Chémia 2014

Process Safety in Chemical Industry

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What is the intention of Process Safety ?

Mechanical Integrity

- Kuwait (2000): 10” hydrocarbon line failure - 4 fatalities, 50 injuries, $1 Billion in facility /business interruption
- Dow (2008): LHC Corrosion Under Insulation

BP Texas City incident March 2005

The 2001 incident in France

TO ng by
Re ns of
an
survivors after a huge explosion at a chemical fertilizer plant in southern France killed at least 29 people and injured 650 others.

on -
reportedly caused by workers improperly mixing chemicals - that had the strength of a 3.2 magnitude earthquake, according to the National Earthquake Surveillance Center.

One year later ...

News release Monday, July 8, 2002

Chemical Safety France Bans Toxic Phosgene Gas From Toulouse Chemical Operations

... will ban toxic phosgene gas from all future chemical manufacturing operations in Toulouse, effectively ending all hope that the disaster-struck area will reclaim its place among t

... killing 30 people and causing billions of dollars in damages a

... recognition that risk management must take precedence over short-term economic considerations.

... 12 potential defendants include maintenance and safety executives, manufacturing managers, and employees who may have handled the chemicals responsible for the explosion. All have been prohibited from communicating with each other, leaving France, or directing a classified industrial facility.

Management of Manufacturing Risk

Three component

Learn from experience
- Incident investigation
- Measurement and metrics
- Auditing
- Management review and continuous improvement

etc.)

Understand hazards and risk
- Process knowledge management
- Hazard identification and risk analysis

Commit to process safety
- afety culture
- nce with
- afety co
- Workforce involv
- Stakeholder outre

Manage risk
- Operating procedures
- Safe work practices
- Asset integrity and reliability
- Contractor management
- Training and performance assurance
- Management of change
- Operational readiness
- Conduct of operations
- Emergency management

Learn from expe
- Accident investigation
- RCI (root cause investigation)

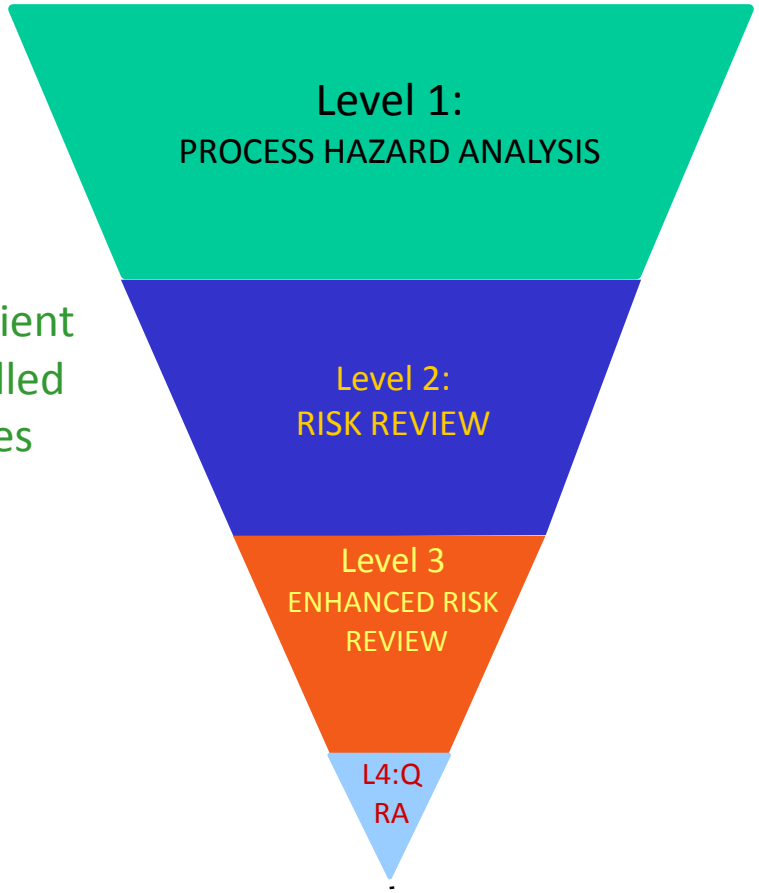
Process Risk Management Standard

Simple Tool

Little Management Involvement

Any substance

Most efficient use of skilled resources



Complex Analysis

Considerable Management Involvement

The Very Select Few

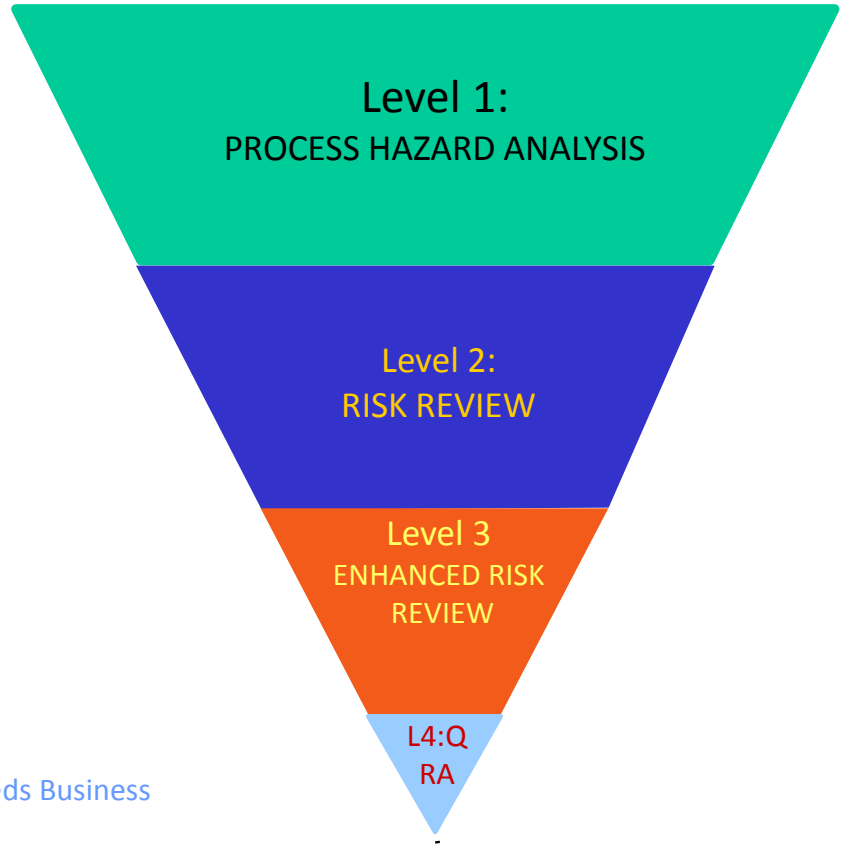
Process Risk Management Standard

LEVEL 1: PROCESS HAZARDS ANALYSIS
– Triggers : All plants, significant projects and changes
- Fire & Explosion Index (FEI)
- Chemical Exposure Index (CEI)
- RC/PHA Questionnaire
- LOPA Target Factors

LEVEL 2: RISK REVIEW
Triggers: F&EI≥…, CEI≥…, LOPA Target Factor ≥ …, government regulations , CEI scenarios with ERPG-3 beyond the property boundary (Emergency Response Planning Guideline)
- Cause-Consequence pair Identification
- LOPA (New technologies are HAZOP'd)
- Explosion Impact (Building Overpressure) evaluation
- Structured Scenario Analysis (e.g., HAZOP, What-If, etc.)

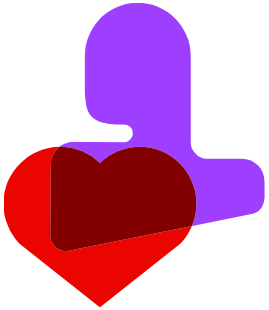
LEVEL 3: ENHANCED RISK REVIEW
– Triggers: LOPA Protection Gap
- Dose-adjusted consequence analysis
- Screen for QRA

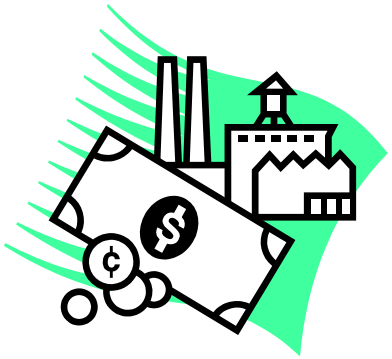
LEVEL 4: QUANTITATIVE RISK ASSESSMENT
– Triggers: Individual Risk contours in off-site population exceeds Business Governance Elevation Criteria
- Combination of Consequence Analysis, Frequency of Impact
- Focuses on highest risk activities



Why care about Acceptable Risk?

Ethics as a professional or corporate citizen requires that we are concern about the well being of others and how our activities impact them.

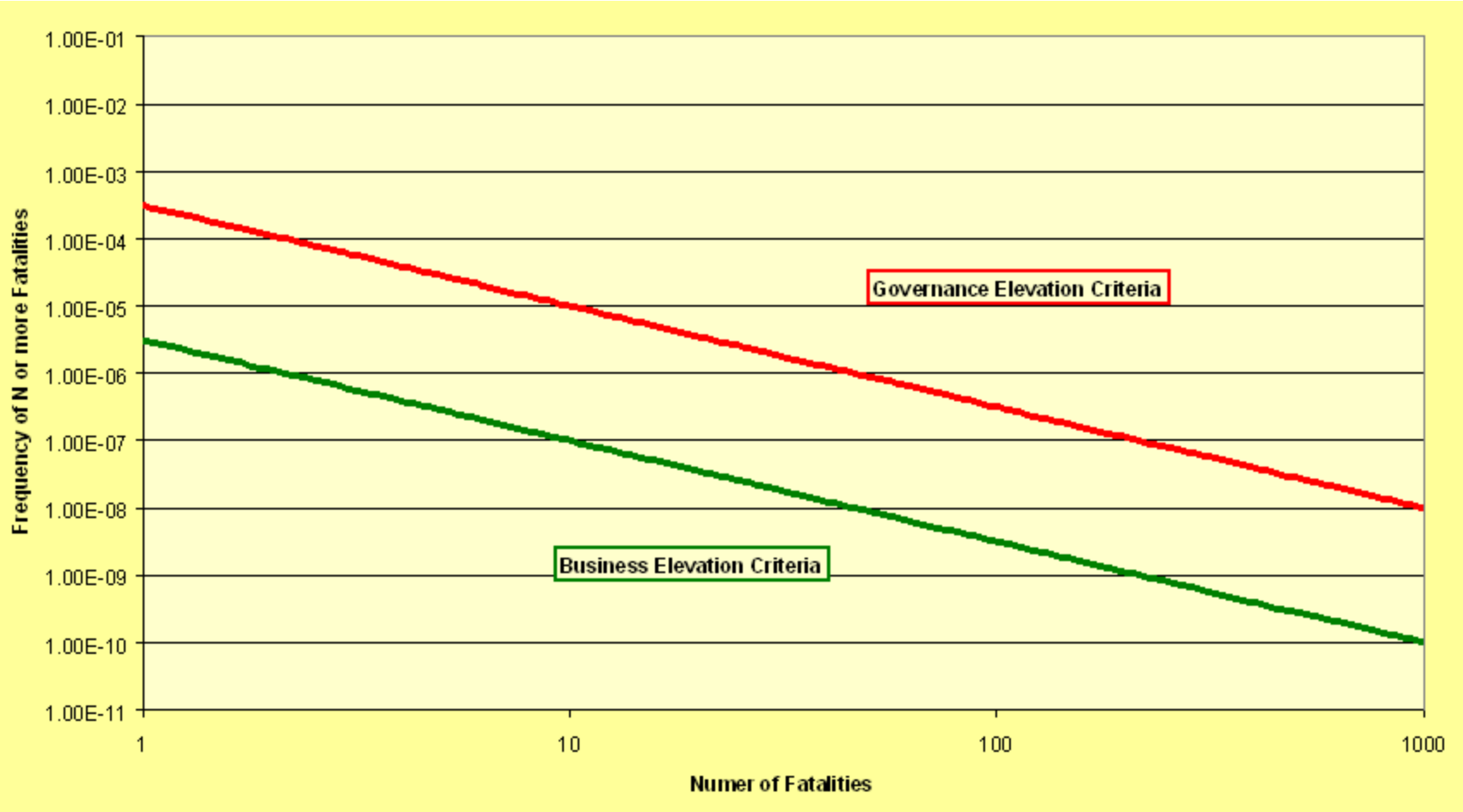




The risk you take may jeopardize the company's privilege of doing business; remember the quote **... will ban toxic phosgene gas from all future chemical manufacturing operations in Toulouse.** Clearly we as chemical industry have a vested interest

Acceptable risk is that level of risk which is being determined to be acceptable personally, for the continuity of business, and by the public (regulations)

Corporate Response - Risk Criteria



But what does this mean…

- Why should we use these curves versus experience?
- How do these curves relate to risk decision that we often make using our experience or ‘gut feel’.
- How Individual risk tolerance must be adjusted to match the corporation’s acceptable risk levels.

Experience or ‘gut feel’.

- EPA Quote

Recurring Causes of Recent Chemical Accidents

“ **From the perspective of the individual facility manager, catastrophic events are so rare that they may appear to be essentially impossible, ...and the circumstances and causes of an accident at a distant facility in a different industry sector may seem irrelevant. However, from our nationwide perspective at …, they are a monthly or even weekly occurrence…”**

James C. Belke
U.S. Environmental Protection Agency
Chemical Emergency Preparedness and Prevention Office

“That is not a credible scenario – it has never happened in 20 years at our plant”

Experience or ‘gut feel’

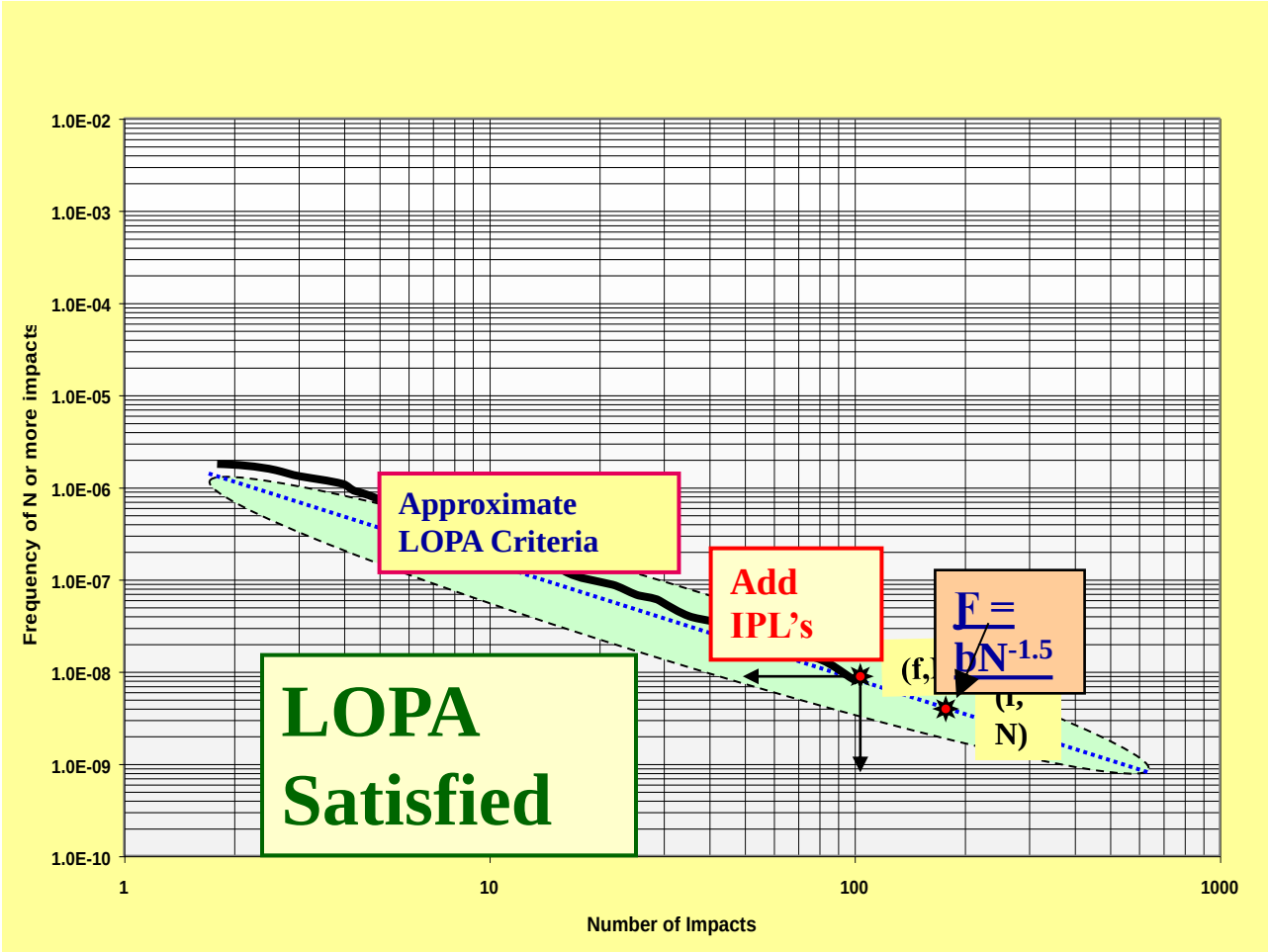
- *You may never had experienced a PS code incident in the 20 years you were at the plant*
- *you might have been below the required performance standard!*

WHAT TO DO?

- 1 Use Analytical approaches

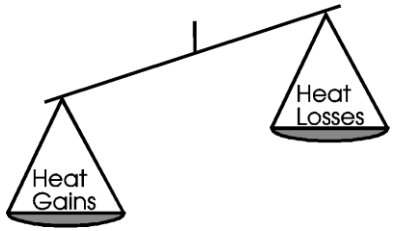
LOPA

Target Factors Derived from Risk Curve

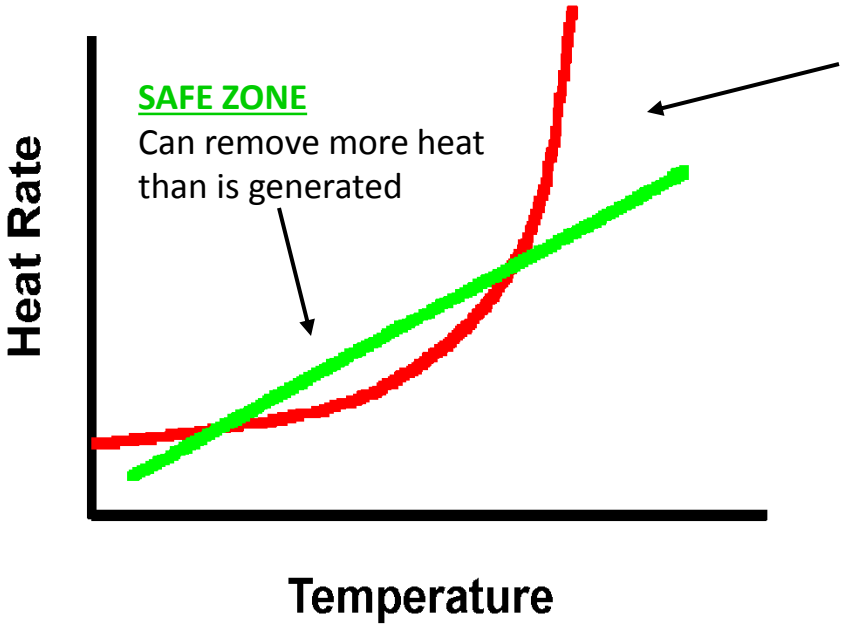


Reactive Chemicals

Definition of Problem ("Game Plan")



- Define Heat Gains
- Define Heat Losses
- Put these together to define operating windows for scale up & plant operations



From this evaluation, we can determine two important parameters:

Temperature of No Return (TNR)

Time to Maximum Rate (TMR)

Reactive Chemicals

Owner Responsibilities

- Ensure that the RC risks are identified
- Ensure that all appropriate operations personnel have a fundamental understanding of the reactivity of the chemicals
- Investigate and report all RC incidents (both Learning Experiences and Accidents) in a database
- Include RC information in the operating discipline

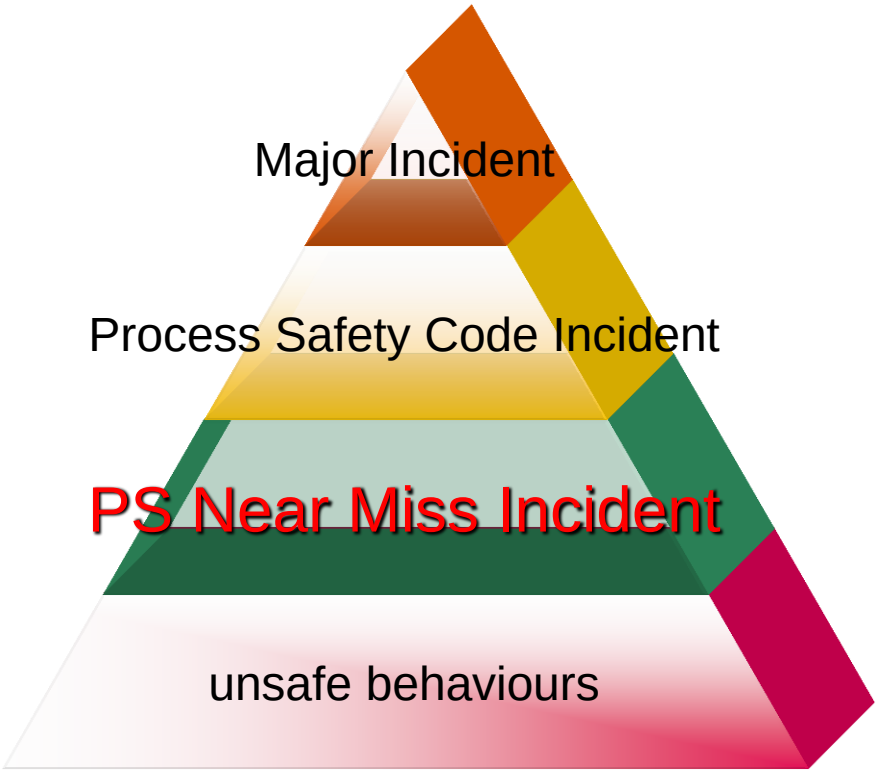
Reactive Chemicals

Owner Responsibilities (cont'd)

- Maintain and update RC data necessary for safe operation,
- Evaluate changes (MOC – management of change) for RC potential,
- Conduct RC/PHA – Reactive Chemicals Process Hazard Assessment reviews for new projects, new leaders, and existing facilities.
- Respond to RC/PHA review recommendations.

2 - Improved Awareness Level

- What you measure is what you get
- It is difficult to focus a program for process safety improvement on a metric that is already recording zeros.
- The near miss will be a leading indicator of PS incidents that provides program focus.

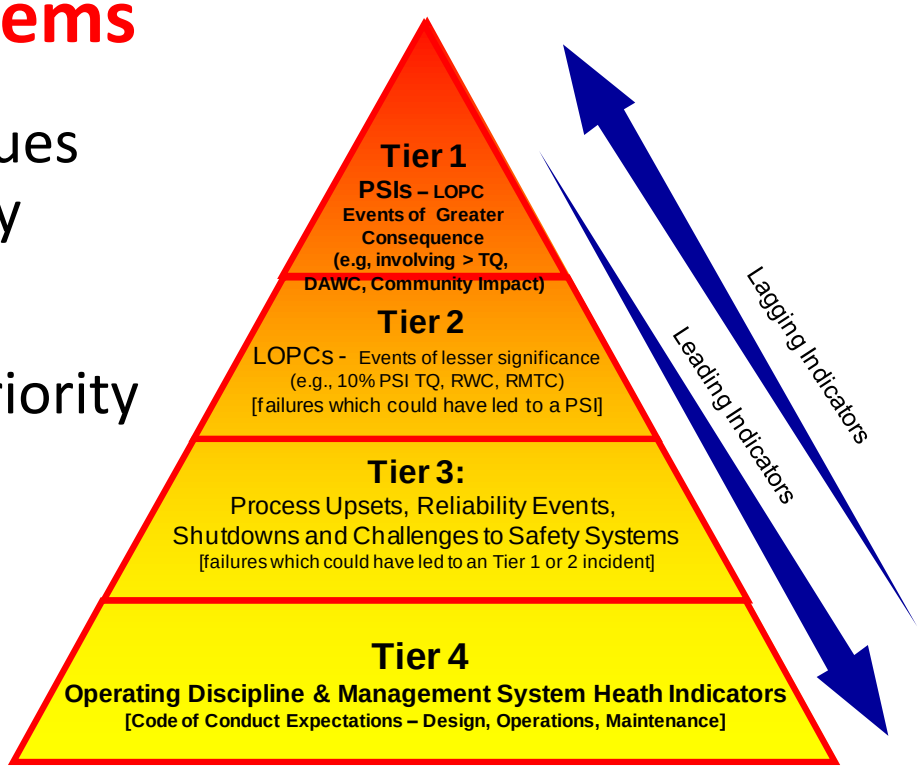


PS Near Miss

Near Miss Program Objectives

Fix our Management Systems

- Resolve system / behavior issues that can lead to process safety incidents
- Leverage the learning from Priority Process Safety Near Misses
- Increased awareness of all personnel on how to prevent incidents



Near Miss Reporting Process

- Formal Corporate Wide Process Safety Near Miss Reporting Requirements & Process to ensure Reporting, RCI, Management System Fixes and Leveraged Learning
- Web based Standard, Process, Tools and Training Resources
- Web based Reporting Tool with Action Recording and Tracking – Event and Action Tool (E&AT)
- All Plants (facilities) have a PS Focal Point role with the responsibility for ensuring all plant personnel are trained and PSNMs are reported and investigated.
- All PS Focal Points are part of a Business or Site Wide PS Network, where PSNM and Learnings are reviewed and leveraging strategy are defined.
- Networks are typically led by PS Resource from the PS Technology Center

Sources to check (Daily) for Potential Near Misses

- Log books & Shift Change Meetings:
  - Small LOPCs,
  - Safety System Activation (SIS or Relief Device),
  - Uncontrolled Reactions,
  - Layer of protection failure,
  - Fires
- Control System Activity Logs:
  - SIS Activation,
  - Alarms indicating uncontrolled reaction
- Maintenance Manage System work orders
  - Small LOPCs
  - 1oo2 SIS s out of Service
- Quarterly Mechanical Integrity “Overdue and Deficiency” Reports

Near Miss Reporting - Tips for Success

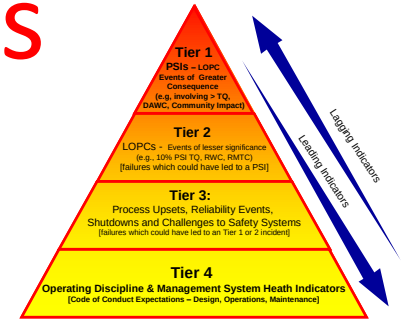
- Reinforce the positive learning aspects of reporting a Near Miss.
- Use the training modules to create the awareness of Process Safety Near Misses at all levels
- Facility Process Safety Resources should review EAT entries and plant incidents to ensure that Process Safety Near Misses are being categorized and reported correctly
- Review Near Miss entries to ensure completeness of the investigations , the definition of effective actions and that the LER process has been used when appropriate
- Implement a formal program to analyze the cause data. Where trends are discovered, implement a program to prevent the specific issue.
- Site, Business Responsible Care Teams monitor the program status and provide recognition for thorough implementation.

Management System Health Indicators (MSH)

Principle: Change the Culture

- What you don't measure, will not improve.
- Metrics reinforce both:
  - **management conduct &**
  - **management system health**
- Leaders must establish what is acceptable performance and how they will respond when it is acceptable or when it is not
- Reviewing performance metrics, taking action and auditing to ensure it happens, drives continuous improvement and changes the culture

Sources for MSH Metrics



- Industry guidance on Metrics / Recognized and Generally Accepted Practices
- Metrics benchmarking with other companies
- There is no silver bullet! Broad combination of factors that need to be monitored and controlled.
  - Facility Design
    - Properly identify & mitigate risks, establish risk management plan including safe operating envelope, and transfer of technology / design to be maintained.
  - Operation
    - Operation with in the risk management plan / safe operating envelope and adherence to life critical standards. Emergency procedures and drills. Corrective actions and learning from unplanned events.
  - Maintenance
    - Maintain the integrity of the design: Pressure Equipment, Interlock and alarms, electrical equipment, critical safety mitigation equipment

Process Safety Performance Indicators for the Refining and Petrochemical Industries
ANSI/API RECOMMENDED PRACTICE 754
FIRST EDITION, APRIL 2010

(Revision 1 – September 2010)

3 - Apply the Concepts of Inherently Safer Designs

"The essence of the inherently safer approach to plant design is the avoidance of hazards rather than their control by added-on protective equipment."

"What you don't have can't leak!"

Trevor Kletz

Plant Design for Safety - a user-friendly approach, 1991

Design Approaches for Inherently Safer Plants

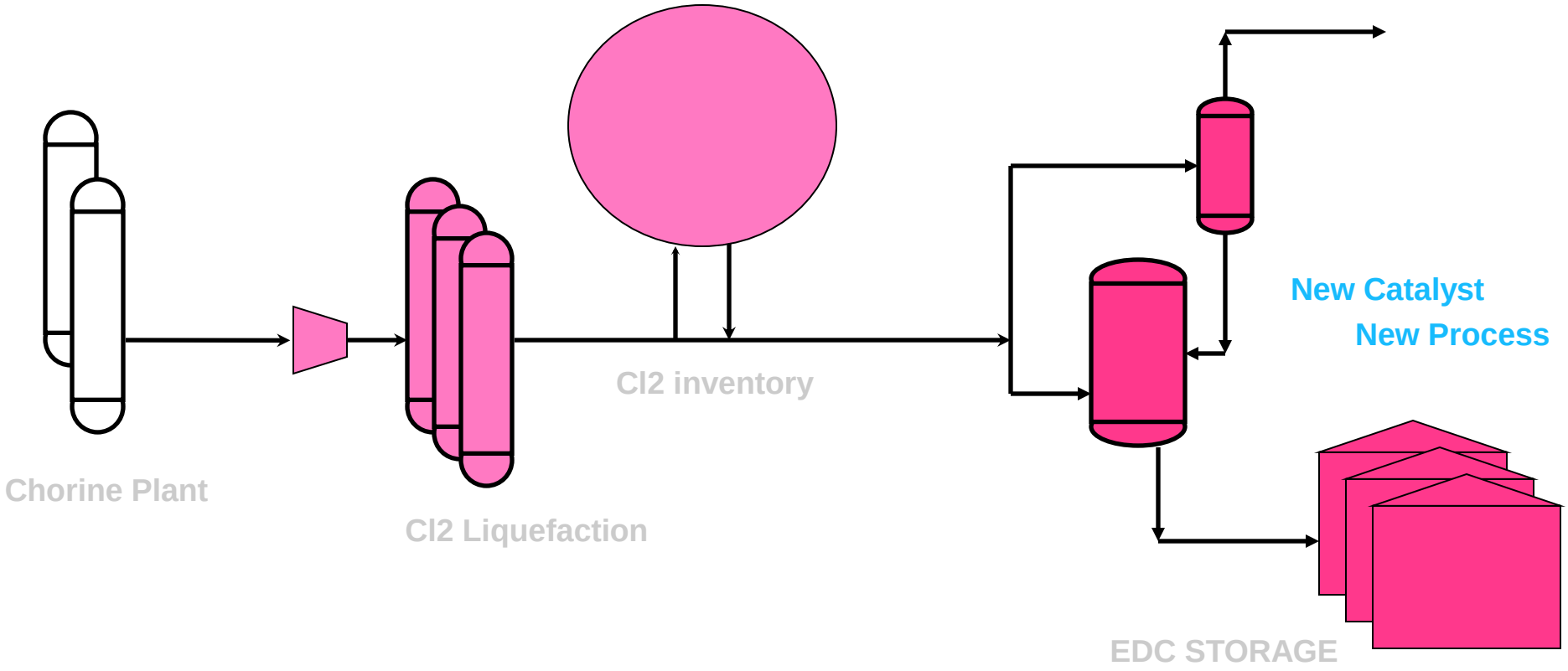
- Minimization or Intensification
- Substitution
- Moderation or Attenuation
- Limitation of Effects
- Simplification and Error Tolerance

Intensification or Minimization

Reduce inventories of hazardous materials and energy used such that leaks from equipment present a minimal hazard.

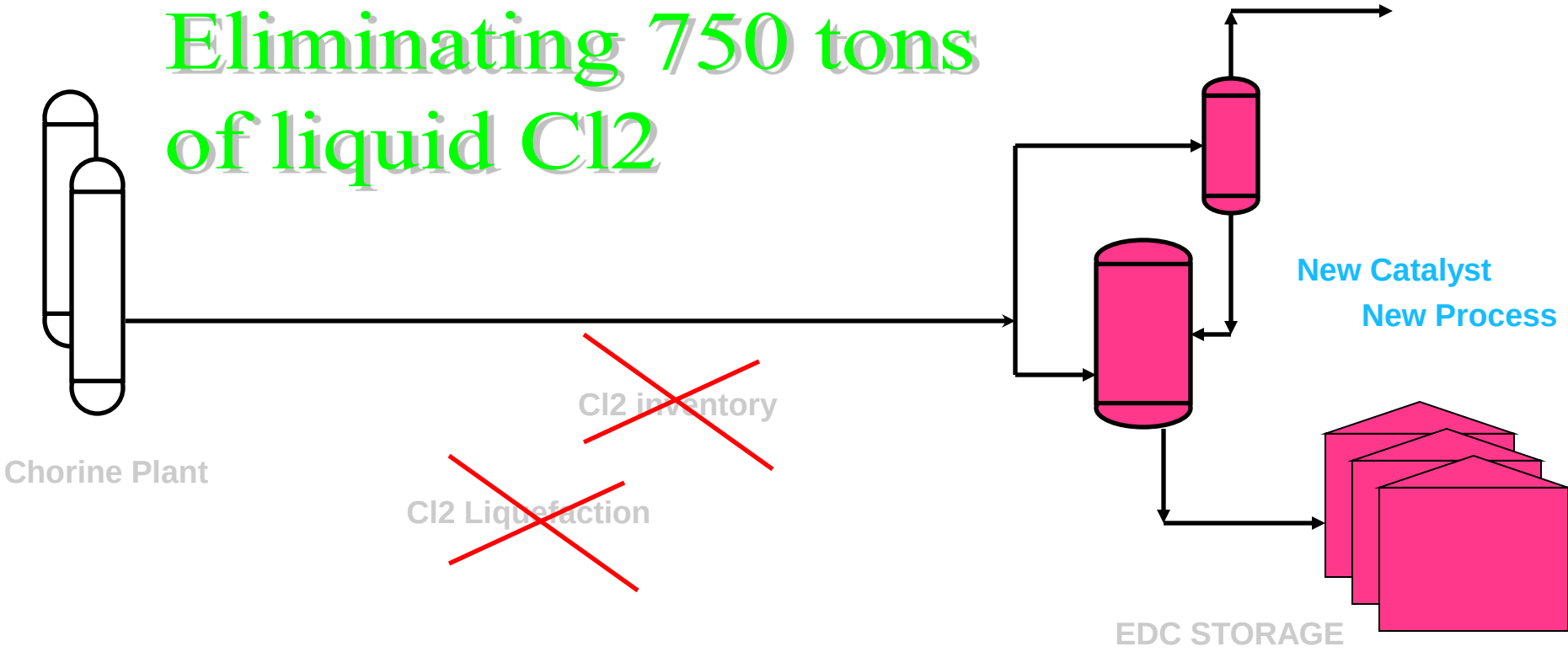
Example – Cl2 sphere

Chlorine Direct to EDC



Chlorine Direct to EDC

Eliminating 750 tons of liquid Cl2



Substitution

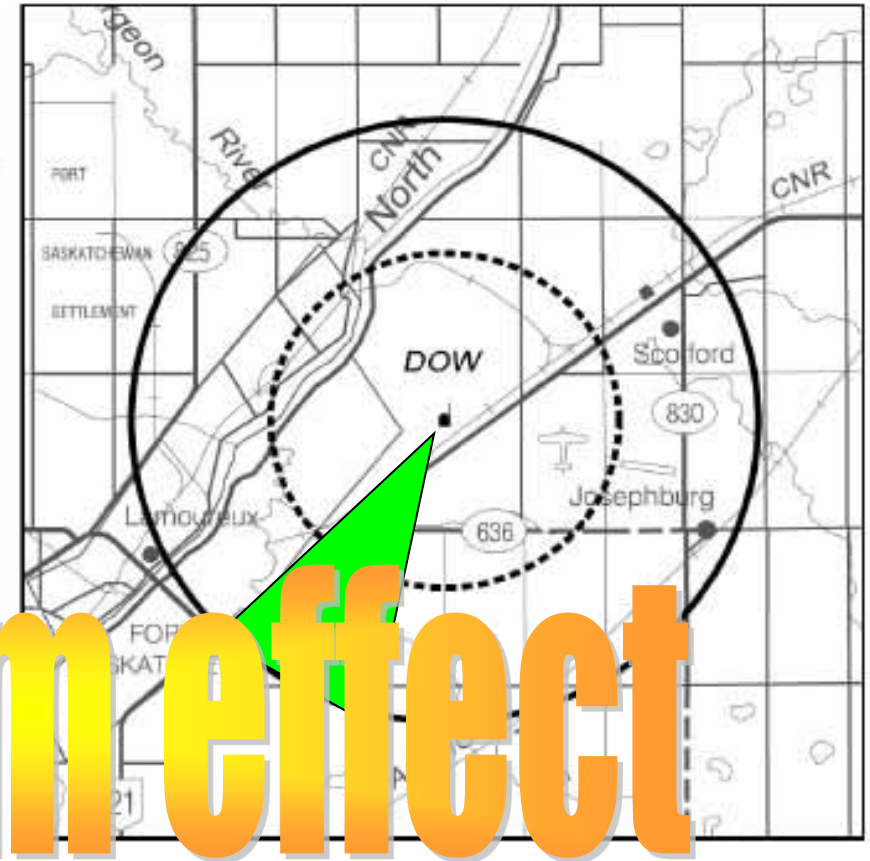
Use alternate materials that are less hazardous or alternate processes that operate in less hazardous conditions.

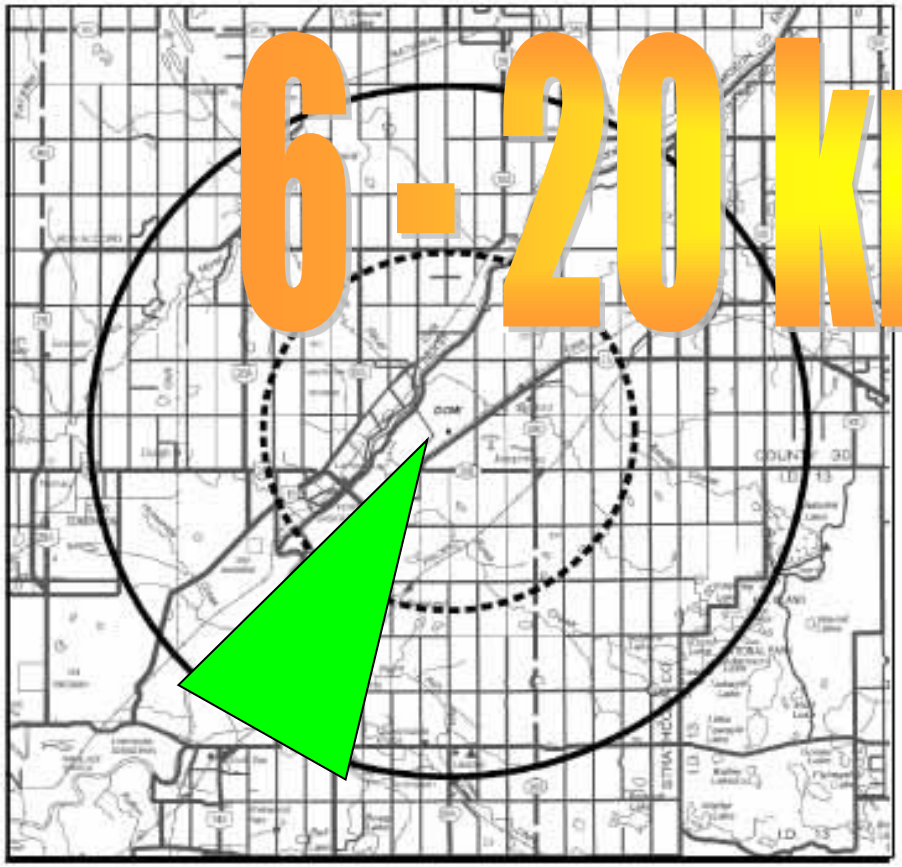
Example - EOEG has replaced anhydrous ammonia with aqueous
- CA is substituting anhydrous SO2 with sodium bisulphite

is this significant? …

Emergency Planning Case
Scenario

1" leak in process vessel or pipeline for 10 minutes releasing 4,430 kg of material; impact up to 6 km downwind.





6 - 20 km effect

Worst Case
Scenario

Complete failure of largest single sulphur dioxide inventory releasing the 82,000 kg contents over 10 minutes; impact up to 20 km downwind.

Moderation also called Attenuation

Moderation results
in the process being operated closer
to ambient conditions.

Examples:

- **Catalyst allow the process to operate at a lower temperature or pressure.**
- **Dilution is a good example of this.**
- **Vancouver aqueous HCl. 36% HCl replaced with 17%. The partial pressure has reduced by over 1000 times vs doubling the deliveries**

Limitation of Effects

Limiting the impact (consequences) of any material or energy released through plant siting, equipment layout or other engineered systems.

Examples:

- **Dikes - if you have a volatile material a dike reducing the surface area will often result in a Limitation of the effects.**

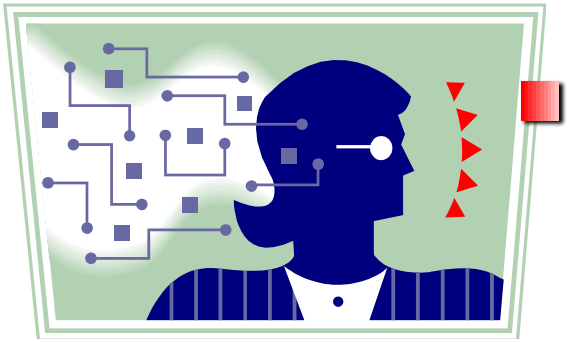
These are difficult to retrofit and should be considered with the original design

Simplification and Error Tolerance

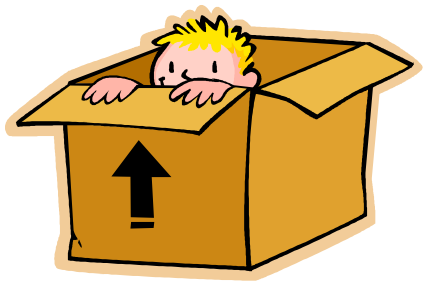
Design processes to eliminate unnecessary complexity, reducing the opportunities for error and mis-operation.

SUMMARY

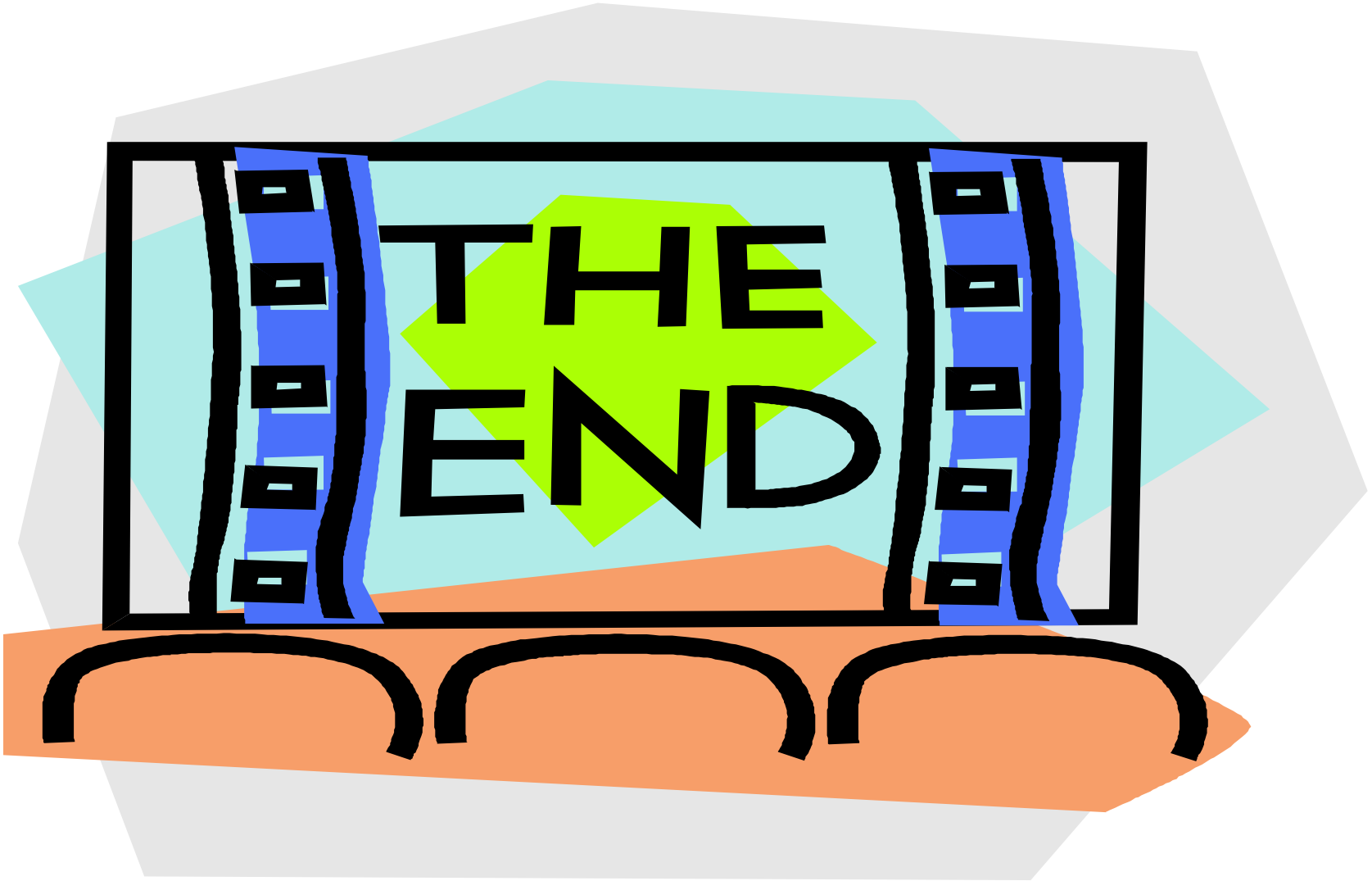
- We manage major risks in our company
- if we ignore or mismanage society may be unforgiving



- need to use technology
  - analytical approach vs gut feel approach



  - need to get out of the box and incorporate inherent safety in our designs (innovation)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