School of Environmental, Physical and Applied Sciences

Educating Health and Safety Professionals in PtD

Dr. Georgi Popov, QEP

PtD Principle

" We take our decisions on policy or submit them to proper discussions: **the worst thing is to rush into action before the consequences have been properly debated.** And this is another point where we differ from other people. We are capable at the same time of **taking risks** and of **estimating them beforehand**. "

Fortune 500 CEO?

Not really…

Source:

Thucydides, *History of the Peloponnesian War,* Translated by Rex Warner. Penguin Books ltd.

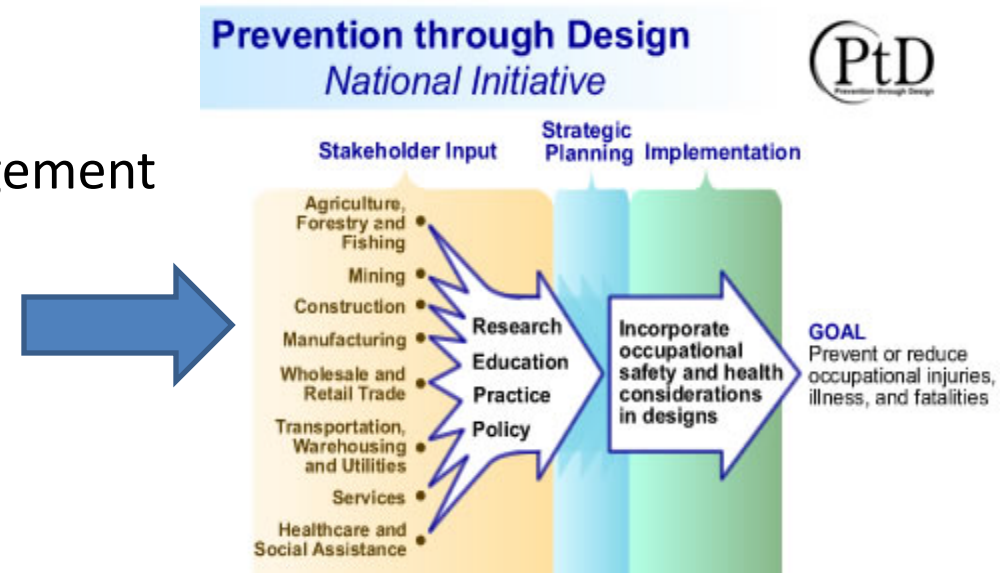
Need for PtD inclusion in course lectures and student projects

- **PtD:** *Addressing occupational safety and health needs in the design and redesign processes to prevent or minimize the work-related hazards and risks associated with the construction, manufacture, use, maintenance, and disposal of facilities, materials, and equipment.*
- **RESEARCH STRATEGIC GOAL:** *Research will establish the value of adopted PtD interventions, address existing design-related challenges, and suggest areas for future research.*
- **EDUCATION STRATEGIC GOAL:** *Designers, engineers, machinery and equipment manufacturers, health and safety (H&S) professionals, business leaders, and workers understand PtD methods and apply this knowledge and skills to the design and re-design of new and existing facilities, processes, equipment, tools, and organization of work.*

Source: http://www.cdc.gov/niosh/programs/PtDesign/goals.html

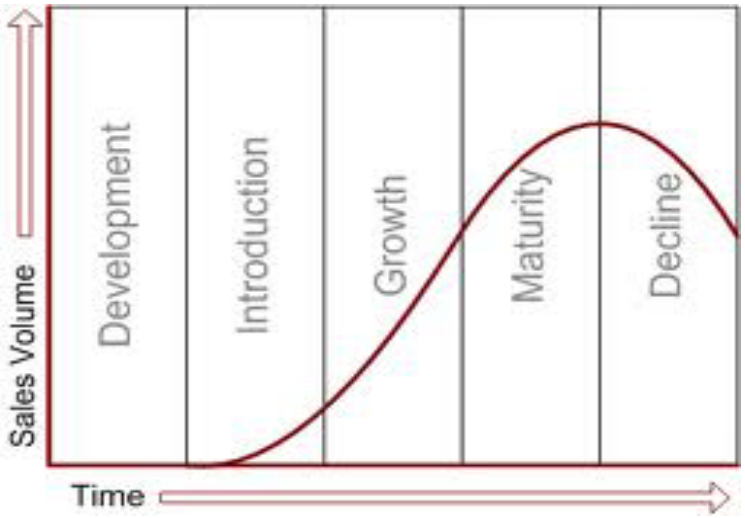
Why is PtD important for EHS programs?

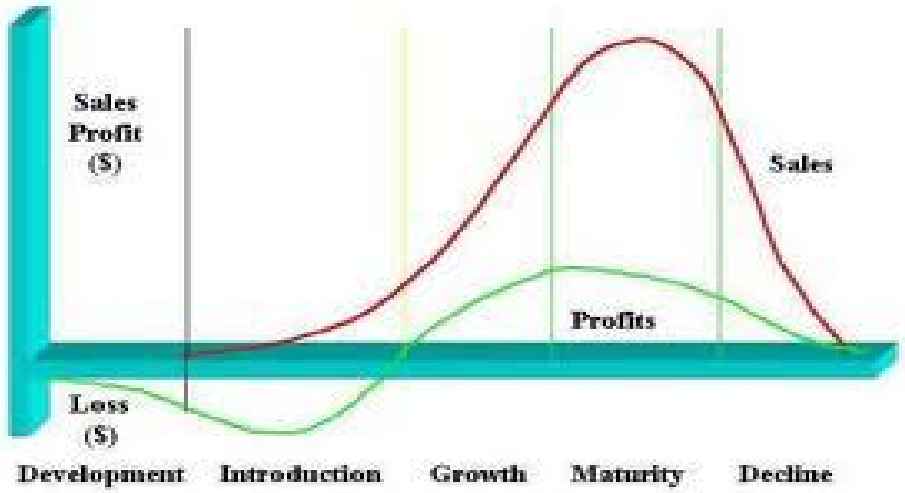
- In August 2007, the Engineering Practice Specialty group within the American Society of Safety Engineers published an article in a Special Issue of its Newsletter "By Design," the title of which was "Prevention through Design: Addressing Occupational Risks in the Design and Redesign Processes." The author of the paper was Fred A. Manuele, CSP, PE. That article was also published in the October 2008 issue of *Professional Safety.*
- PtD became an integral part of UCM's EHS courses in early 2009
- Environmental Compliance
- Ergonomics
- Statistical Analysis for Risk Management
- Food Safety
- ICAP



AIHA/ANSI Z10 Adopted in ICAP Course

- A provision in ANSI Z10 requires that processes be in place “to identify and take appropriate steps to prevent or otherwise control hazards and reduce risks associated with new processes or operations at the design stage.”
- AIHA/ANSI Z10 also says that “The design review should consider all aspects including design, construction, operation, maintenance, and decommissioning.”

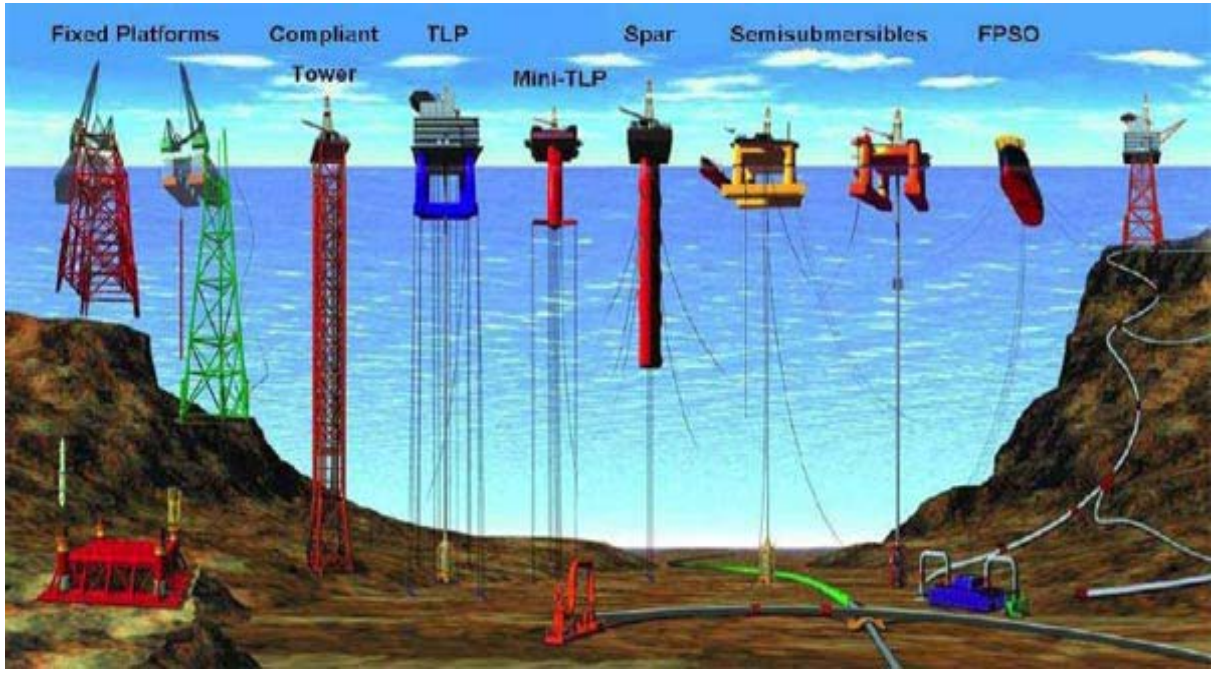


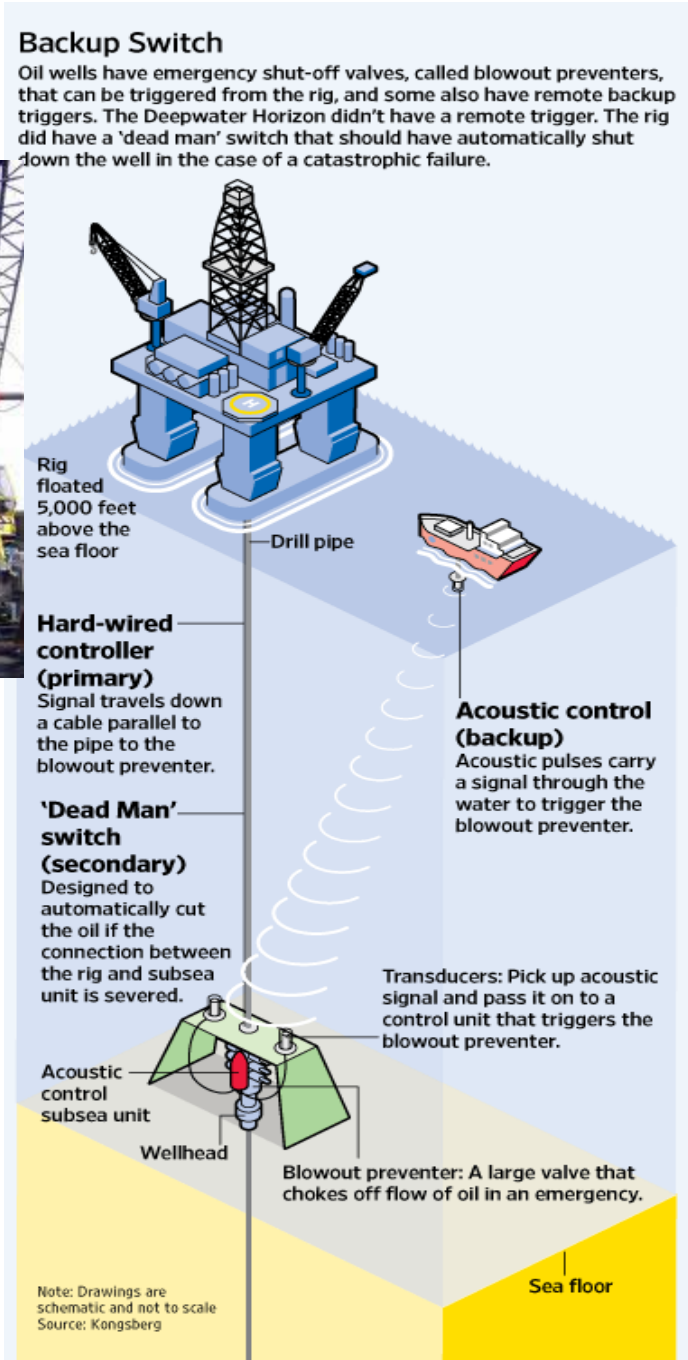


PtD EHS Educational Opportunities

Environmental
PtD Back up Safeguard Devices

- Acoustic control – Back up
- Regulations – Norway & Brazil





PtD - Health

AIHA EXPOSURE CATEGORIZATION SCHEME

Exposure Category	Rule-of-Thumb Description	Qualitative Description	Recommended Statistical Interpretation	Notes
0	Exposures are trivial to nonexistent – employees have little to no exposure, with little to no inhalation contact	Exposures, if they occur, infrequently exceed 1% of the OEL	$X0.95 \leq 0.01 \times OEL$	1
1	Exposures are highly controlled – employees have minimal exposure, with little to no inhalation contact	Exposures infrequently exceed 10% of the OEL	$0.01 \times OEL < X0.95 \leq 0.1 \times OEL$	2
2	Exposures are well controlled – employees have frequent contact at low concentrations and rare contact at high concentrations	Exposures infrequently exceed 50% of the OEL and rarely exceed the OEL	$0.1 \times OEL < X0.95 \leq 0.5 \times OEL$	2, 3, 4
3	Exposures are controlled – employees have frequent contact at low concentrations and infrequent contact at high concentrations	Exposures infrequently exceed the OEL	$0.5 \times OEL < X0.95 \leq OEL$	2, 4
4	Exposures are poorly controlled – employees often have contact at high or very high concentrations	Exposures frequently exceed the OEL.	$X0.95 > OEL$	4

Notes: 1—Category 0 was added to distinguish between highly-controlled exposures and situations where exposures are either nonexistent or trivially low. It was included in the 1991 AIHA rating Scheme. 2—"Infrequently" refers to an event that occurs no more than 5% of the time. 3—"Rarely" refers to an event that occurs no more than 1% of the time. 4—"High concentrations" are defined as concentrations that exceed the TWA OEL.

Source: "Rating Exposure Control Using Bayesian Decision Analysis," by Hewett et al.

PtD - Health

Substance Name	NOEL	Safety Factor		OEL=	
2,3,7,8-TCDF	0.1	10		0.07	um/m3
2,3,7,8-TCDD	1	10		0.7	um/m3
	2	4		3.5	
	3	7		3	
	4	6		4.666667	
	5	9		3.888889	
	6	10		4.2	

$$OEL = \frac{NOELx60\ kg}{10m^3(Safety\ Factor)} = ?$$

Some On-line Databases of Chemical Human Hazard Data Sources

Toxicology Data Network (TOXNET) (http://toxnet.nlm.nih.gov/)

TSCATS (http://www.syrres.com/esc/tscats.htm)

IPCS INCHEM (http://www.inchem.org/)

NTP (http://ntp-server.niehs.nih.gov/)

ATSDR (http://www.atsdr.cdc.gov/toxpro2.html)

EPA HPV Challenge Program (http://www.epa.gov/chemrtk/volchall.htm)

TWA and Exposure to Mixtures Tool

	Ci Concentration	Ti Time (hr)	%		
1	0	0	0.00%	-	
2	0	0	0.00%	-	
3	0.342	8	100.00%	0.342	
Total		8	100.00%	0.342	
				0.342	C1
			OEL	0.500	L1

	Ci Concentration	Ti Time (hr)	%		
1	0	0	0.00%	-	
2	0	0	0.00%	-	
3	0.019	8	100.00%	0.019	
Total		8	100.00%	0.019	
				0.019	C2
			PEL	1.000	L2

	Ci Concentration	Ti Time (hr)	%		
1	0	0	0.00%	-	
2	0	0	0.00%	-	
3	0.171	8	100.00%	0.171	
Total		8	100.00%	0.171	
				0.171	C3
			OEL	1.000	L3

Em	0.874
Result	AL exceeded

$$Em = \sum \frac{Ci}{Li} = \sum \frac{TWA_1}{PEL_1} + \frac{TWA_2}{PEL_2} + \ldots\ldots = ?$$

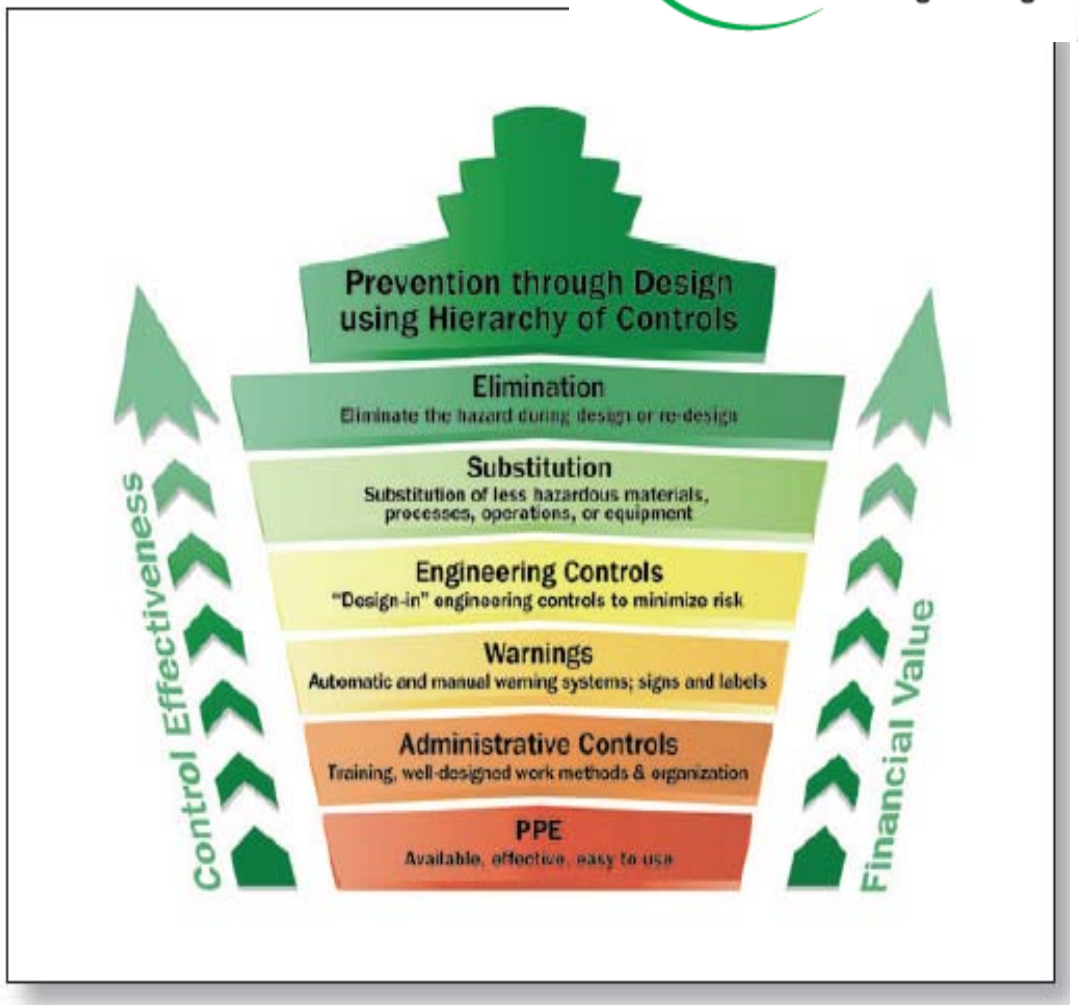
OEL/Al Exceeded? How to prevent exposure? “Traditional” vs. PtD hierarchy of controls.

CONTROLLING HAZARDS

"TRADITIONAL"

- **Engineering Controls**
- **Administrative Controls**
- **Personal Protective Equipment**

Textbooks???



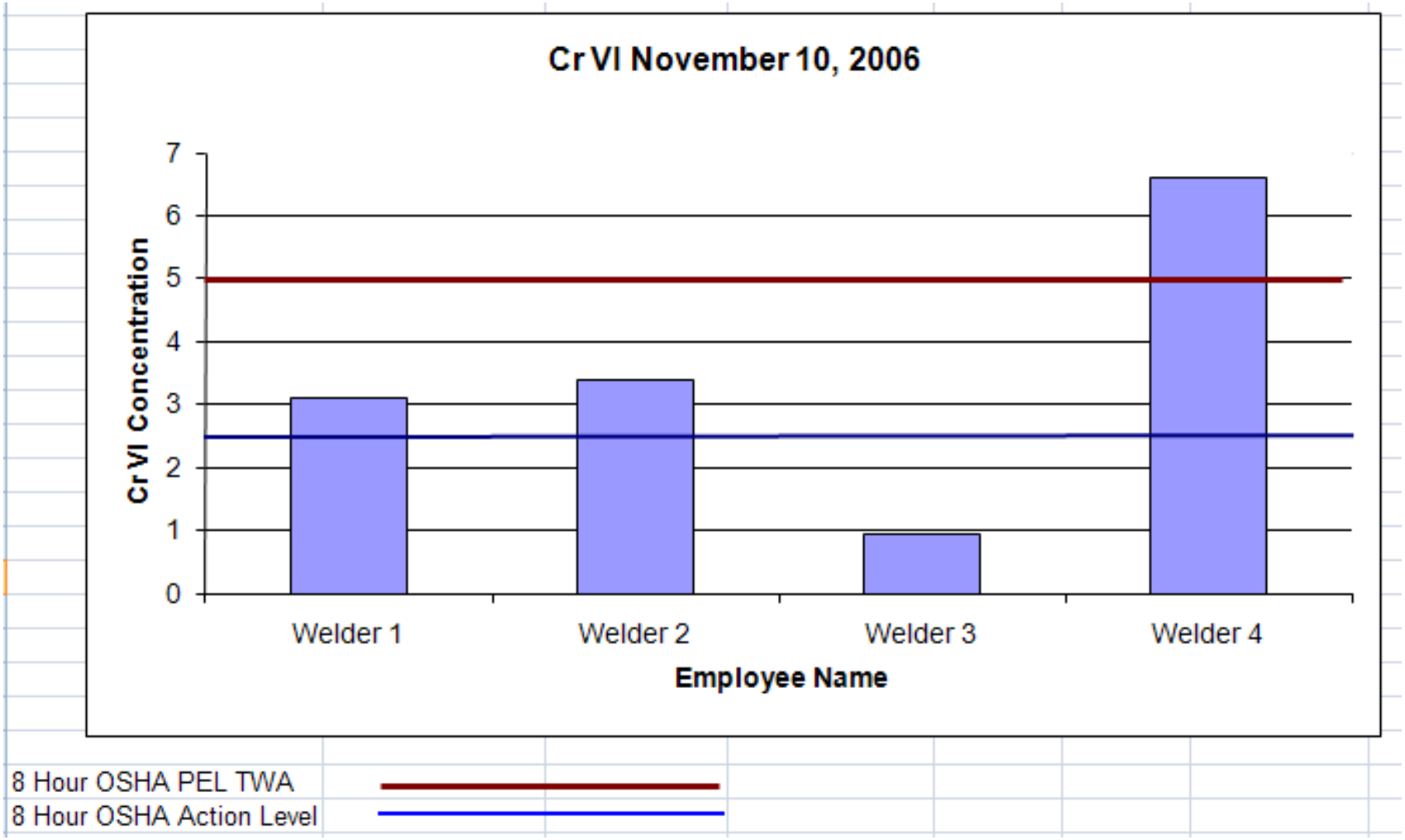
The Hierarchy of Controls Supports Prevention through Design

Welding Fumes – PtD Ventilation Controls

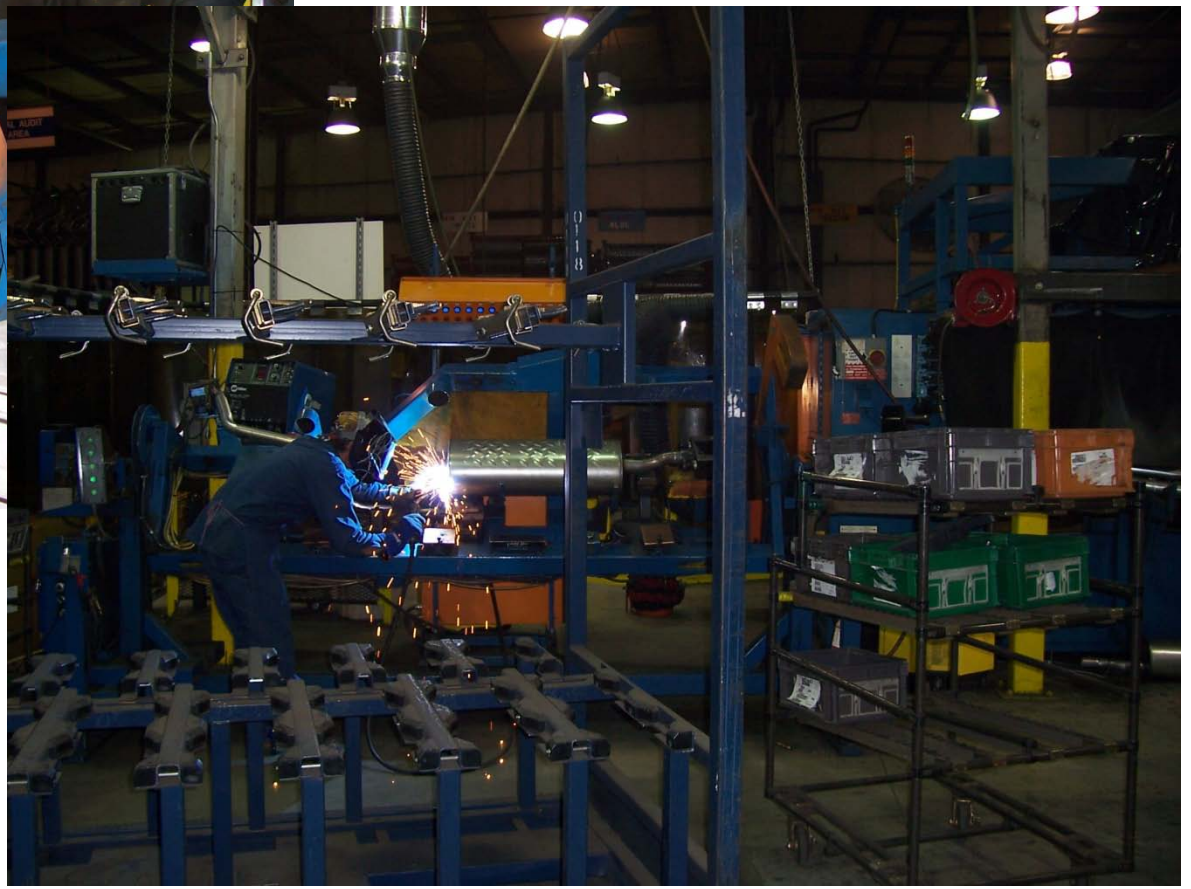
Example

Welding Fumes – PtD Ventilation Controls

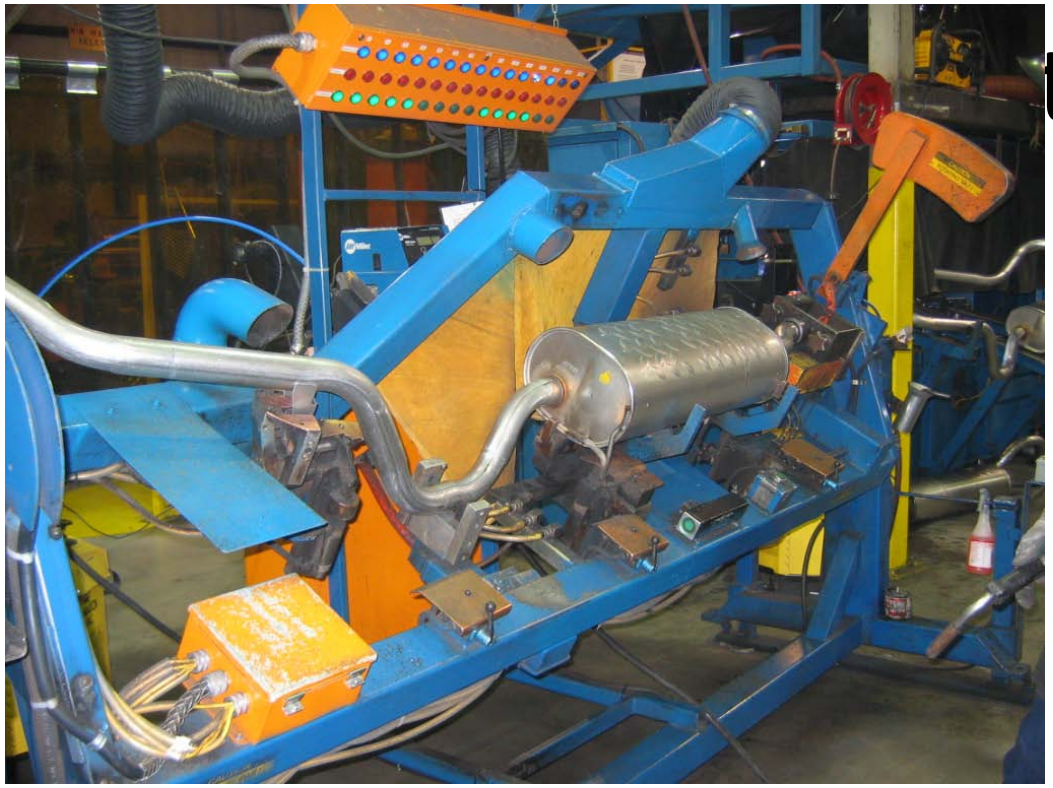
Cr VI Exposure before PtD Eng. Controls



Conditions before controls



Welding Fumes – PtD Ventilation Controls



t

Overall system, 12” reduced to “8, to 6”, into flex going into fixture top tube

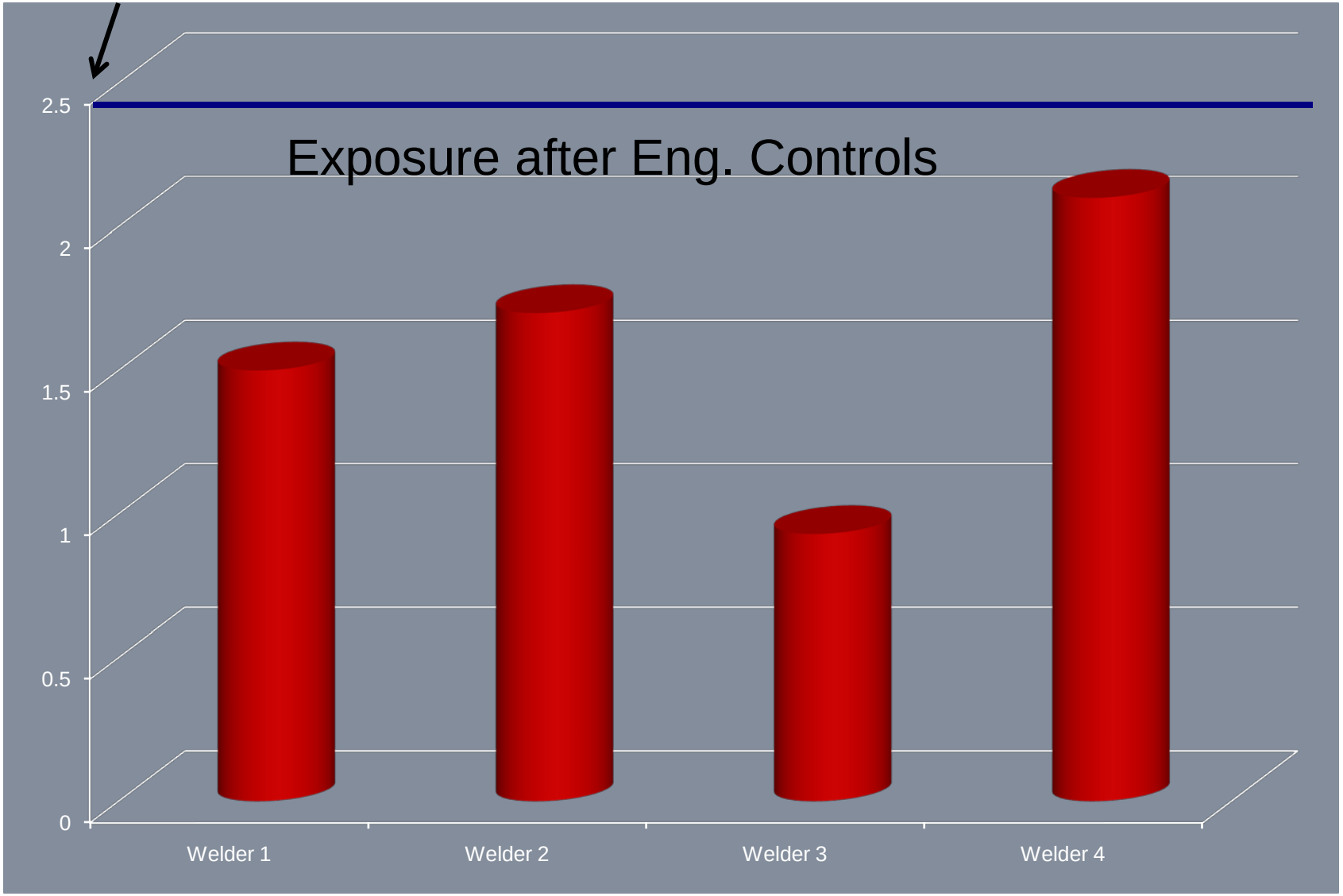
- Welding Fumes – Ventilation Controls

Tailpipe tube, 4 in dia., goes into 4x4 pipe on backside of fixture

- Welding Fumes – Engineering Controls

Outlet end welds collected by 4 in dia., goes into 4x4 pipe on front of fixture – also have a few perforated holes on underside of 4x4

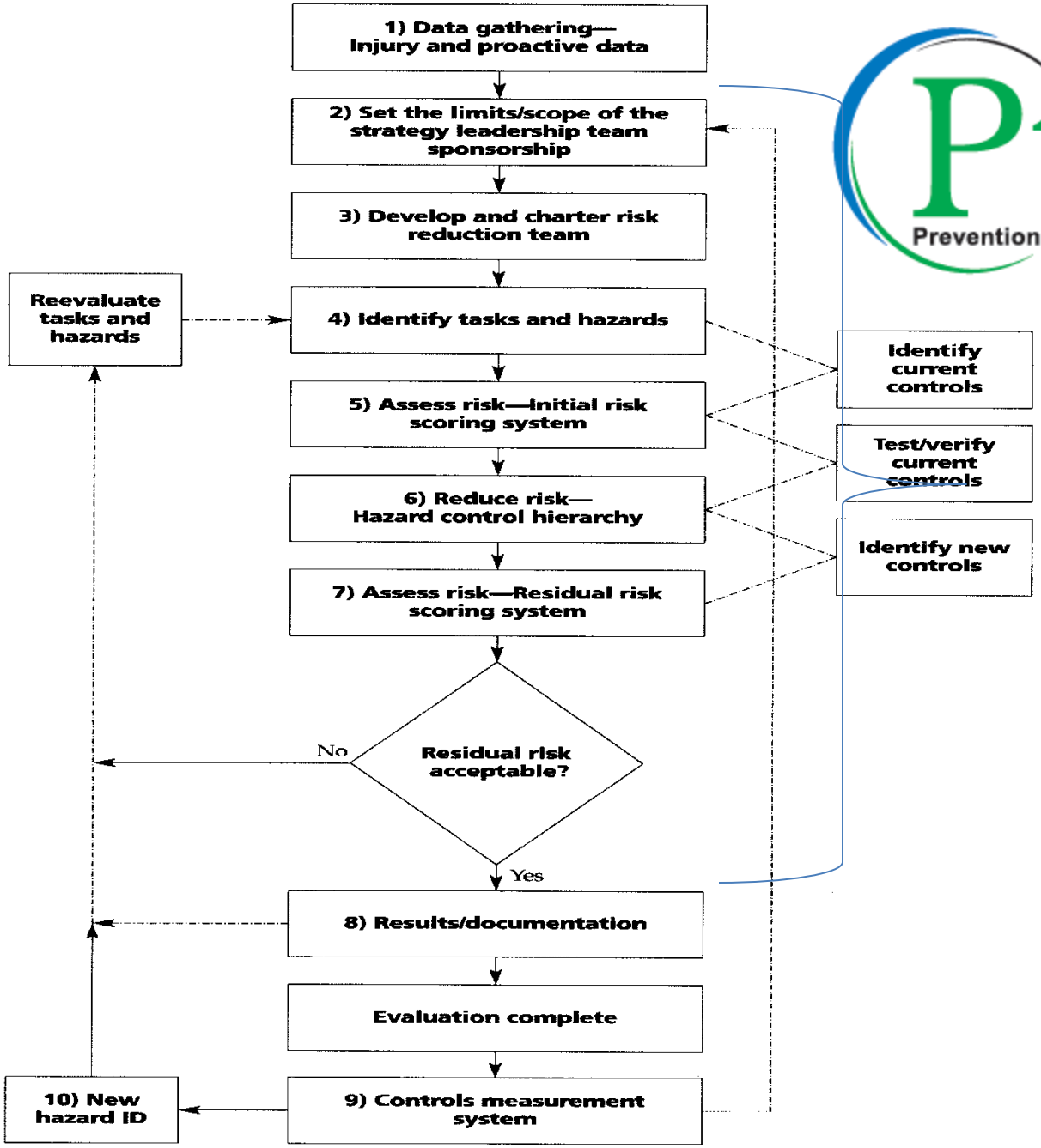
8 Hour OSHA Action Level



PtD – Safety

- **HAZARDS ANALYSES AND RISK ASSESSMENT TECHNIQUES**
- **Preliminary Hazard Analysis (PHA): Initial Hazard Analysis and Risk Assessment.**
- **What-If/Checklist Analysis.**
- **Hazard and Operability Analysis (HAZOP).**
- **Failure Mode and Effects Analysis (FMEA).**
- **Fault Tree Analysis (FTA).**
- **Management Oversight and Risk Tree (MORT).**

The Risk Assessment Process



PtD – Safety

- **Preliminary Hazard Analysis (PHA): Initial Hazard Analysis and Risk Assessment.**

PRELIMINARY HAZARD ANALISIS WITH TRACKING LOG

Date:

Project/Process	New API
Prepared by:	GP

Methods Used	Checklist Review

Hazardous Event	Casual Factors	System Effects	RAC	Comments	Recommended Actions	Controlled RAC	Standards	Action	Ref. Document
API Compound	API Release	CNS affected	15		Glove Bag	7	None	Compl.	Glove Bag SOP

PtD™ Prevention through Design

PtD – Safety

- **Failure Mode and Effects Analysis (FMEA).**

FMEA & RPN WORKSHEET

Part or Process Name		Suppliers & Plants Affected				Prepared By										
Design/ Mfg Responsibility		Model Date				FMEA Date										
Other Areas Involved		Engineering Change Level														
Process Operation, Function or Purpose	Potential Failure Mode	Potential Effect(s) of Failure	SEV	Potential Cause(s) of Failure	OCC	Current Controls Evaluation Method	DET	S x O	RPN	Recommended Action(s)	Area/Individual Responsible & Completion Date	Action Results Actions Taken	SEV 2	OCC 2	DET 2	RPN 2
API Compound	Exposure	CNS affected	5	Respirator failure	2	Fit Test	3	10	30	Glove bag	Management	Reduced Exposure	5	1	1	5
								0	0							0
								0	0							0
								0	0							0
								0	0							0
								0	0							0
								0	0							0
								0	0							0
								0	0							0
								0	0							0
								0	0							0
								0	0							0
								0	0							0

FMEA Process
FMEA Overview
RPN Definition

RPN also defined in: The Six Sigma Handbook, Revised and Expanded By Thomas Pyzdek

PtD™
Prevention through Design

PtD and Industrial Management

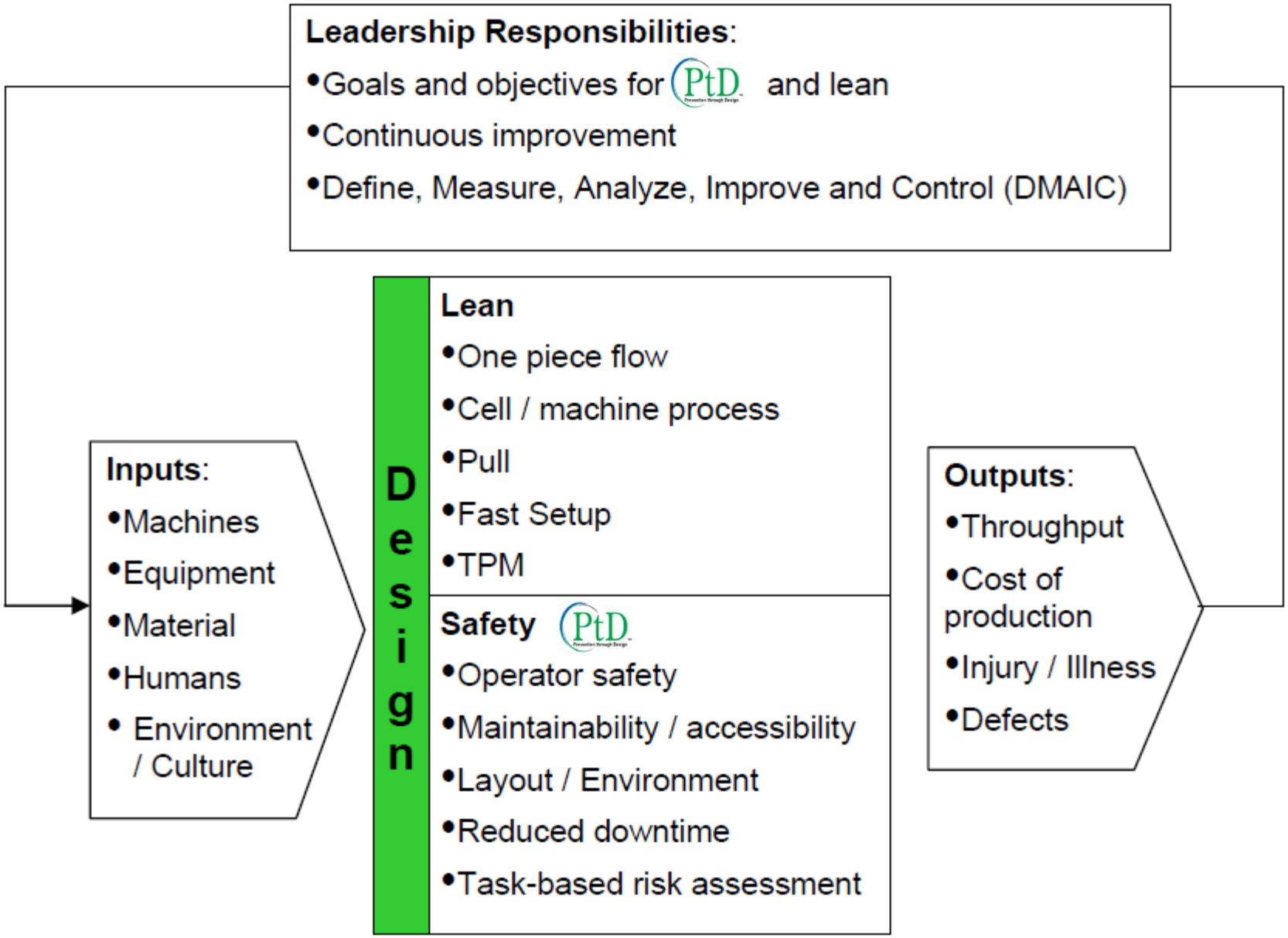
- **Examples of lean and PtD conflict**

  Pneumatic press with adjustable guards pinned out of the way in conflict with safety standards

LEAN Vs. PtD™ Prevention through Design

Source: **ANSI Technical Report B11.TR7 – 2007 "Designing for Safety and Lean Manufacturing"**

Need to “educate” Industrial managers



Need to “educate” Business Managers

Too often:

- Management has a reactive rather than proactive focus
- Lack of understanding (vocabulary – PtD Prevention through Design SAFETY)
- Risks & hazards are poorly communicated
- Safety is considered a cost … not an investment
- Cost/benefit analysis is rarely applied to justify the EHS investments
- Business analysis tools are not commonly used to justify safety investments
- Retrofitting is never as cost-effective as designing it right initially. NIOSH PtD
- EHS professionals should be involved in the early design stages and life cycle assessments.


SAFETY
FIRST
FAA
BENNETT
THE CHRISTIAN SCIENCE MONITOR