equipment that must be included in a MI program. However, this is not intended to be a complete list. Also, while the name of the element implies only mechanical equipment is covered, other equipment which might contribute to a catastrophic release must also be included, for example, electrical equipment. Primatch helps clients determine what equipment should be included in their MI program.

Codes and Standards – There are many industry codes and standards that apply to MI, particularly for design and engineering and preventive maintenance. These must be documented. Primatch assists clients with this process.

Maintenance Tasks – Facilities typically employ a combination of breakdown and preventive maintenance. Primatch helps clients to develop appropriate programs that balance these approaches to maintenance.

MI Procedures – Written procedures must be developed and implemented for key activities including maintenance. Primatch works with clients to develop procedures that emphasize usability.

MI Training – MI personnel must be appropriately trained for the tasks they will perform. Primatch helps design suitable training programs.

Inspection and Testing – OSHA emphasizes the use of preventive maintenance. Primatch helps companies develop procedures and schedules for inspection and testing of critical process equipment.

Controlling and Managing Deficiencies – Equipment deficiencies found during tests and inspections must be addressed before further use, or in a safe and timely manner when necessary means are taken to assure safe operation. Primatch helps companies to determine safe operating limits and to develop procedures for addressing deficiencies.

Quality Assurance (QA) – Primatch helps companies develop procedures for quality assurance for equipment procurement, fabrication, installation, repair, and spare parts, maintenance materials and equipment.

Primatch provides:

- A thorough understanding of applicable regulatory requirements;
- A proven and effective approach to MI;
- The ability to integrate the MI program with existing company maintenance procedures, safe work practices, computerized maintenance management systems (CMMS), etc.;
- Experience in developing MI programs for a variety of companies in the process industries

Primatch offers the training courses:

- *“Mechanical Integrity for Process Safety and Risk Management” (3 days)*
- *“Management of Change (MOC) for Process Safety” (1 day)*
- *“Risk-Based Inspection” (1 day)*



DISPERSION AND CONSEQUENCE MODELING

evaluating the impacts of accidents

Companies employ dispersion and consequence modeling for various purposes including determining impact distances for EPA's Risk Management Program (RMP) regulation; assessing the significance of hazard scenarios identified during PHA; and providing input to risk analysis.

Services Offered:

Primatch calculates source terms (amount and form of material released) for toxics and flammables. For toxics, the distance traveled and coverage by the material is determined along with its effects on people and the environment. For flammables, the heat radiation from a fire is calculated together with its impact on people and property. For explosive materials, blast overpressures are calculated along with their impacts on people, equipment and structures.

Primatch uses models tailored to each situation encountered. Gas, two-phase, and liquid releases are modeled as required and discharge rates are calculated. Dispersion is modeled for buoyant or heavy gases, as appropriate. Toxicity data and dose-response models are used to model toxic effects.

Various types of fires are modeled including:

- pool
- jet
- flash
- fireballs
- warehouse

Types of explosions modeled include:

- confined
- unconfined
- dust explosions
- BLEVEs (Boiling Liquid Expanding Vapor Explosion)
- thermal decompositions
- runaway reactions

Primatch has performed dispersion and consequence modeling for various facilities. We have models available that can be used to handle a wide variety of situations.

Primatch offers the training course:

- "Dispersion and Consequence Modeling" (1 day)



RELEASE AND SPILL ASSESSMENT

evaluating programs and management systems to identify gaps that may result in hazardous material releases

Process plants typically utilize various programs and management systems to prevent and/or control unintended releases of hazardous materials. Such programs are often implemented independently of one another resulting in the possibility of accidental releases due to gaps between programs.

Services Offered:

Primatch performs assessments to identify gaps and help reduce the likelihood of future releases and spills.

Primatch's assessment protocol examines various aspects of your facility including equipment; control systems; management systems; policies, programs and procedures; human and organizational factors; and environmental issues. We make observations of the facility and equipment; review programs, documentation and records; and conduct interviews with the various levels of facility personnel. A report is provided that summarizes findings, identifies root causes of problems, and provides suggestions for corrective action.

Primatch has extensive knowledge and experience with many facilities handling hazardous materials. We have assisted numerous companies in both developing and assessing release prevention programs.



"Never mistake motion for action."

Ernest Hemingway

QUANTITATIVE RISK ASSESSMENT

evaluating the probabilities and consequences of accidents

Quantitative risk assessment (QRA) is used by companies in several ways including analyzing and ranking scenarios identified in process hazard analysis; providing quantitative data for use in decision making on risk; and comparing alternative process options.

The performance of a complete QRA for a process requires highly skilled staff and few companies employ such individuals thus suggesting the need for outside experts.

Services Offered:

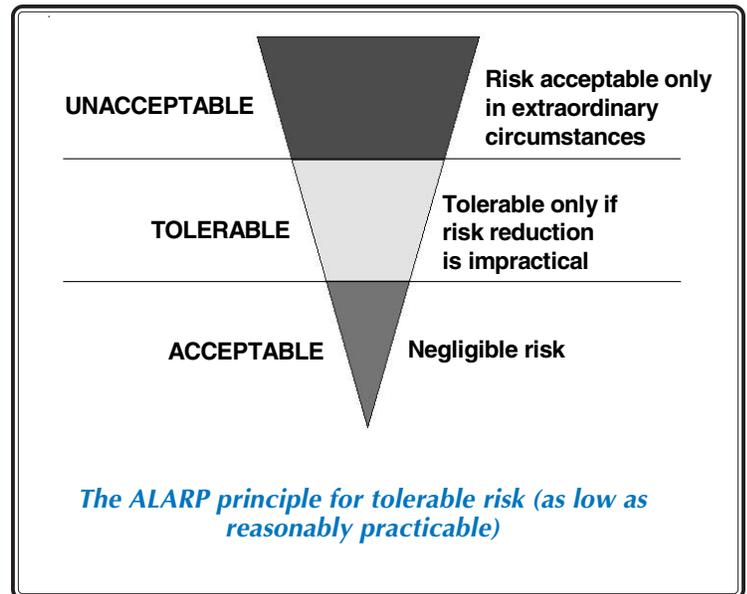
Primatech uses a variety of methods tailored to each situation to calculate accident probabilities and consequences in order to determine risk.

Primatech combines accident consequences and probabilities into various risk measures including indices, individual risk, and societal risk. Results are presented as point estimates, risk contours, or frequency-number (F-N) curves. Usually, the risk measures are compared with risk acceptability criteria such as limit lines. We also evaluate risk uncertainties, sensitivities and importance for consideration in decision making.

Primatech has available modeling tools and data needed to perform QRAs. We are experienced in using them in a variety of projects.

Primatech offers the training course:

- "Risk Analysis and Decision Making" (1 day)



PROBABILITY MODELING

assessing the reliability of process systems and the likelihood of accidents

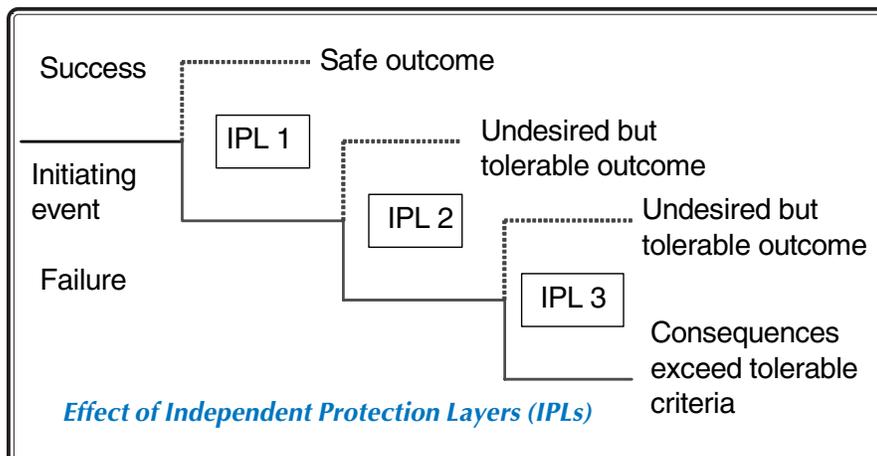
Companies are sometimes faced with the possibility of catastrophic accident consequences and need to assess their likelihood to determine what remediation may be necessary. In such cases, the accident likelihoods are usually very low and must be determined by combining the probabilities of the events that make up the accident scenario using probability modeling. Event probabilities and frequencies are also needed as input to quantitative risk analysis and reliability studies.

Services Offered:

Primatech assesses the reliability of process systems and the likelihood of process incidents for clients using modeling techniques such as fault tree and event tree analysis.

Primatech uses both historical incident data and failure rate data to quantify fault and event trees and evaluate incident probabilities. Studies may involve dependent failure analysis to account for common cause failures and human reliability analysis to quantify human error probabilities. We also perform uncertainty analysis to explore the effects of data uncertainties on the modeling results. We perform sensitivity analysis to identify the most important contributors.

Primatech has available compilations of failure rate data for use in the analyses.



Primatech offers the training course:

- "Probability and Frequency Analysis" (1 day)

"Chance favors the prepared mind"
Louis Pasteur

EMERGENCY RESPONSE PROGRAMS

developing new programs and enhancing existing programs to respond to hazardous material releases

Most facilities have Emergency Response Programs (ERP) in place, although they may not be up-to-date. For example, they may not address accident scenarios identified by process hazard analyses.

Services Offered:

Primatech can develop a comprehensive ERP, or assist companies in improving existing ERPs.

ERPs developed by Primatech address:

- On-site and off-site notification procedures;
- Emergency evacuation procedures;
- Personnel roles, lines of authority, and communication;
- Rescue and medical duties for those employees who are to perform them;
- Emergency response training requirements;
- Site decontamination procedures;
- Provisions for critique of response and follow-up;
- Personal protective and emergency equipment.

It is good practice to conduct emergency response drills to test the efficacy of the ERP and help ensure the program works for actual events. Primatech can assist companies in developing and implementing appropriate drills.

Primatech helps clients to determine credible release scenarios which should be addressed by the ERP and develop procedures that address the scenarios. We compare response plans with release scenarios to

help ensure the emergency planning zones, egress routes, locations of PPE for emergency responders, and specified assembly areas are appropriate.

An ERP management system is also developed to provide a structured framework for the proper implementation of the program. We can also help integrate multiple programs into a single, Integrated Contingency Plan (ICP) for a site.

Primatech has developed numerous Emergency Response Programs for various clients in a variety of industries. Our understanding of OSHA and EPA regulatory requirements helps ensure that programs comply with the regulations.



EXPERT WITNESS AND LITIGATION SUPPORT

providing assistance in litigation, permit hearings and community outreach

Process safety and risk management regulations have been in place since the late 1980s at the state level and the early 1990s at the federal level. While such programs are expected to decrease the likelihood and severity of potential accidents, they cannot prevent all accidents. When the inevitable accidents occur, it is possible that litigation will result. A central element in litigation will be the Process Safety and Risk Management Programs that were in place to help prevent accidents. Issues arise regarding both the design and implementation of the programs.

Services Offered:

Primatech provides litigation support and expert testimony services. We can also perform third-party reviews, provide expert testimony for permit hearings, and participate in community outreach programs.

Primatech applies its expertise in process safety and risk management to provide opinions on the design of process safety and risk management programs. In particular, we can opine on the degree of compliance of programs with applicable regulations and prevailing industry standards.

Primatech is experienced in working with attorneys. We understand the legal process and the role of the expert witness. We can provide technical experts who are trained as expert witnesses and can present their opinions in the face of the often hostile cross examination, as well as prepare effective expert reports.



"Minds are like parachutes; they work best when open."

Lord Thomas Dewar

ABOUT PRIMATECH

Primatech specializes in Safety, Security and Risk Management. We offer consulting, training and software to assist our clients in identifying and reducing the risks posed by their operations.

Companies in a variety of industries choose Primatech to help them manage their risks. We help companies reduce the likelihood and consequences of accidents and malevents, which helps protect employees and the public and prevent damage to equipment and the environment. Reducing these risks also improves productivity and quality. We help companies comply with government regulations such as OSHA's Process Safety Management (PSM) standard, and EPA's Risk Management Program (RMP) regulation, and industry guidelines.

Our capabilities include:

- Process Hazard Analysis (PHA)
- Security Vulnerability Analysis for Deliberate Acts Including Terrorism
- Compliance Audits and Program Assessments
- PSM Program Development and Implementation
- RMP Program Development and Implementation
- Cyber Security Management
- Release and Spill Assessment
- Process Security Management
- S84 - Safety Instrumented Systems
- Layers of Protection Analysis (LOPA)
- Operating and Maintenance Procedures Development
- Mechanical Integrity Program Development and Implementation Guidance
- Human Factors and Human Error Analysis
- Facility Siting Analysis
- Dispersion and Consequence Modeling
- Probability Modeling
- Quantitative Risk Assessment
- Emergency Response Program Development and Implementation Guidance
- Expert Witness Testimony and Litigation Support

Primatech's clients are often Fortune 500 companies but also include medium and smaller sized companies. We specialize in serving the process industries, and have served hundreds of industrial facilities throughout the world.

Primatech's consulting projects have spanned a wide range of industries including:

- Aerospace
- Agricultural Chemicals
- Bulk Commodity Chemicals
- Cold Storage Warehousing
- Electronics
- Food Processing
- Hazardous Waste Treatment
- Inorganic Chemicals
- Mining
- Oil & Gas Production and Distribution
- Oil & Gas Pipelines and Terminals
- Organic Chemicals
- Paints, Coatings, Resins & Adhesives
- Petroleum Refining
- Pharmaceuticals
- Polymers and Resins
- Propane Storage & Distribution
- Pulp & Paper
- Rubber and Plastics
- Semiconductors
- Steel
- Water & Wastewater Treatment

Our services and products enable our clients to achieve their risk, safety and security objectives faster and easier. Primatech is an independent company with no vested interests and is seen, therefore, to deliver work recognized as objective and unbiased.

**50 Northwoods Boulevard
Columbus, OH 43235 USA
Telephone: 614-841-9800
Fax: 614-841-9805
www.primatech.com**

