PROCESS HAZARDS ANALYSIS (PHA), LAYERS OF PROTECTION ANALYSIS (LOPA), AND THE HUMAN FACTOR

by Paul Baybutt, Primatech Inc.

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paulb@primatech.com

www.primatech.com

OVERVIEW

- Meaning of human factors for PHA and LOPA
- Significance of human factors for PHA and LOPA
- Human factor issues in paper
- Issues covered in presentation

MEANING OF HUMAN FACTORS IN PHA AND LOPA

- PHA and LOPA studies address human failures in operating and maintaining processes
  - And the human factors that influence them
- People perform PHA and LOPA studies
  - Such studies themselves are subject to various possible human failures
- Much less attention has been paid to the human factors that influence the performance of PHA and LOPA than those that influence process hazards

SIGNIFICANCE OF HUMAN FACTORS IN PHA AND LOPA

- PHA and LOPA studies are difficult and time-consuming activities
  - Place significant demands on participants
  - Increases chances that errors will be made
  - Human factors must be managed

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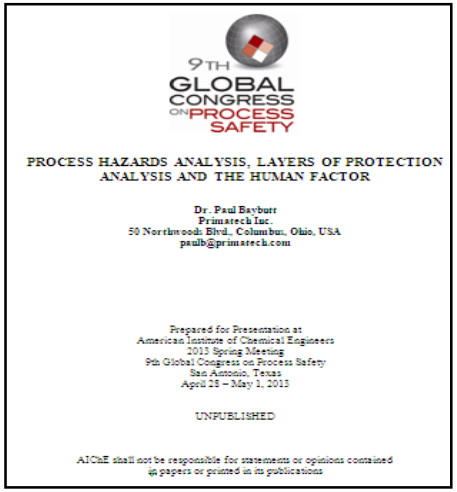
HUMAN FACTOR ISSUES IN PAPER

- Paper identifies and discusses many human factor issues that can influence the quality of PHA and LOPA studies
  - Cover preparing, conducting, recording, documenting, and following-up on studies
  - Based on many years experience
- Issues are not difficult to understand
  - However, often ignored in the performance of studies

HUMAN FACTOR ISSUES IN PAPER (CONTD.)

- Guidelines are provided in the paper to help minimize the extent to which these human factor issues may impair study quality
- Presentation covers some representative issues from the paper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PROCESS HAZARDS ANALYSIS, LAYERS OF PROTECTION ANALYSIS AND THE HUMAN FACTOR

Dr. Paul Bayburt
Primatech Inc.
50 Northwoods Blvd., Columbus, Ohio, USA
paulb@primatech.com

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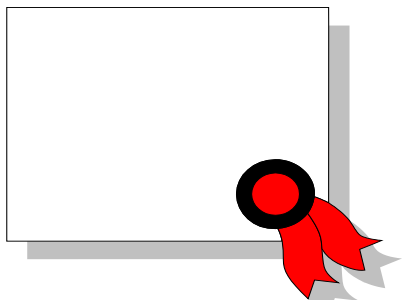
ISSUES COVERED IN PRESENTATION

- Team leader
- Team members
- Design intention
- Risk estimation
- Use of checklists
- Failure data

TEAM LEADER QUALIFICATIONS

- Competence for team leaders means not only technical skills
  - Also people skills in managing the team members
- Team leaders should be screened against qualification criteria
  - With emphasis on their aptitude for facilitation and communication



TRAINEE LEADERS

- Good candidates
- Viable candidates
- Poor candidates

IMPARTIALITY OF TEAM LEADER

- Neither the process engineer nor the design engineer should be assigned as the leader
  - Other team members may be unwilling to criticize the process
  - Process or design engineers likely will have mindsets about their process
  - May result in missed scenarios in PHA or omissions in LOPA
- Leaders should not have day-to-day responsibilities for the process

TEAM COMPOSITION

- Study teams should not consist entirely of people who know the process
  - Groupthink can be a problem
    - Phenomenon in which a group of people think and make decisions in the same way thus discouraging creativity
  - Beneficial to have an independent senior engineer as a team member

HIDDEN AGENDAS

- Team leaders should be watchful for team members trying to influence the study contents, e.g.
  - By proposing severity and/or likelihood values to avoid the need for action items in PHA
  - Promoting additional enablers in LOPA to meet risk criteria

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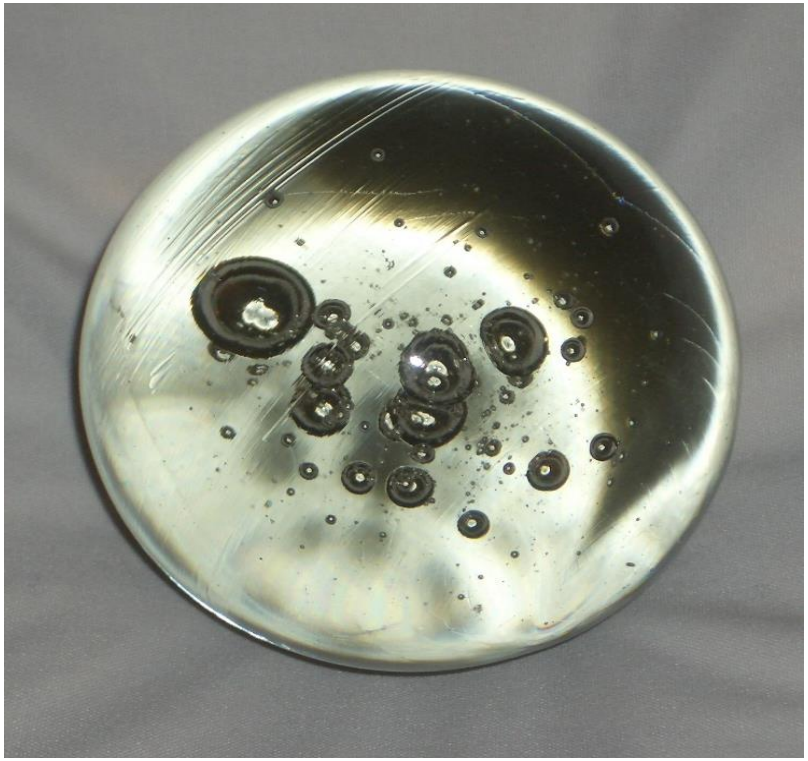
DESIGN INTENTION IN PHA

- Fundamentally, PHA studies look for ways a process may deviate from the design intention
- Critical study steps are deciding:
  - Aspects of design intention to consider
  - Which deviations may result in hazard scenarios of interest

DESIGN INTENTION - CRYSTAL BALL

- Task is akin to looking into a crystal ball to predict the future



DESIGN INTENTION IN PHA (CONTD.)

- Commonly, PHA teams choose parameters that represent aspects of design intention for each process section
  - From checklists
- Eventually, the team reaches a point where they decide to move on:
  - Done enough work
  - Spent enough time
  - Falling behind schedule
- Leads to missed scenarios

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DESIGN INTENTION IN PHA (CONTD.)

- Define relevant aspects of design intention as each process section is considered
  - Before choosing parameters

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PHA RISK ESTIMATION

- Studies focus on scenarios with low likelihoods and high severities
  - I.e. rare and catastrophic events
- Estimating the likelihood of rare events is challenging

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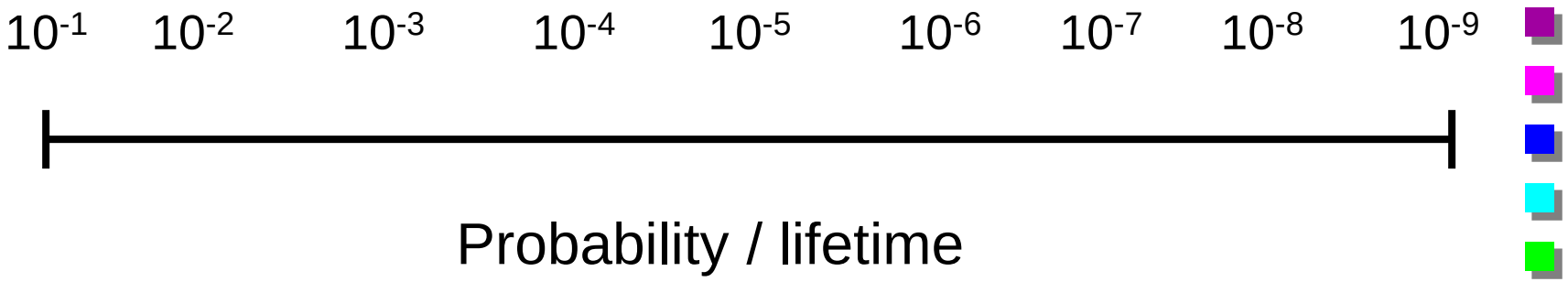
PHA RISK ESTIMATION (CONTD.)

- Human perception influences estimates of likelihood
  - A person's experience is reflected in their estimates
    - Underestimate the probability of an event they have not experienced
    - Overestimate the probability of an event they have experienced

EXERCISE – CREDIBLE ACCIDENTS

- Mark your estimate on the scale below of the probability / lifetime of your being killed by:
  - Flooding
  - Aircraft accident
  - Asteroid impact



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EXERCISE – CREDIBLE ACCIDENTS

- Flooding – 1 in 30,000
- Aircraft accident – 1 in 20,000
- Asteroid impact – 1 in 25,000

MANAGING SUBJECTIVITY

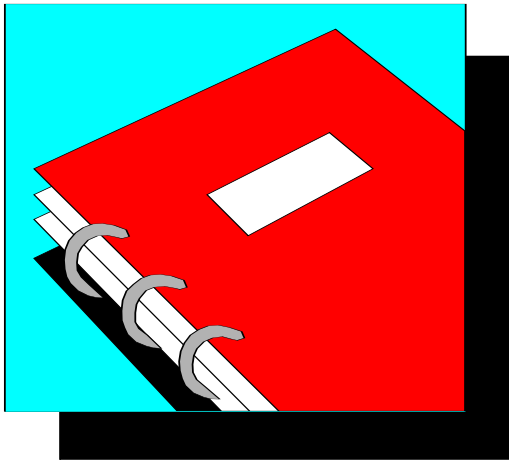
- Reduce subjectivity in likelihood estimates by requiring the team to start with the most frequent likelihood
  - Justify successive reductions to lower levels
- Use LOPA to calculate the frequencies of scenarios that have high consequence severities
  - Regardless of their PHA estimated likelihoods

USE OF CHECKLISTS

- Checklists of issues are used to augment PHA studies
- PHA is intended to be a brainstorming exercise
- Detailed checklists of technical issues can become a substitute for creative thinking and analysis
  - Essential characteristics of a good study
- Checklists can consume large amounts of time and become repetitive
- Should be used judiciously

CCPS GUIDELINES FOR HAZARD EVALUATION PROCEDURES

- Contains 46 pages with over 349 questions, some with more than 10 sub-questions
  - Appendix B, Supplemental Questions for Hazard Evaluations



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CCPS GUIDELINES FOR HAZARD EVALUATION PROCEDURES (CONTD.)

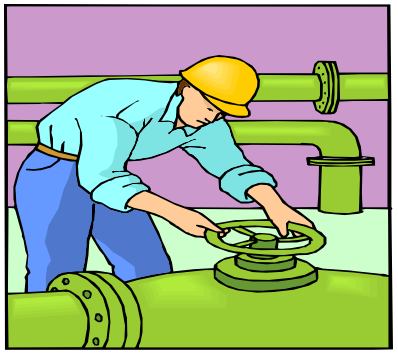
- If this checklist were used for a HAZOP study with these assumptions:
  - Process has 50 nodes
  - Three modes of operation are considered
  - Only 100 questions are applicable to each node
  - Each question takes 15 minutes to discuss and document
- … the checklist would require over one year of 8-hour days to administer!

FAILURE DATA USED IN LOPA

- LOPA studies use data on:
  - Initiating event failure rates
  - Enabler multipliers
  - IPL probabilities of failure on demand (PFDs)
- Data should reflect experience with the actual operating environment and regime for the process
  - Unfortunately, few companies currently have collected plant-specific data
  - Generic industry data are often used
    - Supplemented by engineering judgment

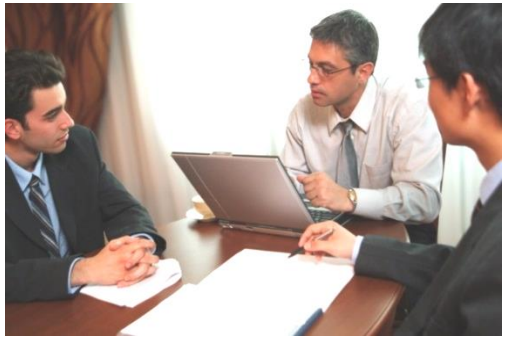
FAILURE DATA – ENGINEERING JUDGMENT

- Teams tend to use optimistic failure data
  - Trying to meet a risk tolerance criterion
- In particular, human error rates may be underestimated
  - Optimistically, assumed people will perform at their highest level



FAILURE DATA FOR LOPA

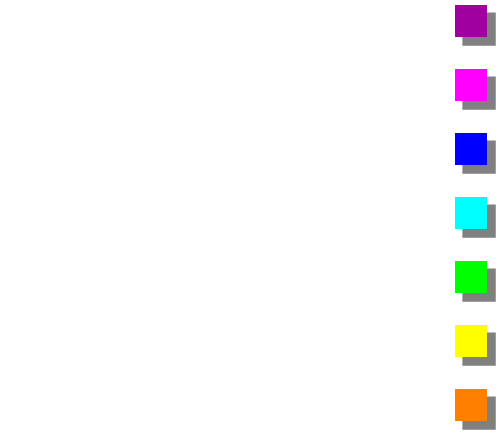
- Establish a standardized set of failure data
- Reduces one of the largest sources of subjective judgment
  - Takes decisions on data values largely out of the hands of team members
  - CCPS Guidelines for Initiating Events and Independent Protection Layers



REMEMBER

Errare humanum est

- Seneca the Younger



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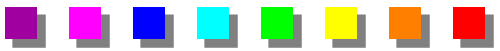

CONCLUSIONS

- PHA and LOPA studies are not just technical analyses
- Study quality can be undermined by many human factor issues
- Manage the issues, proactively where possible
  - During all study stages and steps
  - Recognize and understand the issues
  - Continuous effort is required
- Goal should be to accomplish the best result possible
  - Under the circumstances faced for each study