Process Safety and Risk Management Regulations

USA, UK, France, German, Japan, Korea

History: Prior to 1970

- **Gradual growth of industrial safety programs in the U.S.**
- **Regulations were not well administrated.**
- **Standards varied from state to state, or country to country.**

Increased Awareness and Concern About Hazardous Material Releases

- Highly publicized incidents, 1973 - 1995
  - Shell Refinery (Norco, LA), 1973
  - Flixborough, UK, 1974
  - Seveso, Italy, 1976
  - Three-Mile Island (nuclear), 1979
  - Bhopal, India, 1984
  - Mexico City, Mexico, 1984
  - Chernobyl (nuclear), 1986
  - Piper Alpha, 1988
  - Phillips Petroleum (Pasadena, TX), 1989
  - Arco, Channelview, TX, 1991
  - Napp Technologies, NJ, 1995
- Increasing number, size, and complexity of facilities


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WASTE
PEACE


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History: 1970 - 1990

- Public reaction to incidents increased
- Environmental Protection Agency (EPA) 1989 Acute Hazardous Events Report: 11,000 incidents over 8 years
- Highly publicized catastrophic incidents
  - Bhopal, India, 1984, toxic release
  - Pasadena, TX, 1989, explosion
- Cross-frontier Issues
  - Basel, Swiss, 1986, toxic release

History: 1970 - 1990

- **Industry responded to the concern and debate over chemical safety with recommended practices**
  - **American Petroleum Institute (API), "Management of Process Hazards"**
  - **American Chemistry Council (ACC, was CMA), Responsible Care voluntary program**
  - **Center for Chemical Process Safety (CCPS), 1985, safety management and technology**

History: 1970 – 1990s

- Health & Safety Executive (HSE, UK)
  - CoMAH (Control of Major Accident Hazards)
- Organization des Secours (ORSEC, France)
  - Plan ORSEC
- Bundes Immissionsschutzgesetz, BImSchG, German
- High Pressure Gas Safety Law, Japan
- Safety Management System, Korea

Road to Regulations

- Cars and roads with no speed limits
- High speed, loss of control, accidents
- Increased awareness and concern
- Lack of self regulation
- Laws and requirements were enacted

Regulatory Drivers

- Unions
- U.S. Chemical Safety and Hazard Investigation Board (CSB)
- Regulatory Agencies
- Political pressure – increases with every incident
- Community

OSH Act, 1970

- Occupational Safety and Health Administration (OSHA)
  - Safety information, regulation for work place safety, and accident investigation consistent throughout U.S.
  - Employers responsible for safe working conditions and safety records.
  - Authority to inspect plants, penalties, close plants

OSHA: General Duty Clause

The owners and operators of stationary sources producing, handling, or storing a chemical have a general duty to (1) identify hazards that may result from releases using appropriate hazard assessment techniques, to (2) design and maintain a safe facility taking such steps as are necessary to (3) prevent releases, and to (4) minimize the consequence of releases that do occur.

OSHA Hazard Communication

- "Right to Know" law (1990)
- Written hazard communication program
- Material Safety Data Sheet (MSDS) for each chemical in the workplace
- Training for operations involving hazardous chemicals
- Warning labels

Clean Air Act Amendments, 1990

- **Directed OSHA to develop and enforce process safety management regulations to protect workers and the workplace.**
- **Directed EPA, also created in 1970, to develop and enforce process safety management regulations to protect the public and the environment.**

OSHA PSM

- Process Safety Management of Highly Hazardous Chemicals (PSM), 1992
- 14 elements to manage chemicals, prevent major incidents, and protect the safety of the workplace
- PSM management system
- Outcomes on Accident Prevention
  - 5 Yrs: 40% Reduction
  - 6 Yrs: 80% Reduction

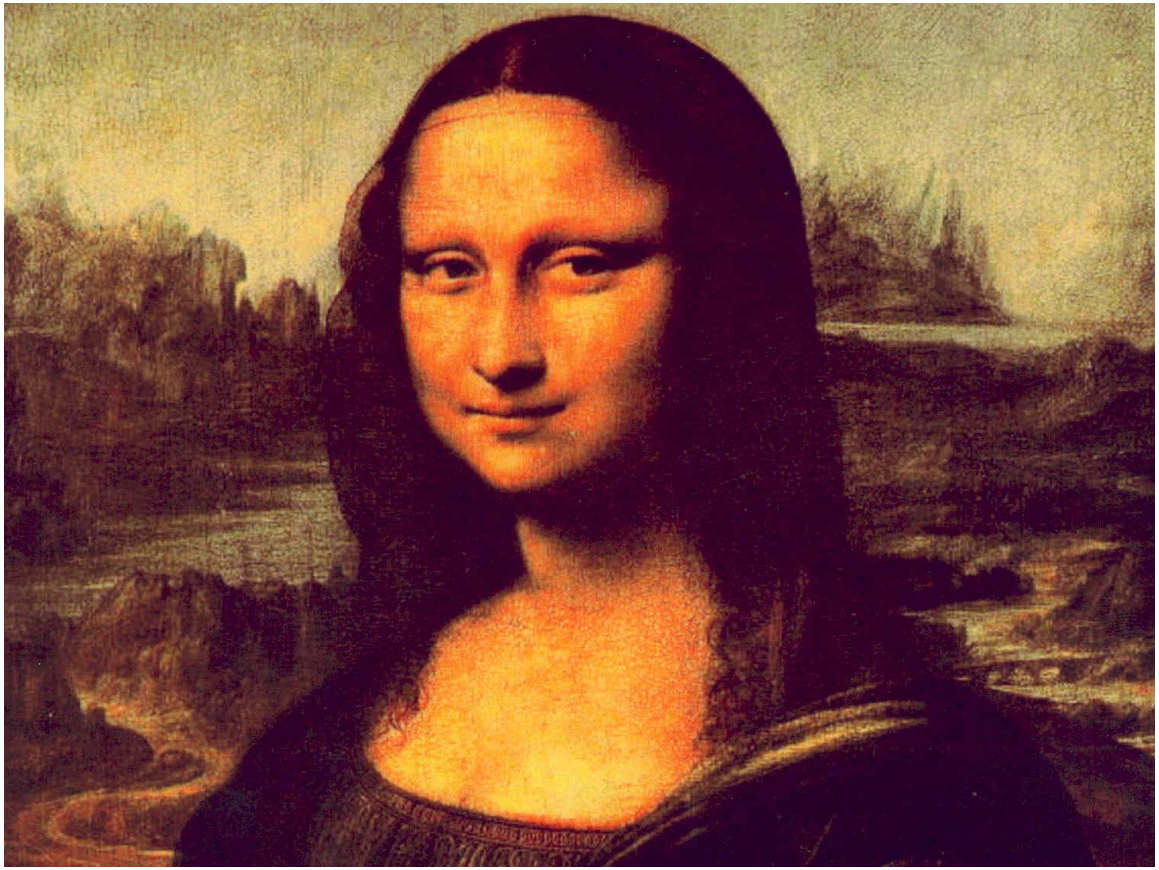
OSHA, PSM: 14 Elements

- Employee Participation
- Process Hazard Analysis (PHA)
- Training
- Pre-startup Safety Review
- Hot Work Permit
- Incident Investigation
- Compliance Audit
- Process Safety Information
- Operating Procedures
- Contractors
- Mechanical Integrity
- Management of Change
- Emergency Planning
- Trade Secrets

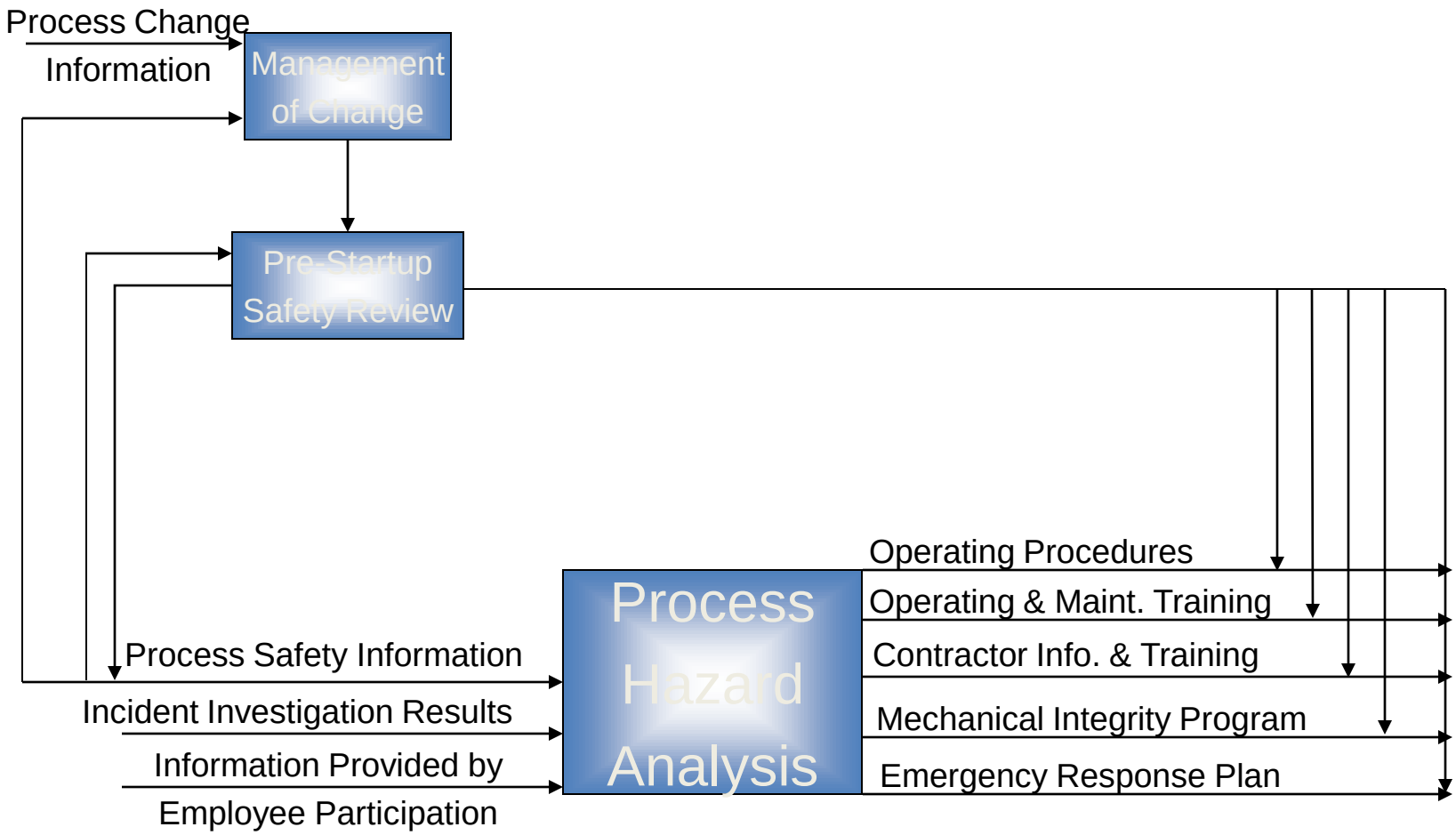
Holistic *vs.* Partial I

Nude?
or Anything Else?

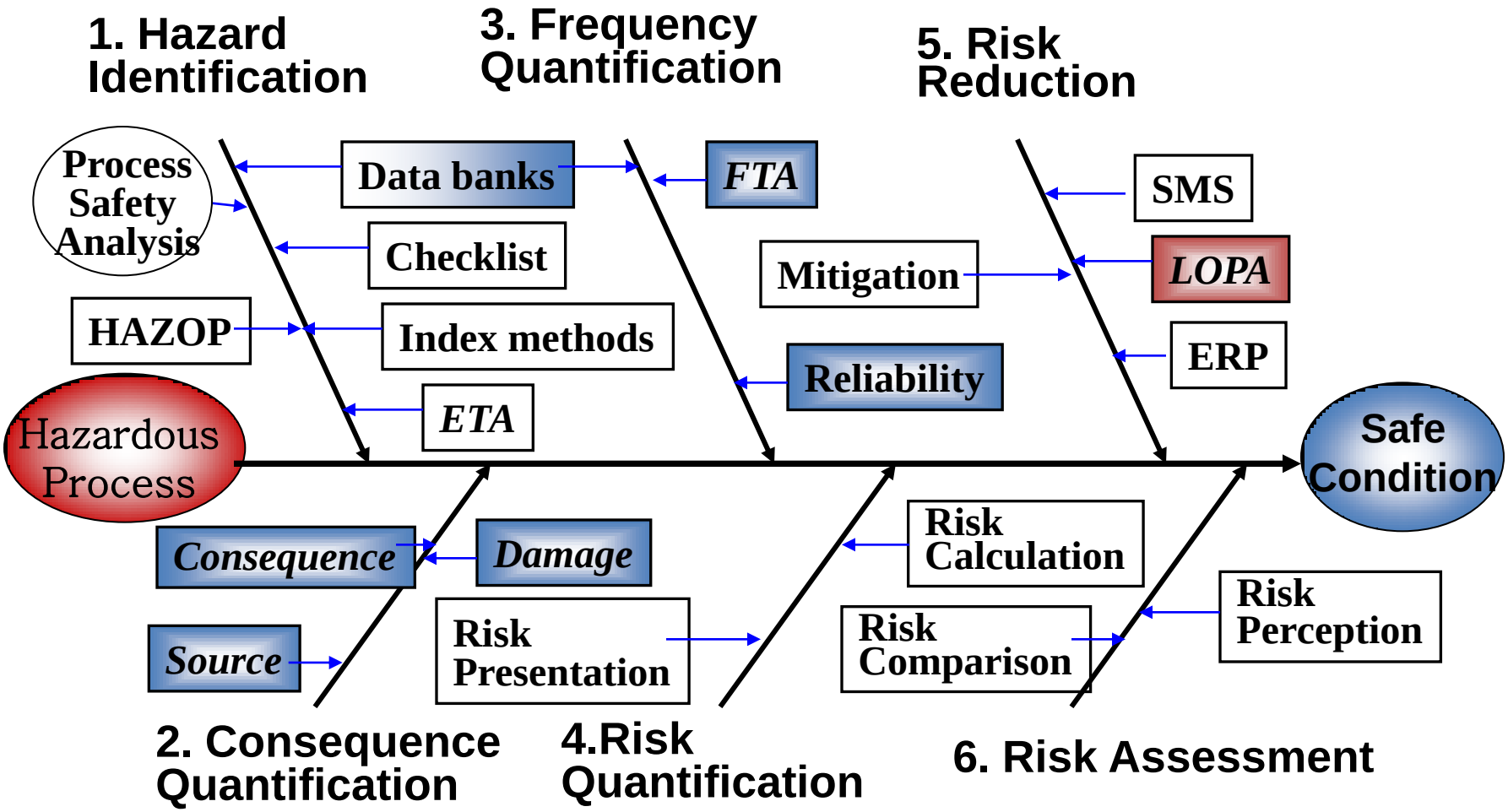
Holistic *vs.* Partial II



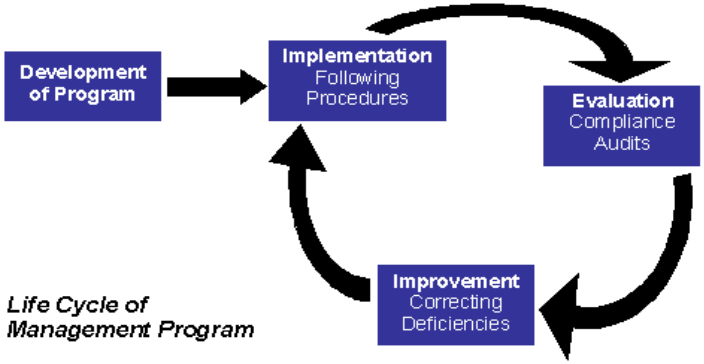
Holistic Approach of PSM



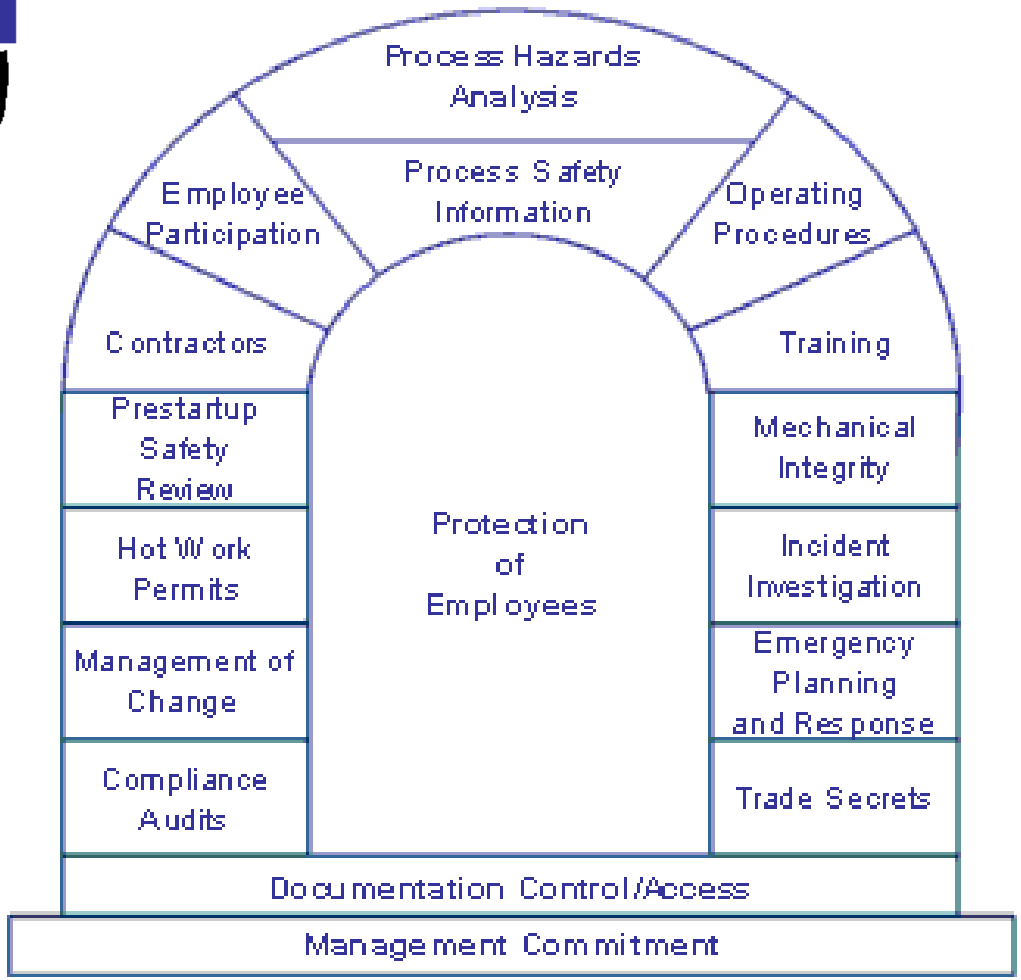
Risk Analysis Methodology



H. J. Pasman et. al., CHISA 2002



Life Cycle of Management Program



Applicability

- List of 137 substances and threshold quantities
- Risk-based criteria
- General duty and obligation to identify hazards and maintain a safe workplace

Employee Participation

- **Written plan of participation of employees with employers in the PSM program**
- **Consult with all employees on the conduct and development of process safety programs**
- **Provide access to process hazard analysis (PHA) and all other information developed for the process safety programs**

Objective: Accountability

Process Safety Information I

- **Chemical Information:**
  - **Toxicity information**
  - **Permissible exposure limits**
  - **Physical data**
  - **Reactivity data**
  - **Corrosivity data**
  - **Thermal and chemical stability data**
  - **Hazardous effects of inadvertent mixing**

Objective: Knowledge and Control of the Operation

Process Safety Information II

- **Technology Information:**
  - **Process flow diagram (PFD)**
  - **Process chemistry**
  - **Maximum inventory**
  - **Safe upper and lower limits**
  - **Consequences of deviation**

Objective: Knowledge and Control of the Operation

Process Safety Information III

- **Equipment Information:**
  - **Materials of construction**
  - **Piping and Instrument diagrams (P&ID)**
  - **Electrical classification**
  - **Relief systems design and design basis**
  - **Ventilation system design**
  - **Design codes employed**
  - **Material and energy balances**
  - **Safety systems**

Objective: Knowledge and Control of the Operation

Safe Work Practices

- Hot work permit
- Fire prevention and protection requirements
- Safe conduct of operating, maintenance, and modification activities
- Control of materials and substances
- Control of access to process areas

Objective: Knowledge and Control of the Operation

Contractors(Host Employer Responsibilities)

- **Host employer must:**
  - **Consider safety records in selecting contractors**
  - **Inform contractors of potential process hazards**
  - **Explain the facility's emergency action plan**
  - **Evaluate contractor safety performance**
  - **Maintain injury/illness log for contractors working in process areas**

Objective: Knowledge and Control of the Operation

Contractors (Contractor Employer Responsibilities)

- **Contractor employer must:**
  - **Train their employees in safe work practices and document that training**
  - **Assure that employees know about potential process hazards and emergency action plan**
  - **Assure that employees follow safety rules of facility**
  - **Advise employer of hazards**

Objective: Knowledge and Control of the Operation

Operating Procedures

- **Written operating procedures for each of the facility operating areas and must address each of the following:**
  - **Initial startup**
  - **Normal operation**
  - **Temporary operations**
  - **Emergency operations**
  - **Normal shutdown**
  - **Startup following turnaround**

Objective: Knowledge and Control of the Operation

Training and Certification

- **Certified training must be provided to all personnel responsible for operating the facility, which should include:**
  - **Initial training**
  - **Refresher and supplemental training**
  - **Communication of change**
  - **Contractor training**

Objective: Knowledge and Control of the Operation

Process Hazards Analysis

- **PHA should be performed at least every five years to minimize the likelihood of a substance release with the following recommended methods:**
  - **What If (what could go wrong)**
  - **Checklist (specific issues, no brainstorming)**
  - **What If/Checklist**
  - **HAZOP (hazards and operability study)**
  - **FMEA (failure modes and effects analysis)**
  - **FTA (fault tree analysis)**

Objective: Hazards Identification and Control of Hazards

Management of Change

- **Establish and implement written management of change procedures which address:**
  - **Technical basis**
  - **Impact on safety and health**
  - **Modifications to operating procedures**
  - **Necessary time period and costs for a change Authorization requirements**

Objective: Hazards Identification and Control of Hazards

Pre-startup Safety Review

- **Pre-startup safety review for new and modified facilities**
  - **Construction is in accordance with design specifications**
  - **Safety, operating, and emergency procedures**
  - **PHA recommendations**
  - **Training of employees and contractors**

Objective: Hazards Identification and Control of Hazards

Mechanical Integrity

- **Establish and implement written procedures and training to maintain the mechanical integrity of:**
  - **Pressure vessels and storage tanks**
  - **Piping systems**
  - **Relief and vent systems**
  - **Emergency shutdown systems**
  - **Controls, alarms, and interlocks**
  - **All suitable for process and properly installed**

Objective: Hazards Identification and Control of Hazards

Emergency Planning and Response Program

- **Establish and implement an emergency action plan within a emergency response program (ERP)**
  - **The ERP should be based on the required assessment of hazards (PHA)**

Objective: Accidents and learning from accidents

Incident Investigation

- **Incidents that result in, or could reasonably have resulted in, a major accident must be investigated**
- **Incident Investigation Report:**
  - **Date of incident**
  - **Date investigation began**
  - **Description**
  - **Factors**
  - **Recommendations to reduce hazards and likelihood of incidents**

Objective: Accidents and learning from accidents

Compliance Audits

- Conduct audit every three years
- Experienced audit team
- Determine appropriate response to each finding
- Correct deficiencies
- Retain two most recent audits

Clean Air Act of 1970: EPA

- Environmental Protection Agency (EPA)
  - Reduce exposure of hazardous substances
  - EPA: authority for releases to the public

Pollution Prevention Act, 1990

- Pollution to be prevented or reduced
- Releases to the environment to be last resort
- Releases to be contained
- Information on pollution prevention & recycling must be provided

Clean Air Act Amendments, 1990

- **Directed EPA to develop and enforce process safety management regulations to protect the environment and public outside the plant.**

- **Added the OSHA General Duty Clause to the EPA regulations for situations not otherwise covered**

EPA, RMP

- **Risk Management Program for Chemical Accident Release Prevention (RMP), 1996**
  - **Reduce the risk of releases of toxic, flammable, and reactive substances**
  - **List of 140 regulated chemicals with a threshold amount of each to determine regulation at a site.**

EPA, RMP

- Three principal components:
  - Hazard Assessment: worst case releases and alternative, more likely, releases
  - Prevention Program: similar to the OSHA PSM with PHA
  - Emergency Response Program (ERP)

EPA, RMP

- **Worst case release: Release over 10 minutes of largest quantity of a regulated chemical at the plant**
- **Alternative release: One or more other release scenarios, each of which are more likely to occur than the worst case release.**
- **Risk matrices are used to categorize release scenarios.**

EPA VISION

- Emphasize community right-to-now (similar to OSHA's right-to-know)
- Let information drive action
- Focus the program at the local level
- EPA support local and state activities
- Coordinate communication at the local level

Risk Management Programs for Chemical Release Prevention

- Register with EPA
- Implement risk management program
  - Hazard assessment
    - Off-site consequence analysis
    - Five year accident history
  - Prevention program[H]
  - Emergency response program[H]
  - Onsite documentation
- Submit risk management plan (RMP)
- Similar to OSHA PSM requirements

RISK MANAGEMENT PLAN

- Summarizes key elements of the Risk Management Program
- Tells a story about safety at a plant:
  - Hazards
  - Worst case scenario
  - Alternative release scenario
  - 5-yr accident history
  - Prevention program
- Emergency response program (ERP)

RMP *vs.* PSM

- RMP: 11 elements
- Regulates off-site people & environment
- Risk Assessment: release consequences
- Info to community
- ERP: notification of community, responders

- PSM: 14 elements
- Regulates workplace
- Employee participation
- Hot work permits
- Contractors

Limitations of PSM and RMP

- List of hazardous chemicals is not informative and can be dangerous
- Should analyze reactivity within a process
- Should analyze normal process conditions and upset conditions
- Should analyze effects of most likely contaminants

Regulations and Safety Standard

- Meeting the regulations is not sufficient
- Safety at the speed limit depends on conditions
- Regulations alone do not make us safe
- Safety requires knowledge, experience, and engineering judgment
- “Beyond regulatory compliance”

U.S. Chemical Safety and Hazard Investigation Board (CSB)

- Independent federal agency, since 1998
- Authorized by CAA amendments of 1990
- Mission: prevent chemical incidents
- Investigates chemical incidents, determine root causes, issue safety recommendations to government, companies, unions, trade associations

CSB Chemical Reactive Hazard Investigation

- CSB conducted a search for incidents in the U.S. that met the reactive chemical incident definition.
- Identified 167 incidents that occurred since 1980. More that 50% were not covered by PSM.
- Public Meeting, September 17, 2002, Houston, TX
- CSB released reactive hazards investigation report with recommendations to OSHA, EPA, and other agencies

Chemical Safety Board Recommendations to OSHA I

- Broaden the application of the PSM standard to cover reactive hazards resulting from process-specific conditions and combination of chemicals
- To better understand potential reactive hazards, multiple sources of information should be considered

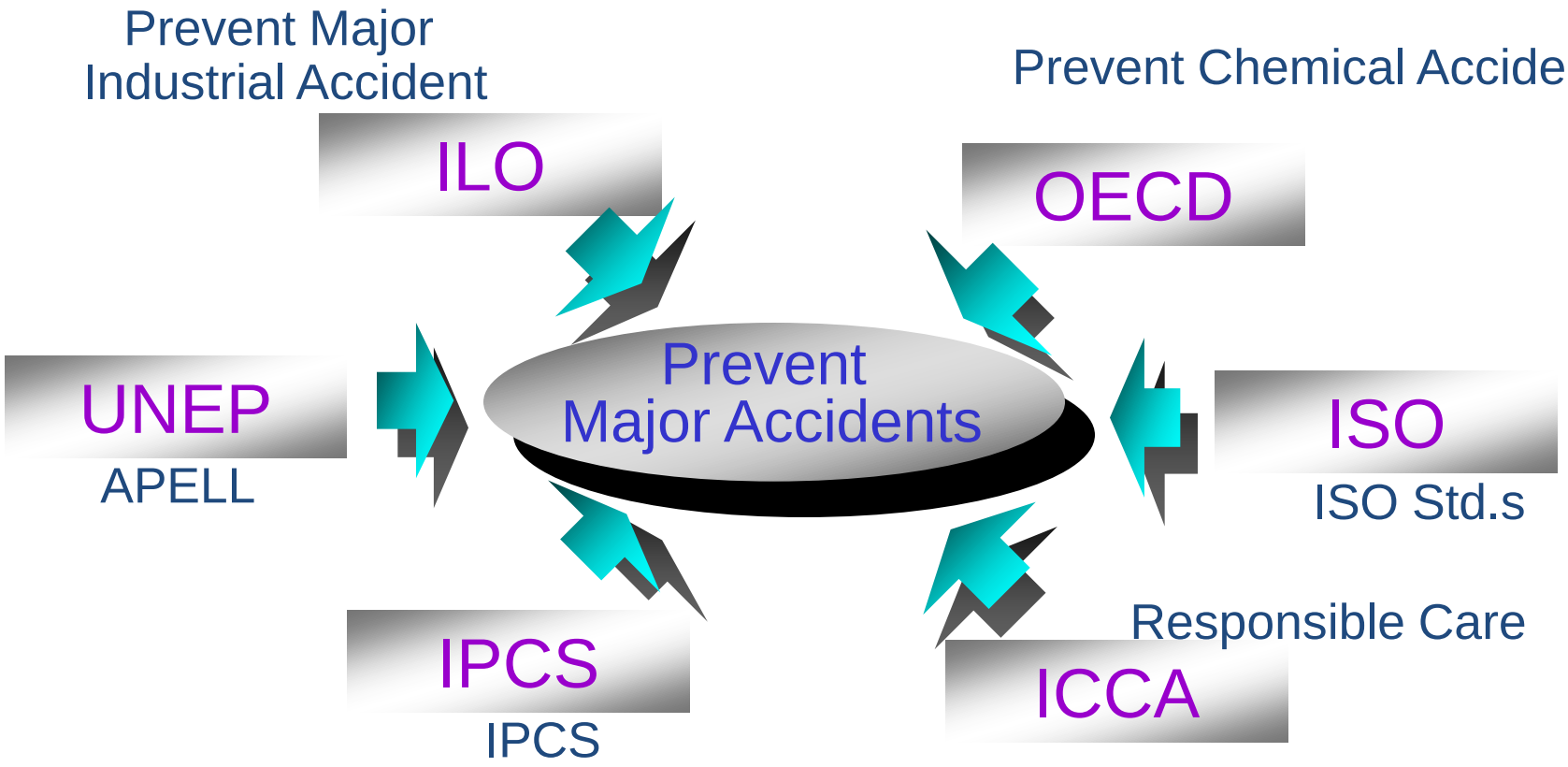
Chemical Safety Board Recommendations to OSHA II

- Augment PHA element of PSM standard to require evaluation of reactive hazards:
- Rate and quantity of heat and gas generated
- Max operating T to avoid decomposition
- Thermal stability of reactants & products
- Effects of variables, e.g., changing rates, catalysts, contaminants
- Consequences of runaways or toxic gases

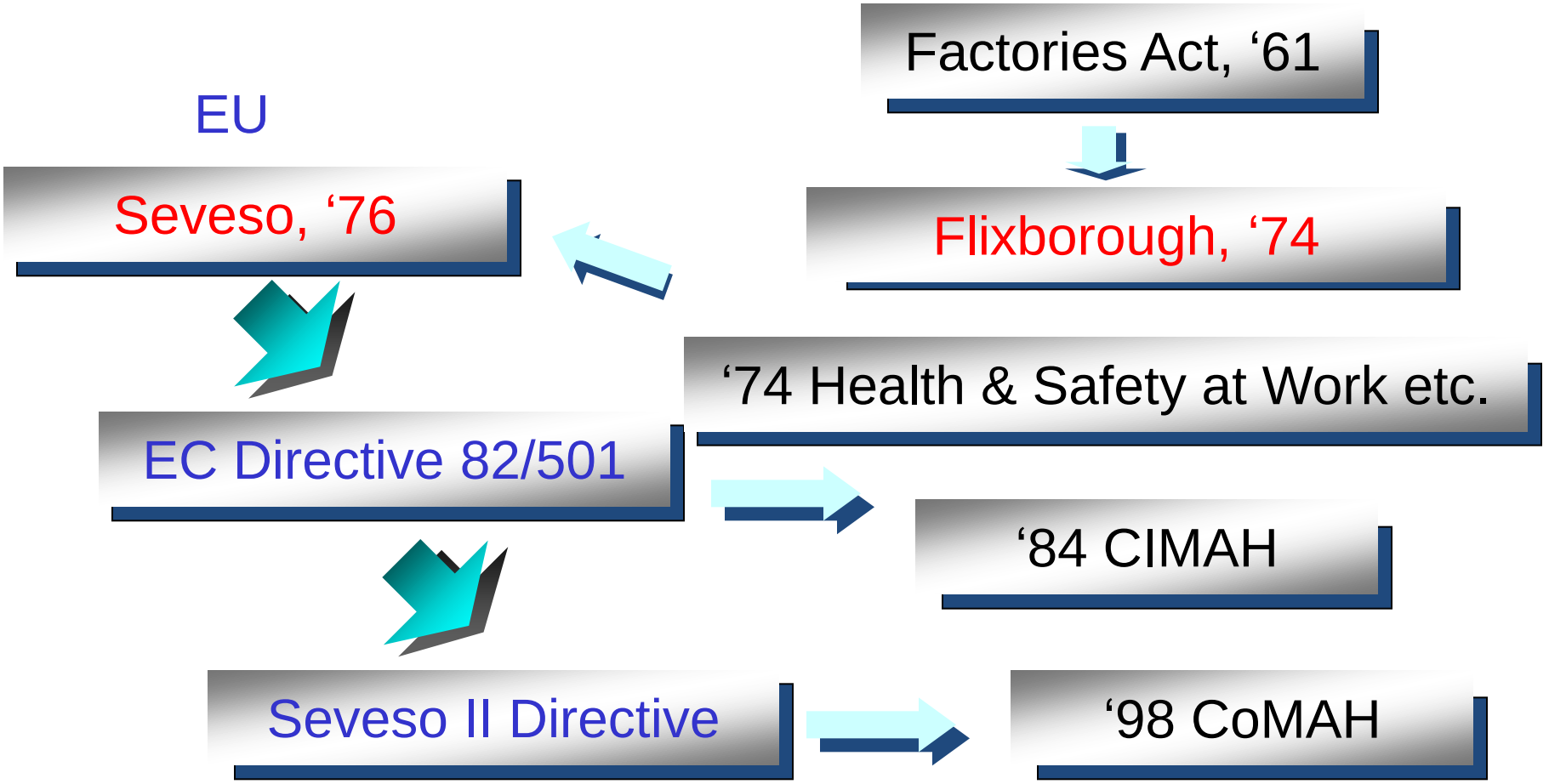
Chemical Safety Board Recommendations to EPA

- **Revise the RMP regulation so that it covers reactive hazards (as to OSHA)**
- **Modify the five year accident report elements collected in the EPA RMP*Info database by defining reactive incidents and collecting relevant data.**

International Program



EU and UK


Factories Act, ‘61
EU
Seveso, ‘76
Flixborough, ‘74
‘74 Health & Safety at Work etc.
EC Directive 82/501
‘84 CIMAH
Seveso II Directive
‘98 CoMAH

European Union (EU)

- Seveso Directive, ‘82
  - 6 Process Facilities, 9 Storage Facilities
  - Inventory on 178 Materials
- Seveso Directive-II, ‘96
  - Apply to Domestic Regulations within 24 months
  - Points
    - Quantitative Risk Assessment
    - Town and Country Planning

United Kingdom (UK)

- Control of Major Accident Hazards Regulation (COMAH, ‘98)
  - Health and Safety at Work etc, ’74
  - Notification of Installation Handling Hazardous Substances Regulations, ’82
  - Control of Industrial Major Accident Hazards Regulation (CIMAH, ‘84)