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Meeting NFPA Requirements for Bunker, Bin, Silo and Hopper Design for Coal and Fuel Handling

The following discusses the latest NFPA standards regarding coal handling, fuel storage, and other energy storage and bulk handling solutions. Key topics include bunker storage, metal bins, expanded flow versus mass flow plus silo design and construction. Visit NFPA.org for complete standards information.

NFPA (National Fire Protection Association) was organized over 100 years ago to develop a technical document that coordinated the design of fire protection sprinklers. Today, NFPA facilitates the development of more than 300 codes and standards (building, fire, electrical and life safety) under a consensus code-making process that is accredited by the American National Standards Institute (ANSI). These safety codes and standards influence every building, process, service, design, and installation in the United States, as well as many of those used in other countries. NFPA is a private, nonprofit membership organization. More than 6,000 volunteers serve on NFPA technical committees, writing NFPA codes, standards, and recommended practices.

NFPA *is not an enforcement authority*. NFPA codes and standards are developed as minimum requirements and are voluntary, unless they are adopted by a jurisdiction and then enforced locally. *[For example, OSHA 29 CFR 1910 (Electrical Power Generation, transmission, and Distribution; Electrical Protective Equipment) refers to NFPA 70 (National Electrical Code) and NFPA 70E (Electrical Safety Requirements for Employee Workplaces). So the government would enforce the OSHA standard, and the OSHA standard has adopted the NFPA standard.]*

Of the many standards that apply to plant design and safety, only two (related to storage and flow of coal) are discussed here. NFPA 85 (Boiler and Combustion Systems Hazards Code, 2007 Edition) and NFPA 850, (Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations, 2005 Edition. These standards are interconnected with respect to solid fuel storage and handling - NFPA 850 refers to the requirements of NFPA 85.

Note the use of *shall* and *should* throughout the codes. *Shall* indicates a mandatory requirement. *Should* indicates a recommendation (advised but not required). The Annex for each code contains explanatory material that is for informational purposes only. A brief summary of the bunker flow aspects of the standards follows:

NFPA 850, section 7.4 Fuel Handling — Coal. This section addresses pile storage and bins, bunkers and silos for all types of boilers. Note that the Annex was updated in the 2005 edition to include the latest Best Practices from the PRB Coal Users Group. Some of the highlights:

7.4.1 Pile Storage. This section discusses the measures to take to avoid fires.

7.4.2 Bins, Bunkers, and Silos. The recommendations of this section should be considered to reduce the probability of serious fire. This section also refers to NFPA 85.

Annex, section A.7.4.1.1. Information on the properties of Powder River Basin (PRB) coal was added.

Annex, section A.7.4.2.1. *Spontaneous heating*. This section has been modified to include information on preparation of a coal bin, bunker or silo for potential fire fighting apparatus, i.e., piercing rod access ports through which to inject fire suppression chemicals.

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NFPA 85, section 9.4.6.5 Bunker and Hopper Designs. This section addresses storage of raw fuel and pulverized fuel in bunkers, bins and silos. Some of the highlights:

9.4.6.5.1 The raw fuel bunker … shall be designed to provide the following mass flow and self-cleaning flow characteristics:

(1) An uninterrupted flow of fuel being handled at a controlled rate

(2) A flow pattern in which arching and ratholing (piping) are avoided

9.4.6.5.1.1 The bunker outlet feeder(s) shall be coordinated with the bunker to avoid the probability that incorrect feeder selection will result in altering the bunker flow characteristics as specified in (1) or (2) above.

9.4.6.5.2.1 These (pulverized fuel) bins shall be designed to permit fuel discharge at an uninterrupted, controlled rate.

Annex, section A.9.3.2:

(1) An uninterrupted, controllable, raw fuel supply is essential to minimize fires and explosions within the system. …….

(2) …… be aware of the wide range in material-handling characteristics of fuel that are related to differences in moisture, size distribution, and consolidation characteristics. The probable range in these characteristics ….. and a determination of time consolidation shear values over these ranges are prerequisites for obtaining a bunker design that provides the desired flow characteristics ……. If the fuel is of a nature in which spontaneous combustion in the raw fuel bunker is likely to occur even when equipment is in service, the bunker design should be a mass flow design.

FAQs

Are older plants grandfathered? Although both standards primarily apply to *new* designs, there are circumstances when they should be considered for *existing* installations. In NFPA 85, section A.1.4 in the Annex suggests that any condition in existing units that represents a serious combustion system hazard *should* be mitigated by application of appropriate safeguards. NFPA 850, section 1.3.2 states "the recommendations contained in this document represent good industry practice and *should* be considered for *existing* installations". In other words, even *existing* silos should be made safe.

Is *expanded flow* acceptable according to NFPA standards? An argument could be made that this flow pattern meets the intent of the standards (by providing *mass flow and self-cleaning flow characteristics*). This would require emptying the bunker on a regular basis to ensure self-cleanout.

Are any tests mentioned in the standards? Yes, time consolidation shear values are discussed in the Annex of NFPA 85, section A.9.3.2 (2) for obtaining a bunker design that provides the desired flow characteristics. The flow function of the coal (i.e., its cohesive strength as a function of consolidating pressure) can be measured through laboratory testing, conducted using an ASTM test method D6128-00 (direct shear tester). Once the cohesive strength is determined, minimum outlet sizes can be calculated through a series of design charts also published by Jenike. Another related test, and equally as important, is wall friction, which also can be measured in a laboratory using ASTM test method D6128-00. From the wall friction test, limiting hopper angles for mass flow can be determined, which will indicate how steep and how smooth the hopper surface must be.

Is the feeder affected by these standards? Yes, in so far as an incorrect feeder design has the potential for altering the bunker flow characteristics (see NFPA 9.4.6.5.1)

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