V. NATIONAL AND INTERNATIONAL STANDARDS APPLICABLE TO GRAIN ELEVATORS AND FEED MILLS

A. INTRODUCTION

This section addresses national, international, and consensus standards applicable to grain elevators and feed mills. A cross-reference of the recommendations contained in this report to the OSHA standard is included (Table 12).

B. OSHA GENERAL INDUSTRY STANDARDS

The General Industry Safety and Health Standards (29 CFR 1910) of the Occupational Safety and Health Administration are broad-based standards [49]. As such, they address many areas of general safety which grain-handling and grain-processing facilities share with all industry. Although the general industry standards do not address grain elevators and feed mills specifically, many of the regulated areas parallel conditions in these facilities and should provide adequate worker protection if directly applied. These areas include hand and portable power tools, ladders and scaffolds, compressed gas equipment, man-lifts, hoisting equipment, firefighting equipment, walking and working areas, machine guards, and emergency planning, as well as electrical equipment and industrial trucks.

Other general industry standards would be considered adequate for grain elevators and feed mills with some modification. For example, regulations in 29 CFR 1910.252 [49] are comprehensive and address most precautions necessary for welding in hazardous areas. However, this section does not require use of a written permit, which is recommended for grain elevators and feed mills.

Areas in the general industry standards either not addressed or lacking in sufficient coverage with respect to requirements for grain elevators and feed mills, where applicable, include the following:

- Protective and safety equipment. General requirements for the use of lifelines, stretchers, and personal flotation devices should be addressed.
- Equipment and machinery. Specific recommendations relative to the safe operation and use of bucket elevators, grain dryers, grinders, and other potentially hazardous equipment and machinery should be addressed.
- Isolation and lockouts. Requirements for the use of lockouts and isolation techniques for specific applications in grain elevators and feed mills should be addressed.
- Confined space entry. Comprehensive regulations addressing entry into bins and other confined spaces are needed.
- Inspection and maintenance. An overall inspection and maintenance program should be addressed, in addition to the inspection and maintenance requirements currently included in the individual subsections.
- Dust control. Comprehensive requirements for dust control should be addressed.

maintenance requirements currently included in the individual subsections.

- o Training. An overall training program should be addressed, in addition to the specific training requirements included in the individual subsection.

C. NATIONAL CONSENSUS STANDARDS

National Fire Protection Association Standards 61B and 61C address design practices, operating practices, and protective features for preventing fires and explosions in grain elevators and feed mills [74, 127]. These standards were developed primarily as guidelines for designers and operators building new facilities or making major modifications. Although some operational considerations are included, the majority of the guidelines are design considerations for facilities and equipment. Many of these guidelines are consistent with the recommendations contained in this report.

D. INTERNATIONAL STANDARDS

Alberta Province Occupational Health and Safety Regulations (Alberta, Canada) contain an addendum covering grain elevators and feed mills [128]. The regulations are brief and principally address personal protective equipment, scaffolding, machine guarding, and manlifts. They do not adequately address dust control, specific hazardous equipment used in grain elevators, or entry into confined spaces.

Ontario, Canada, industrial safety regulations also address grain elevators [129]. These regulations are equipment oriented and are very similar to NFPA 61B in areas of facility construction, bucket elevators, grain dryers, and dust control systems.

Table 12

Cross-Reference of Recommended Safe Work Practices for Grain Elevators and Feed Mills to the OSHA Standard

RECOMMENDED SAFE WORK PRACTICE	OSHA STANDARD
Personal Protective Equipment	1910.28(j)(4) 1910.95 1910.132 1910.133 1910.134 1910.135 1910.136 1910.137 1910.156(e) 1910.252(e)(1) 1910.252(e)(2) 1910.252(e)(3) 1910.252(e)(4)(iv)
Dust Control	1910.22(a) 1910.176(c)
Hot Work	1910.252(c)(4)(ii) 1910.252(d)(1) 1910.252(d)(2) 1910.252(e)
Smoking, Open Flames, and Hot Surfaces	- - - - - -
Inspection and Maintenance	- - - - - -
Emergency Planning	1910.36(b)(5) 1910.36(b)(7) 1910.37(n) 1910.38 1910.156 1910.165
Confined Spaces	1910.28(j)(4) 1910.134(e)(3)(i) 1910.134(e)(3)(ii) 1910.134(e)(3)(iii) 1910.252(e)(4)(iv) 1910.252(f)(4)(iv)
Isolation and Lockouts	- - - - - -
Machine Guards	1910.212(a)(1) 1910.212(a)(2) 1920.212(a)(3) 1910.219

TABLE 12

Cross-Reference of Recommended Safe Work Practices for Grain Elevators and Feed Mills to the OSHA Standard (Continued)

RECOMMENDED SAFE WORK PRACTICE	OSHA STANDARD
Labeling and Posting	1910.36(b)(5) 1910.37(q) 1910.145 1910.176(e) 1910.252(a)(2)(iii)(a) 1910.252(e)(4)(vii)
Lightning Protection	- - - - - -
Foreign Material	- - - - - -
Walking/Working Areas	1910.22(a) 1910.22(b)(1) 1910.22(c) 1910.23(a) 1910.23(b) 1910.23(c) 1910.36(b)(1) 1910.36(b)(4) 1910.36(b)(5) 1910.36(b)(8) 1910.37(e) 1910.176(c)
Static Electricity	1910.219(p)(2)(iii) 1910.309
Hazardous Material Storage	1910.106 1910.176(c)
Bucket Elevators	- - - - - -
Dryers	- - - - - -
Electrical Equipment	1910.308 1910.309
Manlifts	1910.68
Fire Protection	1910.37(m) 1910.157 1910.158 1910.159 1910.160 1910.162 1910.181(j)(3) 1910.252(d)
Hand and Portable Power Tools	1910.242(a) 1910.243(a)(5) 1910.243(b)(2)

TABLE 12

Cross-Reference of Recommended Safe Work Practices for Grain Elevators and Feed Mills to the OSHA Standard (Continued)

RECOMMENDED SAFE WORK PRACTICE	OSHA STANDARD
Powered Industrial Trucks	1910.178(a)(3) 1910.178(c)(2)(vi) 1910.178(c)(2)(vii) 1910.178(l) 1910.178(q)
Ladders and Scaffolds	1910.25(b)(1)(i) 1910.25(d) 1910.26(a)(1) 1910.26(c)(1) 1910.26(c)(2) 1910.26(c)(3) 1910.27 1910.28(a)(3) 1910.28(a)(4) 1910.28(a)(5) 1910.28(a)(6) 1910.28(a)(7) 1910.28(a)(11) 1910.28(a)(14) 1910.28(a)(19) 1910.28(a)(26) 1910.28(j)
Compressed Gas Equipment	1910.166 1910.167 1910.168 1910.169 1910.242(b) 1910.252(a)(2)(i)(a) 1910.252(a)(2)(i)(b) 1910.252(a)(2)(iii)(a) 1910.252(a)(2)(v)(b)(2) 1910.252(a)(2)(v)(b)(6) 1910.252(a)(2)(v)(b)(7) 1910.252(a)(2)(v)(b)(15) 1910.252(a)(2)(v)(b)(18)(ii)(c)(2) 1910.252(b)
Hoisting Equipment	1910.179(b)(8) 1910.181(b)(3) 1910.181(f) 1910.181(d) 1910.184(e)(5) 1910.184(f)(1)
First Aid Equipment	1910.151

VI. SAFETY RESEARCH NEEDS

A. INTRODUCTION

Recommendations for research in several areas where additional study should prove beneficial are contained in this chapter.

B. RESEARCH RECOMMENDATIONS

1. Dust Control

The value of dust control in grain elevators and feed mills should be recognized throughout the industry. Housekeeping is thought by many to be the most important factor in reducing the risks associated with secondary grain dust explosions. Although the value of a clean facility is recognized, there is no clear definition of what is meant by "clean." Some literature implies that anything more than a trace of dust should be cleaned up. Other literature indicates that accumulations should not exceed 1/64, 1/16 or 1/8 inch. Research to determine definitive guidelines for the degree of cleanliness that is considered safe would be of value throughout the industry. The guidelines should address all surfaces where dust may accumulate, both inside and outside of enclosures, as well as techniques which can be used to measure the level of cleanliness.

Of equal importance is the need to measure airborne dust levels at grain transfer points and within enclosed handling and processing equipment. In many cases airborne dust levels exceed the lower explosive limit, even with air aspiration systems operating. Explosive dust concentrations, combined with rapidly moving components within the equipment which may provide the ignition source, result in a continuously hazardous operation. Although monitoring devices for dust concentrations [25] have been developed, additional testing of the device on a large scale basis with numerous types of grain would be desirable. This testing and the development of additional techniques for measuring airborne dust levels should be included as part of this effort.

A third area requiring resolution is the practice of returning dust from pneumatic collection systems to the grain. Many experts indicate that limiting reintroduction of dust improves safety. However, other experts question whether the safety benefits justify the economic cost and the potential problems associated with handling the dust separately. Research should be conducted to determine the relative safety benefits of total restriction of returning dust to the grain, partial restriction, and no restriction, for the various sizes and types of grain-handling and grain-processing facilities. Research should include an investigation of the techniques that may be used to return dust without subsequently throwing the dust into suspension.

A fourth area needing additional study is the practice of using additives to reduce emissions of dust from grain during handling and processing operations. This approach shows promise; however, there appears to be very little positive response from within or outside the industry. The most obvious question to be resolved is the possibility of additives altering the taste or

question to be resolved is the possibility of additives altering the taste or

quality of the product. Additional investigation is needed to answer this question and other relevant aspects associated with the use of additives.

The synergistic effect between grain dust and fumigants has also been suggested as a factor contributing to explosions in grain elevators and feed mills. There is an indication from some of the research conducted that the minimum amount of energy required to ignite fumigated grain dust may be reduced due to the presence of fumigants. One of the problems with grain dust is there are many marginal but possible ignition sources. Additional investigation is needed to determine the difference in ignition energies between various grain dusts and dusts with fumigants added.

A detailed comparison of the grain-handling operations of the United States and Australia should be conducted with respect to volumes and types of grain handled, dust control, and equipment safety devices. This information could then be used to determine the feasibility of applying the operational and safety techniques which have proved successful in Australia to United States grain-handling facilities.

2. Bucket Elevators

Bucket elevators are by far the most hazardous equipment used in grain elevators and feed mills. Tests have shown that elevator legs routinely produce airborne dust levels exceeding the minimum explosive concentration. Although any location where dust is present can be hazardous under certain conditions, bucket elevators are exceptionally hazardous. Development of specific preventive and protective measures for bucket elevators should be given high priority. Certain techniques, such as the use of slow speed legs, appear advantageous and should be further developed. The advantages of using plastic buckets to reduce the chance of sparks should be evaluated, along with the possible disadvantages associated with the addition of flammable materials, the possibility of static charge buildup on plastic buckets, and the possibility of health hazards from the burning of plastic materials. The advantages and disadvantages of PVC versus rubber belt material should be evaluated. Investigation of internal dust levels with respect to the location, configuration, and capacity of the dust-collection system would also be valuable. Other aspects of bucket elevators including basic design, reliability, and maintainability should be investigated from a system safety standpoint. The possibility of removing the suspended dust should be considered. Various safety features such as interlocks, alignment devices, speed monitors, and choke detectors should be examined.

3. Explosion Venting

Explosion venting is frequently recommended in the literature as a method of limiting the destructive effects of an explosion. Venting is usually recommended for bins, bucket elevators, dust collectors, pneumatic conveyors, and other equipment and building enclosures. However, specific recommendations for the configuration and type of venting best suited for the various applications (with the exception of recently completed research concerning venting of bucket elevators) [113] and the needed relief area are often poorly defined or conflicting, especially for large height-to-diameter configurations.

The practice of extending bucket elevator casings above the roof is common; however, most experts concede that this practice is not fully effective because of the rapid pressure rise rate associated with most explosions [2]. Recommendations for venting of storage bins also vary widely. Effective venting of existing concrete bins is usually not practical because of the large height-to-diameter ratio and lack of venting considerations in the initial design.

Research to determine the optimum venting configuration for each application would be valuable. Research should be conducted separately for new construction applications and for existing facilities. Venting should be considered on a large scale in new construction; i.e., the entire side of a headhouse or gallery. Little information is readily available on such a large vent configuration. Research for new construction should consider basic design changes in the equipment to accommodate or lessen the need for venting, as well as recommendations for the best location of the equipment. Research for existing facilities should consider the most efficient and cost-effective means of adding relief vents.

4. Fire Extinguishing Methods

Extreme caution must be exercised in fighting grain dust fires. It is important to avoid extinguishing methods which might spread or disperse the dust into suspension, thereby raising the risk of explosion. Effective methods need to be developed for extinguishing grain and grain dust fires in order to eliminate this risk. In addition, deep-seated fires in grain bins pose special problems that need to be adequately addressed by developing effective extinguishing methods.

5. General Safety Studies

The need for additional investigation into the various causes and controls of fires and explosions in grain elevators and feed mills and investigation of actual incidents is obvious. Not so apparent, however, is the need for investigation of the many accidents and injuries suffered daily by workers in the performance of their assigned tasks. It is known that back injuries, cuts, bruises, and sprains are among the most frequently occurring injuries. Information indicating the type of equipment most often involved in accidents can also be obtained to some extent. However, data of sufficient detail to enable the accurate identification of the contributing factors and the actual causes of accidents are not readily available. A system to provide these causative data would be a valuable aid in establishing specific safety guidelines and effective training programs for the entire industry.

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