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Implications of ANSI/ASSE Z590.3: A Prevention through Design Standard

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Introduction

Worldwide recognition is now extensive with respect to the benefits of including requirements for hazard identification and analysis and risk assessments as specific elements within safety management systems. Having knowledge of what has occurred and its significance will help in appreciating the implications and value of an applied Prevention through Design standard. So, a bit of history and discussion of current events follows. The trending is significant as it relates to the knowledge and skills safety professionals will be expected to have. The Z590.3 standard will be a sound reference base for developing and applying the required knowledge and skills.

The Institute for Safety through Design

In the early 1990's, several safety professionals recognized that incident investigation reports for occupational injuries and illnesses infrequently identified design causal factors. For example, a study this author made at that time indicated that although there were implications of workplace and work methods design inadequacies in over 35 percent of the incident investigation reports analyzed, the corrective actions proposed – often additional training – rarely pertained to the design factors.

It was also noted that articles on designing for safety seldom appeared in the popular safety literature, and that it was the exception when safety and health management systems included safety through design elements. With the support of several colleagues, a proposal was made to the National Safety Council to emphasize having safety needs incorporated into the design process.

In 1995, the Council established The Institute for Safety through Design. Its Advisory Committee concluded that significant benefits will be derived if decisions affecting safety and health and the environment are integrated into the early stages of the design and redesign processes. The benefits noted were:

- Improved productivity
- Decreased operating costs
- Significant risk reduction
- Avoiding expensive retrofitting

The Institute's Mission was:

> To reduce the risk of injury, illness and environmental damage by integrating decisions affecting safety, health, and the environment in all stages of the design process.

Safety through Design was defined as:

> The integration of hazard analysis and risk assessment methods early in the design and engineering stages and taking the actions necessary so that risks of injury or damage are at an acceptable level.

Much was accomplished by the Institute. Seminars and symposia were held. Proceedings were issued. Presentations were made at many safety conferences. And a book titled *Safety Through Design* was published by the National Safety Council. It is used in some college courses. In accord with its sunset provision, the Institute was disbanded in 2005.

The National Institute for Occupational Safety and Health

In June 2006, a follow-on activity was initiated at the National Institute for Occupational Safety and Health (NIOSH) to create a sustainable national strategy for Prevention through Design (PtD). The timing for the initiation of this work was excellent. The concept of PtD, as in an Internet bulletin, is defined as:

> Addressing occupational safety and health needs in the design process to prevent or minimize the work-related hazards and risks associated with the construction, manufacture, use, maintenance, and disposal of facilities, materials, and equipment.

At an ASSE Professional Development Conference in 2006, Dr. John Howard, who heads NIOSH, said that:

> One important area of emphasis will be to examine ways to create a demand for graduates of business, architecture and engineering schools to have basic knowledge in occupational health and safety principles and concepts.

That statement defines a major goal: To achieve a culture change whereby managements insist that engineers and safety science graduates have knowledge of Prevention through Design concepts. What NIOSH has undertaken to establish a "sustainable national strategy" for Prevention through Design is a major undertaking. Its potential for reducing occupational injuries and illnesses is immense. This NIOSH initiative is based on its stated premise:

> One of the best ways to prevent and control occupational injuries, illnesses, and fatalities is to design out and minimize hazards and risks early in the design process.

In July 2007, NIOSH held a workshop to obtain the views of a variety of stakeholders on its Prevention through Design undertaking. Some participants in that workshop expressed the view that the long term impact of the NIOSH initiative could be "transformative," meaning that a

fundamental paradigm shift could occur resulting in greater emphasis being given to the higher and more effective decision levels in the hierarchy of controls (avoidance, elimination, substitution, and engineering controls.)

Enthusiasm for additional knowledge of Prevention through Design principles and practices was significant. Several attendees at the workshop said that a guideline, regulation or standard is needed that sets forth the principles and the methodologies to address hazards and risks in the design and redesign processes.

On September 23, 2008, NIOSH held a "Kick-off meeting" with respect to its initiative on Prevention through Design. One of the action items discussed was to:

> Develop and approve a broad generic voluntary consensus standard on Prevention through Design that is aligned with international design activities and practice."

This author volunteered to lead the development of such a standard and arranged to have the work done under the auspices of ASSE, an ANSI-accredited standards entity.

Activity at ASSE

The ASSE Engineering Practice Specialty group had published an article in the August 2007 issue of its Newsletter "By Design," the title of which was "Prevention through Design: Addressing Occupational Risks in the Design and Redesign Processes." Fred A. Manuele was the author. This article was also published in the October 2008 issue of *Professional Safety*.

On November 18, 2008, the ASSE Standards Development Committee discussed extending the paper on Prevention through Design published by ASSE into a technical report and a standard. A decision was made by the committee to develop a technical report, first, to be followed by an ANSI standard. A draft Technical Report was developed and distributed for comments. Over 50 contributors made suggestions for improvement. Many responders said they needed the guide that the Technical Report provided.

ASSE Technical Report Z790.001 – Prevention through Design: Guidelines for Addressing Occupational Risks in the Design and Redesign Processes was published in November 2009. Comments will be made later in this paper on the actions taken to convert the Technical Report into an American National Standard.

Worldwide Promotion of Risk Assessments

While the activity by the National Safety Council, NIOSH and ASSE described here was in progress, entities throughout the world were also promoting the inclusion of requirements for hazard identification and analysis and risk assessments in guidelines and standards. And the results are truly impressive. Throughout the world governmental agencies and safety-related organizations are promoting the inclusion of risk assessment provisions in safety-related laws, standard, and in relative guidelines. There is a significant message here for which safety professionals should be attentive. As is evident by worldwide developments, a consensus is evolving that recognizes the need to have elements in safety management systems setting forth the requirements with respect to

hazards identification and analysis and risk assessments. Z590.3 serves well as a resource base from which that can be accomplished.

A list follows of standards, guidelines and initiatives dating from 1996 that include requirements for, or promote making, risk assessments. It is intentionally lengthy to convey the significance of the transitions taking place.

1. ANSI/RIA R15.06-1999. American Standard for Industrial Robots and Robot Systems—Safety Requirements.

2. ANSI B11.TR3-2000. Risk Assessment and Reduction – A Guide to Estimate, Evaluate and Reduce risks Associated with Machine Tools.

3. MIL-STD-882D. Standard for System Safety – Fourth Edition – 2000. Being revised: First issued in 1969.

4. ISO 12100-1: Safety of Machinery – Basic concepts, general principles for design, Part 1. Basic terminology, methodology, 2003.

5. ISO 12100-2: Safety of Machinery – Basic concepts, general principles for design. Technical principles. 2003.

6. AS/NZS 4360:2004. Risk Management. Standards Association of Australia

7. BS 8800:2004. British Standard: Occupational Health and Safety Management

8. ANSI/AIHA Z10-2005: Occupational Health and Safety Management Systems standard.

9. Guidance on The Principles Of Safe Design For Work. Australian Government: Safety and Compensation Council, 2006.

10. In 2006, NIOSH announced a major national initiative on Prevention through Design.

11. ANSI/PMMI B155.1-2006: Safety Requirements for Packaging Machinery and Packaging-Related Converting Machinery.

12. SFPE Engineering Guide to Application of Risk Assessment in Fire Protection Design, 2006.

13. SFPE – Introduction to Fire Risk Assessment [Believe release date was 2006.

    Enter the title in a search engine and course modules (19) on fire risk assessment will come up.

14. CSA Z1000-2006, the Occupational Health and Safety Management Standard issued by the Canadian Standards Association.

15. The Industrial Safety and Health Act of Japan was revised in 2006 to stipulate – without penalty – that employers should make efforts to implement risk assessment procedures.

16. ISO 14121-1: Safety of Machinery – Principles for risk assessment. 2007.

17. In 2007, the OSHA Alliance Construction Roundtable developed a video training program titled “Design for Construction Safety.”

18. NFPA: 2007. Guidance Document for Incorporating Risk Concepts into NFPA Codes and Standards.

19. BS OHSAS 18001, Occupational health and safety management systems – requirements: A British Standards Institution publication, 2007 revision.

> One of the purposes in revising 18001 in 2007 was to have some of its provisions to be more in line with Z10. A committee was formed at AIHA to provide the requested assistance. Requirements for risk assessments are more explicit. Significantly, the term “tolerable risk” was replaced by “acceptable risk.”

20. ANSI B11.TR7 2007: ANSI Technical Report for Machines – A Guide on Integrating Safety and Lean Manufacturing principles in the use of Machinery.

21. China’s State Administration of Work Safety published provisional regulations on risk assessment in 2008.

22. In August 2008, The European Union launched a two-year health and safety campaign focusing on risk assessment.

> Risk assessment is the cornerstone of the European approach to preventing occupational accidents and ill health. If the risk assessment process – the start of the health and safety management approach – is not done well or not at all, the appropriate preventive measures are unlikely to be identified or put in place.

23. The Health and Safety Executive in the U.K. issued “Five steps to risk Assessment” in 2008. www.hse.gov.uk/risk/fivesteps.htm

> All employers in the U.K. are required by legislation to conduct risk assessments. An HSE bulletin says “The law does not expect you to eliminate all risk, but you are required to protect people as far as is ‘reasonably practicable’”.

24. ICEL 1008: Emergency Lighting – Risk Assessment. September 2008. By the Industry Committee for Emergency Lighting, Ltd. London, U.K.

25. “Machine Safety: Prevention of mechanical hazards.” Issued by The Institute for research for safety and security at work and The Commission for safety and security at work in Quebec, 2009.

26. ASSE Technical Report Z790.001: Prevention through Design: Guidelines for Addressing Occupational Risks in the Design and Redesign Processes, 2009.

27. Singapore Standard SS 506. Occupational safety and health (OSH) management systems, Part 1: Requirements, 2009.

28. ANSI-ITAA GEIA-STD-0010 – 2009: Standard Best Practices for System Safety Program Development and Execution.

> The G-48 System Safety Committee of the Information Technology Association of America, or ITAA (formerly GEIA), developed this document.

29. ISO/IEC 31010—Risk Management – Risk Assessment Techniques: Was issued in 2009.

30. EN ISO 12100-2010: Safety of Machinery. General principles for design. Risk assessment and risk reduction.

> This standard combines three previously issued ISO standards (items 7, 8 and 19 in this listing) and replaces them. Risk assessments are explicitly required.

31. In a July 19, 2010 letter to the OSHA staff, Assistant Secretary David Michaels wrote on several subjects. One of his statements was:

> Ensuring that American workplaces are safe will require a paradigm shift, with employers going beyond simply attempting to meet OSHA standards, to implementing risk-based workplace injury and illness prevention programs.

32. ANSI B11.0: Safety of Machinery - General Safety Requirements and Risk Assessments, December 2010

33. The U. S. Nuclear Regulatory Commission, in 2010, modified its fire protection regulations to allow licensees to adopt NFPA Standard 805, “Performance-Based Standard for Fire Protection for Light-Water Reactor Electric Generating Plants” on a voluntary basis in lieu of their existing fire protection licensing provisions.

34. In the December 8, 2010 Federal Register, the Federal Railroad Administration issued an advance notice of proposed rulemaking for certain railroads to have a Risk Reduction Program.

> It is proposed that each Risk Reduction Program be supported by a risk analysis and a Risk Reduction Program Plan.

35. On December 17, 2010, Darryl Hill as President of ASSE wrote to Assistant Secretary David Michaels to express the Society’s views on OSHA’s proposed Injury and Illness Prevention Program (I2P2). Of the 10 enumerated points in Hill’s letter, the first is:

An I2P2 standard must encourage a movement in this nation towards risk-based management of workplace hazards.

36. ANSI-ASSE Z590.3 – 20xx. Prevention through Design: Guidelines for Addressing Occupational Hazards and Risks in Design and Redesign Processes

Additional comments on this standard are made later in this paper.

ANSI/RIA R15.06-1999, which pertains to robots and robot systems, was the first American national standard – an ANSI standard – that contained requirements for risk assessments.

Of the thirty-six items in the forgoing list, twenty-nine are dated from the year 2005. A few relate to the reissuance of previously issued standards or guidelines. Nevertheless, activity throughout the world since 1995 to require or promote identifying and analyzing hazards and making risk assessments has been significantly greater than in previous years. This trend, a minor explosion, is significant. Since the core of Z590.3 is hazard identification and analysis and making risk assessments to achieve acceptable risk levels, it will be a good resource for managements, design engineers, and safety professionals who initiate the application of or improve Prevention through Design concepts.

Transitions in the Practice of Safety

It is evident from the foregoing that a transition is taking place in the practice of safety which requires focusing additionally on hazard identification and analysis and risk assessments. As the transition progresses, more safety professionals will be expected to have the related skills. Further evidence of that transition exists in the titles of presentations that are to be made in ASSE's 2011 Professional Development Conference. The number of presentations relating to risk exceeds what has been typical, and that number is noteworthy and informative. Some safety professionals, it seems, have become considerably involved in studying and applying risk control concepts. The titles of relative presentations follow:

- Concept of Dynamic Risk Assessment
- A Risk Management Model
- Risk Based Safety Leadership
- Risk Based Management of Non-Regulated Fleets
- Prioritizing Risks: A Cost Benefit Approach
- Aligning Risk Assessment and Risk Mitigation
- Safety Engineering and the Design Review Process
- Risk Control Relationships
- Implications of ANSI-ASSE Z590.3: A Prevention through Design Standard

It is obvious that the trend is for more organizations to include consideration of hazards and risks in their decision making processes, and that safety professionals are involved.

Further evidence of the transition taking place in the practice of safety was noted at the symposium held by ASSE in November 2010, the title of which was "Rethink Safety: A New View of Human Error and Workplace Safety." This author was pleasantly surprised to hear speakers who are human error specialists say that the first action to take when human errors are noted is to identify and analyze the hazards and assess the risks in the work system and in the work methods adopted. A presentation by one speaker included the following quote from James Reason's book *Managing the Risks of Organizational Accidents* and it set the tone for several of the following presentations:

> Workplaces and organizations are easier to manage than the minds of individual workers. You cannot change the human condition, but you can change the conditions under which people work.

Eliminating design errors to avoid human errors was a large part of one presentation. The speaker discussed poor design of equipment, processes, procedures, etc., that may lead to someone making an error. He went on to discuss: Exclusion design, which makes it impossible to commit a human error; Prevention design, which makes it difficult, but not impossible, to make an error; and Fail-safe design, which does not reduce the likelihood of error but does reduce the consequences.

Another presenter said that application of the hierarchy of controls is the preferred method in limiting human error: risk avoidance, elimination, substitution, and engineering controls.

Also, consider the implications of the following quotations:

> Managers may wish to address human error by "getting into the heads" of their employees. Training is often the default corrective action, and that is not effective if error potential is designed into the work.
>
> When errors occur, they expose weaknesses in the defenses designed into systems, processes, procedures, and the culture.
>
> It is management's responsibility to anticipate errors and to have systems and work methods designed so as to reduce error potential and to minimize severity of injury potential when errors occur.

This recognition of the need to design systems, processes and procedures to reduce the potential for human error is noteworthy and may be another indication of the transition taking place in the practice of safety. And Z590.3 – a Prevention through Design standard – will be a valuable resource for those who recognize human error potential in the design process and make design decisions to avoid that potential.

Status of ANSI/ASSE Z590.3 – Prevention through Design: Guidelines for Addressing Occupational Hazards and Risks in Design and Redesign Processes

It was recognized that additional work would be necessary to convert the 2009 Technical Report on Prevention through Design issued by ASSE into an ANSI standard. Several drafts were developed and sequentially improved. An Executive Review Committee agreed in August 2010 that the then current draft of Z590.3 was ready for submission to a Canvass group for review and balloting, in accord with ANSI procedures. Response was highly favorable. Of the 53 responders, only three 'No" votes were received. Comments received for improvement were extensive: 347 suggested revisions were proposed. Responses to those suggestions were developed, and resolved by a Canvass Resolution Committee. That work was completed in December 2010.

Two drafts of Z590.3 were sent to the Canvass group for review and comment on February 11, 2011. One draft showed the changes made: The other was a clean copy. Revisions proposed by reviewers in this second Canvass exercise will also be resolved by the Canvass Resolution Committee and final approval will be sought from the Executive Review Committee. The ASSE goal is to submit the standard to ANSI for administrative approval in the spring of 2011 and to have the approved standard published in the summer of 2011.

The Table of Contents as of January 31, 2011 for Draft Number 10 follows.

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Content of the standard prior to page 9 includes the title page, the foreword, a listing of participants, and the table of contents.

Highlights of Z590.3

As was the case with the Safety through Design concept, ***hazard identification and analyses and assessing risks are the core of Prevention through Design.*** These definitions, as they appear in Z590.3, will help in understanding its focus.

> A hazard is defined as the potential for harm. Hazards include all aspects of technology and activity that produce risk. Hazards encompass the characteristics of things (e.g., equipment, technology, processes, dusts, fibers, gases, materials and chemicals) and the actions or inactions of people.
>
> Hazard analysis is a process that commences with the identification of a hazard or hazards and proceeds into an estimate of the severity of harm or damage that could result if an incident or exposure occurs.
>
> Risk is an estimate of the probability of a hazard-related incident or exposure occurring and the severity of harm or damage that could result.
>
> Risk assessment is a process that commences with hazard identification and analysis, through which the probable severity of harm or damage is established, followed by an estimate of the probability of an incident or exposure occurring, and concluding with a statement of risk.

A brief review follows of the subjects listed in the Table of Contents. It is to provide an indication of the breadth of coverage of Z590.3 and its implications as a resource for managements, design engineers, and safety professionals who are involved or become involved in hazards identification and analysis and risk assessments. It is important to note that this standard provides guidance on including Prevention through Design concepts as elements within an occupational safety and health management system – not separate from.

Z590.3 focuses principally on the avoidance, elimination, reduction or control of occupational safety and health hazards and risks. But, reference is also occasionally made to other types of losses – property damage, business interruption, and environmental issues. Intentionally, the standard is drafted to be applicable in all types and sizes of occupational settings. A very large part of the Roles and Responsibilities are duplicated here since that section gives a good indication of the implications of the standard.

ROLES AND RESPONSIBILITY

Top management shall provide leadership to institute and maintain a policy and effective processes for the design and redesign processes through which:

1. Hazards are anticipated, identified and evaluated for avoidance, elimination, or substitution.

2. Risks deriving from identified hazards are assessed and prioritized in accordance with accepted hazard analysis and risk assessment techniques.

2. Risks are reduced to an acceptable level through the application of the hierarchy of controls as described in Section 9.

3. The knowledge, skills, experience, insight, and creativity of employees close to the hazards and risks are utilized in the risk assessment process.

4. Design and/or redesign process effectiveness are monitored through feedback between employees and management to provide for continuous improvement.

5. Appropriate recordkeeping systems are developed and used to document design reviews and to track feedback and safety and health reports over the life cycle.

Note: The processes of identifying and analyzing hazards and assessing risks improve if management establishes a culture where employee knowledge is valued and respected and they collaborate in significant aspects of the design and redesign activities. Employees who do the work can make valuable contributions in identifying and evaluating hazards, in risk assessments, and proposing risk reduction measures.

Top management shall carry out the foregoing responsibilities when:

- New facilities, equipment, technologies, materials, and processes are being planned, designed, acquired or installed.

- Alterations are made in existing facilities, equipment, technologies, materials, and processes.

- Incident investigations are made and corrective actions are taken.

- Demolition, decommissioning or reusing/rebuilding operations are undertaken.

- Top management shall make clear to all personnel (and subcontractors) that the goal of the risk assessment process is to achieve acceptable risk levels.

The development of acceptable risk levels begins with the establishment of occupational safety and health goals during conceptual design, at the same time when occupational hazards are

anticipated. During preliminary design, acceptable risk targets for the hazards that cannot be eliminated are established. These acceptable risk targets will assist in the design/identification of risk control alternatives.

Top management shall determine that the design process includes input from those who have design responsibilities, safety and health professionals, maintenance personnel, supervisors, operations personnel who will be affected, and safety and health professionals, to the extent practicable.

Participants in the development of this standard pleaded for guidance on how to deal with suppliers so as to avoid bringing hazards and risks into the workplace. Assistance is given on that subject in a section titled Relationships with Suppliers. Additional supportive information on the procurement process is provided in Addendum C.

Design reviews are significant in achieving acceptable risk levels. That subject is dealt with in the section on Safety Design Reviews. Addendum E is additionally informative on design reviews.

Guidance on The Hazard Analysis and Risk Assessment Process is extensive. Top management is to apply the hazard analysis and risk assessment elements necessary in achieving acceptable risk levels, as in the following, that are appropriate to a given design situation.

- Select a risk assessment matrix
- Establish the analysis parameters
- Identify the hazards
- Consider failure modes
- Assess the severity of consequences
- Determine occurrence probability
- Define initial risk
- Select and implement hazard avoidance, elimination, reduction and control methods
- Assess the residual risk
- Risk acceptance decision making
- Document the results
- Follow-up on actions taken

Addenda A and B depict the hazard analysis and risk assessment process in graphic form. Several variations of risk assessment matrices and descriptions of probability and severity terms actually used in risk assessment processes are provided in Addendum F. The data in Addendum F is to serve as a base from which choices can be made to arrive at a risk assessment matrix suitable for a particular operation.

Hazard Analysis and Risk Assessment Techniques are discussed briefly in the standard but the subject is more extensively covered in supporting informative data. Addendum G comments on several hazard analysis and risk assessment techniques. The intent is to provide information from which decisions can be made in selecting the technique to be used in a given situation. Addendum E is an example of a real world risk assessment report. Addendum H is an outline of a Potential Failure Mode and Effects analysis process.

Comments on The Hierarchy of Controls are substantial in the standard and that data is expanded in Addendum I – The Logic Supporting the Hierarchy of Controls.

Conclusion

It is obvious that the trending throughout the world in recent years has been to promote having safety management systems include provisions pertaining to hazard identification and analysis and risk assessments. Safety professionals should be cognizant of that trend, as it will have an effect on the knowledge and skills they will be expected to have.

The development of Z590.3 is timely in relation to the evolving needs and the transition taking place in the practice of safety. It provides an excellent resource for management, design engineers, and safety professionals as Prevention through Design concepts are applied or improved.

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