

# SAFETY BRIEF

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## STANDARDS - IMPACT AND IMPOTENCE

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### ABSTRACT

Most of the technical works of humankind are designed without the guidance of safety codes and standards. Specific safety standards are generally developed when contrivances give rise to numerous accidents and liability actions. The salient features of such standards are briefly outlined in this article.

### I. INTRODUCTION

Safety is characterized by only two concepts: Severity (How badly can something hurt you) and Frequency (How often will it hurt you?). It is axiomatic in the field of safety that nothing created by man or nature is completely incapable of inflicting harm [Ref. 1]. It follows that a technologist is then confronted with the question, "How safe is safe enough?" Unfortunately, safety is not an uncoupled concept that can be studied independently. Reduced to its simplest form, a technologist must balance safety, function, and cost. Referring to the Engineering Code of Ethics, the first tenet of every engineering society requires that: "Engineers shall hold paramount the safety, health, and welfare of the public in the performance of their professional duties." There are two points that should be emphasized. First, the duty of an engineer derives from an obligation to harness technology for the benefit of mankind. Second, welfare includes economic well being. Welfare is defined as, "A state characterized especially by good fortune, happiness, well being, or prosperity." [Ref. 2]

Observe that the code of ethics is silent on other properties of design that arise from such things as religion, history, or esthetics. These concepts, together with severity or well being, have no metric or standard of measurement. Scientific Monthly said, "No metric exists that can be applied directly to happiness." Without a metric, science and technology have no protocols for quantifying safety [Ref. 1]. The problem of specifying a level of safety becomes even more perplexing if different metrics exist; for example, cost, weight, and frequency. Trade-offs among qualities with various metrics are like comparisons of apples and oranges. How then do we specify how much safety is required for a given mechanical device? The answer is found in various value systems such as the judicial value system, consensus standards, and statutory codes.

### II. DEFINITION - SAFETY STANDARDS

The engineering and legal professions view safety standards differently. Engineers produce standards that describe "minimum requirements" for meeting an implicit level of

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safety [Ref. 3]. Standards are revisited at short intervals (usually five years) to correct errors and reflect modern ideas. Technologists, by and large, treat a standard as a “bible” which provides guidance for fulfilling their safety obligations.

The legal profession is primarily interested in codes and standards from a liability point of view. Three distinct legal positions can be identified:

- **Minimum Requirements:** In the U.S., compliance with a safety standard is treated as a necessary but not sufficient condition for precluding liability. The fundamental argument against the sufficiency of standards stems from a 1932 decision by Judge Learned Hand: “Indeed, in most cases reasonable prudence is, in fact, common prudence; but strictly, it is never its measure; a whole calling may have unduly lagged in the adoption of new and available devices.”

Almost no states will accept code compliance as a defense in a product liability case and sometimes judges will not allow standards to be introduced. Defendants in product liability actions present code compliance merely as a persuasive argument in favor of their position.

- **Rebuttable Presumption:** In 1979, the framers of a Draft Uniform Product Liability Law [Ref. 4] advanced the notion that compliance with a safety standard should create a rebuttable presumption of proper design. This position was also espoused by Martin S. Seltzer in 1981 in a position paper presented to the American Society of Mechanical Engineers [Ref. 5]. Roughly, the concept of rebuttable presumption requires a judge to instruct the trier of fact, e.g. a jury, to presume a product is not defective if the injury-causing aspect of the product meets a “good” non-governmental safety standard – unbiased, up-to-date, more than a minimum standard, and carefully developed through testing and formal safety evaluations. This presumption may be rebutted by clear and convincing evidence that the standard was not “good”.

The rebuttable presumption concept is a rational theory of product liability that provides *a priori* a “certain” design criteria. It can be formulated to be compatible with the doctrines of Strict Liability [Ref. 6] and Reasonably Foreseeable Use [Ref. 7].

On the other hand, it cannot satisfy Alternative Design Theory, Restatement of the Law Third [Ref. 8]. This theory holds that a product is defective if a feasible and economical alternative design can be hypothesized that will prevent the accident under consideration. This is an irrational theory [Ref. 9] that implies that your dog is ugly if my dog is prettier.

Rebuttable presumption has not been adopted in the U.S.


- **Compliance vs. Non-Compliance:** For many countries, including those in the European Union, compliance or non-compliance with a safety standard forms the criterion for determining whether or not adequate safety has been achieved. Many E.U. standards have been developed by government agencies as opposed to voluntary or non-governmental bodies. In the U.S. there are some government developed codes, such as the Poison Prevention Packaging Act, that completely define the acceptable safety level and specifically forbid any product liability actions under state law when compliance is achieved [Refs. 10, 11 & 12]. Clearly, under such conditions the quality of the standard is essential. Otherwise the public safety is compromised and no corrective is available; codes take precedence over other standards and the plaintiff’s bar is manacled.

### III. CHARACTERIZATION OF SAFETY STANDARDS

#### A. Standardization

Engineering, Science and Technology do not address the commonality among designs; they focus strictly on the problems at hand. If there is any advantage to be gained by imposing a social structure on the works of technology, this is a role that only standards can fulfill.

- **Uniformity** Sometimes safety is derived entirely from the property of uniformity imposed by standards. Examples include driving in the right-hand lane and the relative layout of the brake and accelerator pedals in automobiles. In the U.S., the spacing between rungs on portable ladders is specified by standards [Ref. 13] at twelve inches. This is not an optimum spacing; this is one third the arm length of King Henry I of England (1120 A.D.). Nevertheless, safety is promoted because every ladder trains the user for other ladders [Ref. 14].
- **Technology Transfer** The Principle of Uniform Safety states that “similarly perceived dangers should be uniformly treated” [Ref. 14]. By concentrating on the commonality among machines, the principle imposes a uniform safety profile on all machines. For example, the maintenance safety philosophy Lockout/Tagout should apply universally to machines and systems. The color red should be reserved for stop controls. To achieve these safety common denominators, one must appeal to safety standards.
- **Interchangeability** The standardization of hose couplings and fire hydrants throughout the country provides for an integrated fire fighting system. In 1904 most of the old business section of Baltimore burned down because of incompatible couplings on equipment called in from Washington, New York and Philadelphia.

- **Safety Symbols** Because the International Safety Alert Symbol  has no intrinsic pictorial to communicate danger, it is necessary to train workers to understand its meaning [Ref. 15]. Codes and standards have been very helpful in promulgating safety symbols. Many examples may be found in highway signage.
- **Level Playing Field** The lower cost associated with the absence of safety devices on machines provides an advantage in the marketplace. When buying commodities, professional purchasing agents and government agencies are motivated and/or obligated to choose the lowest bidder. Consequently, small differences in cost have profound effects on procurement. By requiring all similar machinery to have the same safety devices, safety standards level the playing field among bidders, and all bids present machines that satisfy the community's safety interests.

## B. Safeguards With Harmful Side Effects

The harmful side effects of medicines have their counterparts in technical safeguard systems. Many safety devices have characteristics that compromise safety, e.g. seatbelts, air bags, man-cages for cranes, power line proximity alarms, and emergency stop devices. Such safeguards have been classified as Types 4 through 7 on the Classification of Safeguard Systems [Ref. 16]. Instead of the watchdog Federal Drug Administration, machinery safeguards are governed by a philosophy called the Dangerous Safeguard Consensus [Ref. 17].

The most unequivocal and widespread position taken in the safety literature is the admonition against the use of safeguards which introduce hazards of their own. Typical excerpts from this literature, which date from 1916, provide some insight into this philosophy:

1975: "Handbook of Occupational Safety and Health," Chicago, National Safety Council, 1975, page 138. "It is a cardinal rule that safeguarding one hazard should not create an additional hazard."

1994: "General Requirements For All Machines," 19CFR 1910.212 (a) 2. Washington, D.C., OSHA, effective August 27, 1971 "General Requirements For Machine Guards: guards shall be affixed to the machine where possible and secured elsewhere if for any reason attachment to the machine is not possible. The guard shall be such that it does not offer an accident hazard in itself."

The admonition not to adopt safeguards that have a safety downside applies to individual designers and manufacturers. This prohibition is specifically stated in most of the standards, codes, or statutes yet these very

standards, codes and statutes regularly demand, recommend, or permit safety features with dangerous side effects such as falling object protective structures on forklifts or automobile seatbelts. There is no contradiction; engineers, designers, and manufacturers are not allowed to make judgments that hurt people even when the benefits are substantial, but value systems are.

A value system is defined as "a system of established values, norms, or goals existing in a society." [Ref. 2] The most important value systems which give designers permission to use safety devices that have downsides are safety codes and standards.

Since every device causes harm, should technology consider every safety problem? The answer cannot be found in technology. It is currently provided in law: if a danger is not *reasonably foreseeable*, it is not a safety problem [Ref. 7]. Determining whether a danger is reasonably foreseeable is often a complex problem and it is here that safety codes and standards may be useful. Any safety problem identified in a code or a standard may be considered to be reasonably foreseeable. For example, many standards identify warning signs that should be appended to machinery. Every safety problem identified by those warning signs may be considered to be reasonably foreseeable.

## C. Trade-off: Cost, Safety, Function

Committees who write codes and standards are explicitly mindful of compromising the function of machines or burdening the community of users with excessive costs. Safety standards usually reflect an industry's trade-off among safety, cost and utility. An example of such a trade-off by the Federal Highway Administration (FHWA) may be found in the study of underide guards used to prevent submarining of automobiles that crash into the rear end of trucks. Rulemaking efforts by the FHWA to improve the protection of passenger car occupants by "beefing up" existing underide guards were terminated because the benefits achievable in terms of lives and injuries saved were not commensurate with the costs [Ref. 17].

## D. Safety Factors

A safety factor is defined as an experience-driven multiplier which ensures that the generalized loads do not exceed the generalized resistance of items [Ref. 18]. They are often referred to as factors of ignorance since they deal with our lack of understanding of the actual loads and resistances. Minimum safety factors are generally codified to reflect the experience of an entire industry. Safety factors provide an example of how standards treat an otherwise irrational topic.

## E. Reliability and Related Properties

The ability of a safety device to perform a required function under stated conditions for a specified period of time is measured by its reliability. Reliability may be expressed as a probability or an admonition that no single failure should result in a potential for injury or disaster. The design of elevated work platforms may compel a manufacturer to adopt a redundant lift system. The European Union mandates fail-to-safety interlocks. Redundant safety devices on the point of operation guard/doors of injection molding machines must employ diversity; this is the principle requiring the use of functionally different types of safety devices. The cylinders used in hydraulic cranes must employ pilot-operated check valves. Without the existence of safety codes and standards, none of the above cited features can be imposed on equipment.

## IV. DISCUSSION

If technologists design systems by appealing only to first principles, they will not be able to satisfy the safety requirements of society. Formalization of safety expectations requires codes, standards, and statutes. Indeed, the most important design decisions cannot be made by science or technology – they ultimately rest on doctrine advanced by value systems.

Most of the important features of safety codes and standards are outlined in this paper. Many of the philosophical notions presented fall outside the general experience profile of the technical experts who make up standard writing bodies.

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