Incorporating Prevention through Design Methods into the Design & Re-design Process

Frank M. Renshaw, PhD, CIH, CSP
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Prevention Through Design Initiative
A Systematic, Step-by-Step Approach

**Step 1**
Create Awareness of PtD in All Sectors, Organizations, Agencies & Schools

**Step 2**
Incorporate PtD into Work Processes and Health & Safety Management Systems

**Step 3**
Monitor the Impact of PtD on Eliminating Hazards & Minimizing Risks
PREVENTION THROUGH DESIGN METHODS

Eliminating Hazards & Controlling Risks at the Source or as Early as Possible in the Life Cycle

Including Design & Re-design of New & Existing Facilities, Equipment, Tools, Processes, Products & Work Methods

Including Prevention Methods in All Designs that Impact Workers and others on the Premises
Capital Project Process (CPP)

The mechanism used within an organization to manage the development and execution of capital projects from idea conception through start-up and process optimization.
New Technical Center
Eliminating Open Systems
Retrofitting Laboratory Hoods
New Acquisition - Completion - Start-up
Key Partners

Safety Services
  Industrial Hygiene
  Occupational Health Services
  Environmental Services
  Security
  Company Fire Brigade

Project Leader
Project Team
  Specialist Engineer
  Site Manager
  Project Owner
  Technical Services/Maintenance

Safety Contractor Engineering
  Safety Coordinator Design
  Safety Coordinator Construction
  Notified Body/Official Organizations
  Public/Community Fire Brigade
  Insurance
  Contractor
Incorporating PtD Methods into CPP - Key Essentials -

• Setting Policy & Standards

• Establishing Work Processes & Procedures

• Applying Tools & Practices
Incorporating PtD Methods into CPP
- Key Essentials -

• Setting Policy & Standards

- Policy
- Standards

• Establishing Work Processes & Procedures

- Work Processes & Procedures

• Applying Tools & Practices

- Tools & Practices
Incorporating PtD into EHS Policy

Pole Vault Approach

Steady Climb Approach
The XYZ Company is the world’s leading manufacturer of ___ products. Our environmental, health, and safety values are of the utmost importance to us. They are embodied in the guiding principles set forth in this policy. They reflect our respect and care for the environment, our employees, contractors, customers and communities. We are committed to incorporating these values into everything we do as we seek to improve the quality of life and the environment through our products and services.

Our Guiding Principles are:

• We will design our businesses, processes and products with full consideration for the needs of the present global community and the impact of our design decisions on the ability of future generations to meet their needs.

• We will include “Prevention through Design” considerations in the design and redesign of all facilities, equipment, processes, work methods and products, and will incorporate methods of safe design into all phases of hazard and risk mitigation.

• We will continuously review and improve our worldwide operations, processes, and products, with the goal of making them free of adverse environmental, health, and safety impacts for all of our stakeholders.

• We will meet or exceed all applicable laws, regulations, and XYZ Company standards.

• __________

• __________

Every employee and contractor is responsible for compliance with this policy. We will audit our performance and the Board of Directors will monitor our commitments and progress.

*Adapted from the former Rohm and Haas Company
3.1 Management Leadership

3.1.2 OHS Policy

The organization’s top management shall establish a documented occupational health and safety policy as the foundation for the OHSMS. This policy shall include a commitment to:

A. Protection and continual improvement of employee health and safety;

B. Inclusion of “Prevention through Design” considerations in design and redesign of all facilities, equipment, processes, work methods and products, and incorporation of safe design methods into all phases of hazard and risk mitigation;

C. Effective employee participation;

D. Conformance with the organization’s health and safety requirements; and

E. Compliance with applicable laws and regulations.

*Proposed Amendments to ANSI/AIHA Z10-2005

5.1 OHSMS Operational Elements

5.1.2 Design Review and Management of Change

The organization shall establish and implement processes which incorporate Prevention through Design concepts to identify, and take appropriate steps to prevent or otherwise control hazards and reduce potential risks associated with:

A. New processes or operations at the design stage;

B. Changes to its existing operations, products, services or suppliers.

The process for design reviews and management of change shall include:

a. Identification of tasks and related health and safety hazards as early as possible in the life cycle of facilities, equipment, processes, work methods and products;

b. Consideration of hazards associated with human factors;

c. Consideration of control measures, taking into account the hierarchy of controls;

d. Review of applicable regulations, codes and standards;
Incorporating PtD Methods into CPP - Key Essentials -

• Setting Policy & Standards

• Establishing Work Processes & Procedures

• Applying Tools & Practices
Capital Project Process Summary Map

Stage 0: Initiation
Stage 1: Project Deliberation
Stage 2: Select Option and Conceptual Estimate
Stage 3: Detail the Option
Stage 4: Design & Procure
Stage 5: Construct
Stage 6: Start-up
Stage 7: Close-out

Stage Gates

End of FEL
Internal/External Stage Gates

Ongoing Activities: VEP’s, Performance Measurements, Quality Audits, Progress Reporting, Cost and Schedule Control, Total Value Added

= Decision Gate
= Progress / Status Gate

2i = Agree to proceed on “selected option”.
2 = Conceptual estimate review and approval - agreement to move into detail the option.
<table>
<thead>
<tr>
<th>CPP</th>
<th>STAGE 1 Project Deliberation</th>
<th>STAGE 2 Select/Detail Option</th>
<th>STAGE 3 Design/Procurement</th>
<th>STAGE 4 Construction</th>
<th>STAGE 5 Start-up</th>
<th>STAGE 6 Closeout</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Project mission, initial goals and objectives, scope 1.1.1</td>
<td>Finalized goals and objectives 2.1.1</td>
<td>Updated goals and objectives 3.1.1</td>
<td>Detailed construction plan and schedule 4.1.1</td>
<td>Commissioning &amp; start-up plan and detailed schedule 5.1.1</td>
<td>Closeout Plan 6.1.1</td>
</tr>
<tr>
<td>Key Project Execution &amp; Design Deliverables</td>
<td>Generate &amp; initial screen of options 1.1.2</td>
<td>Select best option, finalized project scope document (IBL/OBL) 2.1.2</td>
<td>P&amp;IDs, mechanical, electrical, civil, structural, control system programs all complete 3.1.2</td>
<td>Construction roles &amp; communication plan 4.1.2</td>
<td>Operating rates documented 5.1.2</td>
<td>Final acceptance documentation 6.1.2</td>
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<tr>
<td></td>
<td>Project execution strategy 1.1.3</td>
<td>Project execution plan 2.1.3</td>
<td>Detailed spare parts list 3.1.3</td>
<td>Facility mechanically complete (approved for commissioning) 4.1.3</td>
<td>Facility operating to specifications 5.1.3</td>
<td>Project critique, customer feedback, closeout report 6.1.3</td>
</tr>
<tr>
<td></td>
<td>Afford to spend model 1.1.4</td>
<td>Finalized design basis, process description, PFDs, P&amp;IDs, control philosophy, site plan, list of materials, major equipment quotes/bids 2.1.4</td>
<td>All equipment purchase orders issued 3.1.4</td>
<td>As-built, quality assurance, spare parts, turnover documentation 4.1.4</td>
<td>Revised operating and maintenance procedures, and documentation for design changes (as-built) issued 5.1.4</td>
<td>Appropriate learnings &amp; design ideas communicated 6.1.4</td>
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<tr>
<td></td>
<td>Order of Magnitude estimate 1.1.5</td>
<td>Finalized economic analysis &amp; AR submitted 2.1.5</td>
<td>Cost compliance report 3.1.5</td>
<td>Construction cost report 4.1.5</td>
<td>Revised start-up cost estimate 5.1.5</td>
<td>Project &amp; equipment files submitted to facility 6.1.5</td>
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<td></td>
<td>Prevention through Design principles in project scope 1.1.6</td>
<td>Prevention through Design compliance 2.1.6</td>
<td>Prevention through Design compliance 3.1.6</td>
<td>Prevention through Design compliance 4.1.6</td>
<td>Prevention through Design compliance 5.1.6</td>
<td>Prevention through Design compliance documentation 6.1.6</td>
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<table>
<thead>
<tr>
<th>STAGE 1</th>
<th>STAGE 2</th>
<th>STAGE 3</th>
<th>STAGE 4</th>
<th>STAGE 5</th>
<th>STAGE 6</th>
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<tr>
<td>Project Deliberation</td>
<td>Select/Detail Option</td>
<td>Design/Procurement</td>
<td>Construction</td>
<td>Start-up</td>
<td>Closeout</td>
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<tr>
<td>Early OHS Hazards &amp; Risks Review 1.1</td>
<td>OHS Project Plan Review 2.1</td>
<td>OHS Design Review 3.1</td>
<td>OHS Project Construction Review 4.1</td>
<td>OHS Project Start-up Review 5.1</td>
<td>OHS Project Evaluation 6.1</td>
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<tr>
<td>Preliminary OHS project plan 1.2.1</td>
<td>Refined OHS project plan 2.2.1</td>
<td>OHS Design Review complete, recommendations resolved, actions tracked 3.2.1</td>
<td>Pre-construction safety plan 4.2.1</td>
<td>Pre-start-up OHS Review completed &amp; actions addressed 5.2.1</td>
<td>Assessment of residual risk versus targets 6.2.1</td>
</tr>
<tr>
<td>Preliminary regulatory &amp; permit plan 1.2.2</td>
<td>OHS Hazard Analysis &amp; Risk Assessment requirements defined, studies initiated as needed 2.2.2</td>
<td>Hazard Analysis - Risk Assessment studies complete, recommendations resolved, risk targets met, actions tracked 3.2.2</td>
<td>Construction permits 4.2.2</td>
<td>Completed site acceptance testing of equipment &amp; OHS devices 5.2.2</td>
<td>Prevention through Design compliance verification 6.2.2</td>
</tr>
<tr>
<td>Preliminary regulatory &amp; permitting requirements defined, documents submitted 2.2.3</td>
<td>Regulatory &amp; permitting requirements defined, documents submitted 2.2.3</td>
<td>Appropriate permit applications &amp; regulatory approval 3.2.3</td>
<td>Construction safety program effectiveness verification 4.2.3</td>
<td>Completed checks, tests &amp; critical retrofits 5.2.3</td>
<td>Feedback on OHS standards and modifications initiated as appropriate 6.2.3</td>
</tr>
<tr>
<td>Early identification of significant &amp; unique OHS hazards &amp; risks 1.2.3</td>
<td>Early identification of significant &amp; unique OHS hazards &amp; risks 1.2.3</td>
<td>Detailed drawings reviewed &amp; approved 3.2.4</td>
<td>Regulatory permit completion and approval verification 4.2.4</td>
<td>Preliminary industrial hygiene exposure monitoring complete 5.2.4</td>
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<tr>
<td>Early identification of Prevention through Design opportunities 1.2.4</td>
<td>Insurance assessment complete, fire protection &amp; security requirements finalized 2.2.4</td>
<td>Equipment specs approved, checks &amp; test protocols developed 2.2.5</td>
<td>Preliminary industrial hygiene exposure monitoring complete 5.2.4</td>
<td>All incidents investigated and impact of root causes on design/operation addressed 5.2.5</td>
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</table>

Bayberry EHS Consulting, LLC
# OHS Deliverables Planning Template

<table>
<thead>
<tr>
<th>OHS Deliverable</th>
<th>Description</th>
<th>Date Completed mm/dd/yy</th>
<th>Deliverable Documented (Y/N)</th>
<th>Actions Tracked (Y/N)</th>
<th>Proj. Mgr. Reviewed (Y/N)</th>
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<tbody>
<tr>
<td>1.1</td>
<td>Early OHS Hazards and Risks Review</td>
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<tr>
<td>1.2.1</td>
<td>Preliminary OHS project plan</td>
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<tr>
<td>1.2.2</td>
<td>Preliminary regulatory &amp; permit plan</td>
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<tr>
<td>1.2.3</td>
<td>Early identification of significant &amp; unique OHS hazards &amp; risks</td>
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<td>2.1</td>
<td>OHS Project Plan Review</td>
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<td>2.2.1</td>
<td>Refined OHS project plan</td>
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<td>2.2.2</td>
<td>Hazard Analysis &amp; Risk Assessment requirements defined, studies initiated</td>
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<td>2.2.4</td>
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<td>2.2.5</td>
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Management of Change

Definition
A system to assess and address the EHS impact of changes to a process, facilities, or organization before the changes are made.

Key Principles
• Every change must be managed.
• Changes must not be made without an appropriate review.
• They type of review should be consistent with the complexity of the change
• MOC systems should be simple to use
What Level Are These Changes?

1. New filtration system in the plant
   - Identical Substitution
2. New pump identical to the one it replaces
   - Replacement in Kind
3. Change of valve for identical type from different manufacturer
   - Basic Change
4. Change of valve for a different type
   - Major Change

FLL and OMT Training

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Management of Change Process – Matching the Type of EHS Review to the Level of Change

- **Identical**
  - Always a Formal EHS Review; May also require a Process Hazard Analysis
  - HAZOP Study
  - What-If/Checklist
  - FTA, QRA, etc.

- **Substitution**
  - Personal Review

- **Replacement In Kind**
  - Formal EHS Review

- **Basic Change**
  - Personal Review

- **Major Facility or Process Change**
  - Personal Review
Incorporating PtD Methods into CPP
- Key Essentials -

• Setting Policy & Standards

• Establishing Work Processes & Procedures

• Applying Tools & Practices
Applying Tools and Practices

- Robust
  - In Sync with CPP
    - Applied Properly & Consistently
      - By Competent People
        - Working Together
          - Straightforward & Simple as Possible
Process Hazard Analyses

HAZOP – What-If/Checklist – FTA – QRA

Robust Tools!  Robust Tools!  Robust Tools!  Robust Tools!
Top Unloading
In Sync with CPP

Ongoing Process Development

- Refine Goals
- Generate Options
- Reduce & Select Option
- Detail Option

Project Execution

- Engineering
- Construction
- Startup
- Operations & Maintenance

- Previous Plus: Design Basis of ERS Equipment Specs P&IDs
- Previous Plus: Physical Properties of Intermediates/Product/Wastes
- Previous Plus: Reactivity Data
- Previous Plus: Thermal & Chemical Stability Data
- Previous Plus: Operating Instructions
- Previous Plus: Disposition of Waste Streams

- Basic Chemistry Process Description
- Physical & Hazard Properties of RMs
- Previous Plus: Block Flow Diagram
- Major RM Inventory
- Material & Energy Balances
- Major Equipment Sizes

- Previous Plus: Design Basis of ERS Equipment Specs
- Previous Plus: Vendor Drawings
- Previous Plus: Electrical Classification
- Previous Plus: Special Site Considerations
- Previous Plus: Building & Equipment Layout
- Previous Plus: Control System & Interlocks

- Previous Plus: Operating/Operator's Experience
- Prior PHA's
- SHE Reviews of Changes
- Incident Reports
- Equipment Reliability Experience
- Emergency Response Plans

- Early EHS Process
- EHS Agreements at this time
- RISK Indices
- EHS Reviews
- CHA Chemistry Hazard Analysis
- Checklists
- FSHI Index

- Optimum timing for HAZOP is at end of "Detail Option"
- Optimum timing for MAPP Review of Design Changes

- Interaction Matrix Started
- Interaction Matrix (w/intermediates, MOCs, Utilities)
- What-If/Checklists

- MAPP (Worst Case Scenarios Only)
- MAPP
- HAZOP
- FTA
- LOPA
- Generic Process HAZOP
- QRA
- FMEA

- PreStartUp Safety Review
- PHA Renewals 3-5 year basis using appropriate PHA technique
- MOC Reviews all changes using appropriate PHA technique

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Applied Properly and Consistently

- Tool balancer - allows clip pipe to be raised and lowered with minimum effort.
- Compressible PVC ducting enclosing clip pipe at all times.
- Antistatic PTFE bypass vent. This ensures that the drum is ventilated when in place.
- Drip cup is ventilated when in place.

Drumvent at rest with drip cup in place

Drumvent in use

Standard Design
CTTL Drumvent*

*CTTL - Chemical Transfer Technology Ltd, Newcastle, UK
Enclosed, Ventilated Drum Hood
Competent People to Apply Tools
Working Together
Straightforward & Simple
<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Complete (Y,N,N/A)</th>
<th>Section in Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Medical Services and First Aid.</strong> Where the eyes or body of any person may be exposed to injurious corrosive materials, suitable facilities for quick drenching or flushing of the eyes and body shall be provided within the work area for immediate emergency use.</td>
<td>(Y,N,N/A)</td>
<td>1910.151(c) 1926.50(q)</td>
</tr>
<tr>
<td>2</td>
<td><strong>General Requirements for Dipping and Coating Operations.</strong> Emergency shower and eyewash station must be provided close to dipping or coating operations when working with liquids that may burn, irritate or otherwise harm the skin.</td>
<td>(Y,N,N/A)</td>
<td>1910.124(g)(2)</td>
</tr>
<tr>
<td>3</td>
<td><strong>13 Carcinogens (4-Nitrobiphenyl, etc.)</strong> Emergency deluge showers and eyewash fountains supplied with potable water must be provided near, within site of, and on same level where direct exposure to ethyleneimine or beta-propiolactone would likely result from equipment failure or improper work practices.</td>
<td>(Y,N,N/A)</td>
<td>1910.1003(d)(2)(vi) 1915.1003</td>
</tr>
<tr>
<td>4</td>
<td><strong>Acrylonitrile.</strong> Employer must assure that, in the event of skin or eye exposure to liquid acrylonitrile, the affected employee shall shower immediately.</td>
<td>(Y,N,N/A)</td>
<td>1910.1045(m)(3) 1915.1045</td>
</tr>
<tr>
<td>5</td>
<td><strong>Formaldehyde.</strong> Quick drench showers must be conveniently located where employees’ skin may be splashed with &gt; 1% formaldehyde solution, and eyewash facilities provided within immediate work area where there is possibility of splash with ≥0.1% formaldehyde solutions.</td>
<td>(Y,N,N/A)</td>
<td>1910.1048(i)(2) 1910.1948(i)(3) 1915.1048</td>
</tr>
<tr>
<td>6</td>
<td><strong>Occupational Exposure to Hazardous Chemicals in Laboratories.</strong> Laboratory facilities handling hazardous chemicals should have easily accessible drench-type safety showers and eyewash fountains. (Non-mandatory)</td>
<td>(Y,N,N/A)</td>
<td>1910.1450 Appendix A 1915.1450</td>
</tr>
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</table>
Summary

• First Seek to Understand
  – PtD Methods
  – CPP Process
  – Partners

• Then Implement the Key Essentials
  – Setting Policy & Standards
  – Establishing Work Processes & Procedures
  – Applying Tools & Practices

• Always Be a PtD Champion