A PROACTIVE APPROACH TO MAINTAINING YOUR SILO

Preventive maintenance and care is the most effective way to ensure the integrity of concrete and steel silos. A proactive cleaning and inspection program is crucial to increasing your silo’s life and ensuring the safety of those working around your structures. This article discusses ways preventive maintenance, inspection, and cleaning can help you cost-effectively maintain your silo and keep it operating effectively.

Dennis Blauser, Marietta Silos

Silos are essential to processing industries, providing bulk storage for borax, carbon black, cement, clay, clinker coal, fly ash, foundry sand, flour, grain products, gypsum, lime, salt, soda ash, animal feed, flour, and many more materials. When a silo has structural issues or starts clogging, so does plant production.

Bulk solid storage structure failures, such as for silos and bins, don’t occur suddenly or without warning. In most cases, the silo structure shows small signs of distress until the signs become too obvious and, if nothing is done, cause the structure to fail and potentially collapse. Third-party inspection, maintenance, cleaning, and repair services are the best way to manage safety on any scale since many structural issues, if caught early, can be easily and economically addressed. A proactive general safety program should always include silo inspections to check for potential structural issues.

Time, weather, and use all contribute to the degradation of silo structures, regardless of whether they’re made of steel or concrete. Foundation deterioration, improper filling and unloading practices, and discharge cone or bin floor issues also can cause problems. Silos can exhibit different signs of degradation and failure depending on their construction. For example, signs of steel silo failure include wall deformation, buckling, wear, and corrosion. Concrete silo failure signs show up in the form of wall delamination (concrete separates into layers), cracks, rebar corrosion, and discharge configuration issues.

Regular silo inspections on 1-, 2-, or 5-year schedules can help identify these problems. Based on inspection results, maintenance can be performed to avoid larger, more expensive repairs later. The cost of preventive maintenance and repair is minimal when compared to the financial and physical toll that a full collapse would have on your company and your team.

Conduct in-house inspections
While professional inspections are recommended every 1 to 5 years — unless there are structural or
operational concerns that would necessitate more frequent inspections — there are numerous areas that you can inspect in-house and should do so on a regular basis. These include:

**Roofs.** Roofs are an essential part of the silo structure. During an in-house inspection, you should look for signs of cracking or peeling in the rooftop coating. Besides the safety risk, leaking roofs can lead to contamination of stored materials, which impacts product quality.

Water penetration also leads to corrosion of metal silo components like roof beams — an issue that can lead to total roof failure if not addressed. Roof beams are a frequent area of corrosion, often due to roof leaks. Concrete spalling (flaking) on roof beam pockets can further expose beams and easily lead to a roof failure or collapse. You should also look for signs of ponding water on the roof. Regular ponding that sits on the roof shortens the coating membrane’s lifespan. More seriously, ponding water is usually caused by issues with the roof beam supports and can indicate potentially severe structural problems.

**Exterior surfaces.** Though concrete is a superior material for storage silo construction, normal loading and unloading operations can lead to structural issues over time. Cracks in silo walls, linings, roofs, and foundations are an indication of stress. Concrete walls that show horizontal, vertical, or diagonal cracking may indicate delamination, which is a serious issue and can lead to wall failure or collapse. This should be addressed immediately by a professional silo repair company. Metal silo component corrosion or buckling, exposed rebar, or other deterioration also should be noted during a visual inspection.

**Maintenance schedules.** Verify during inspections that regular preventive maintenance measures are being followed. Silo maintenance should include regular checks of airflow systems, a routine professional cleaning, and regular, complete silo emptying.

Of these measures, one of the most important is regular emptying. Silos that are regularly emptied and refilled are less likely to experience buildup issues seen in silos that are kept topped off. Regularly emptied silos need professional cleaning less frequently and are less likely to experience problems, such as material compacting and hydrating. Hydrating occurs when moisture mixes with stored material and causes it to solidify within the silo. When this happens, materials can expand and cause added wall pressure, increasing the likelihood of structural failure. Lime and cement are highly susceptible to compacting and hydrating, respectively.
**Benefits of professional inspections**

While frequent in-house inspections are important, so is understanding their limitations. Certain problems can only be identified by experienced silo inspectors or silo engineers. While failed silos can sometimes be repaired and stored material recovered, companies often can face additional costs after a failure in the way of cleanup, possible environmental damage, injury, and even loss of life. For example:

- In December 2016, while a crew was welding and fabricating metal bins for a concrete silo, a fire broke out and resulted in a crew member’s death. After determining that the crew didn’t have the required confined-space permit, a general negligence action was settled for $1.75 million (*Michigan Lawyers Weekly*, April 2017).

- In August 2013, employees at an Ohio-based concrete facility attempted to remove fly ash buildup from a clogged silo. After cleaning attempts using “a metal bar and air hose” failed, an employee, who entered the silo without a lanyard and harness, died when a fire erupted. During the investigation, OSHA noted 10 serious safety violations, which resulted in a $55,800 fine (OSHA news release, November 2013).

Both of these accounts demonstrate preventable accidents where the required permit wasn’t in place and cleaning crew members didn’t have proper safety training. Confined-space permits and rescue procedures are essential for safe inspections. While there are no inspection recommendations specific for silos, OSHA does have policies regarding confined-space entry that are essential for silo interior inspections.

Effective inspections, however, depend on more than a permit. Inspectors also must have field experience and an understanding of the unique properties that affect silo material flow and structural integrity. Industry experience further enables trained inspectors to determine predictive maintenance to address issues before they become real problems. Effectiveness and safety, therefore, rely on industry experience and proper silo engineering, design, and construction training. Inspectors need to be familiar with the nuances of silo construction.

**What to expect from a professional inspection**

A professional inspection engineer will begin by looking at the outside of the structure with both the naked eye and binoculars. The process will then proceed to the inside of the silo, where he or she will “sound” the wall at different spots. This audio part of the inspection is meant to identify any spots that have a “dead” or muted sound, which could possibly indicate delamination.

If there are particularly troubling areas, the engineer may take a core sample so that the layers can be evaluated in more detail. That data, along with all the other information gathered, will be studied in detail, and the inspection engineer will issue a report summarizing the silo’s health.

Other issues professionals should check include:

**Silo cone issues.** Silo discharge cone failures are a prevalent problem that’s easily preventable through routine inspection and maintenance. However, silo cone inspections should be left to professionals as the construction, design, and use need to be considered based on stored materials, current best practices, and material flow. A professional inspection can conduct thickness testing and identify potential issues with existing cone designs.

Both cone construction and design affect silo safety and performance. Silos constructed with a suspended cone are no longer recommended as these units have a high failure rate. Existing large silos that use a suspended cone design should be remediated by a professional design, construction, and repair company that can reinforce the cone, creating one that’s supported from underneath. This follows best practices.
Structural roof issues. Some roof issues, such as buildup that adds additional weight and exceeds maximum capacity, risk a roof’s structural integrity. This can overload the structure and cause a collapse, so a professional should inspect for these types of issues. Damaged roof beams or roof beam bearing pockets also can lead to structural failure and should be professionally evaluated.

Material flow issues. Buildup in the silo indicates ratholing and potentially asymmetric flow, which can increase pressure loads inside silo walls. When you have buildup in the silo, the loads associated with asymmetric flow can be detrimental to the structural integrity as they can lead to wall failure and total silo failure.

Routine cleaning prolongs silo life
Just as routine silo inspections are an essential component of your maintenance program, so are routine cleanings. Regularly cleaning your silo can help keep it operating efficiently and limit potential liabilities. Regular cleanings also can increase your silo’s useable lifespan and minimize big-ticket repairs and cleaning costs. Silos that are emptied regularly and refilled don’t have the same buildup issues as silos that are kept topped off, but every silo can benefit from a regular cleaning schedule.

Cleaning your silo can save you money in several ways. The primary savings are in recovering stagnant material that has built up inside your silo. This prevents losing that material and the resources — time, energy, labor — that went into storing it. Depending on your material, cleaning also can help prevent degradation or contamination that occurs when material sits too long, reducing or destroying its value.

Considering more than just price is important when deciding on a cleaning plan. The proposed price doesn’t always offer a clear picture of the costs or what the cleaning company can deliver. The following tips can help you understand what to look for when accepting silo cleaning bids to ensure the most accurate quote and the biggest return on investment.

As with most quotes for services, chances are that you started your search by completing an online quote request. Such questionnaires set the groundwork for a project by collecting basic information that helps professionals determine a project’s scope. While these forms vary in length, there are limitations to the amount of detail a questionnaire can provide.

A follow-up conversation helps build on these basic questions to paint a clearer picture of the project and allows for a proposal that’s tailored to your silo cleaning requirements. By talking to a company one-on-one, you can better describe any material flow issues and determine possible contingencies. This not only helps the company provide the most accurate proposal possible, it also helps you gauge the company’s technical knowledge.

In any proposal, the biggest variable that needs to be determined is the scope of the work. The proposal should outline the scope of the work to be completed and include all particulars discussed in the follow-up conversation and any completed questionnaires. The proposal also should include a breakdown of pricing that clearly outlines everything included in the final figure, such as whether it includes only labor charges.

Additional charges to look for include:
- Per diem (hotel and living expenses) for the crew
- Consumables and items like personal protective equipment
- Emergency response surcharges
Mileage and mobilization fees to get crew and equipment to the site
Vehicle charges
Site-specific equipment charges
Any additional premiums

Per-diem costs, in particular, can add up quickly. A standard crew, for safety purposes, consists of at least three people. On a 40-day project, a daily per diem of $142 per person adds $17,040 to the final bill. Larger crews and further exclusions of any of these charges can make the final cost an even greater surprise. To help avoid any surprises, look for a proposal that includes hotel and other personnel expenses to ensure the company locks in those numbers.

Allow for contingencies
While cleaning experts can use the follow-up interview and online questionnaire to anticipate possible contingencies, there are unknowns with any project — even if you perform regular cleaning, inspection, and maintenance chores. Unlike itemized charges, contingencies can’t always be anticipated and included in a proposal, so budgeting for them is a good idea. If a surprise does arise — particularly if it’s related to the silo’s safety and performance — your cleaning company should promptly inform you of the problem.

Since unknown expenses can come up throughout the scope of work, transparency is key. For this reason, silo cleaning companies bill based on time and materials. This type of billing can make a definitive project price inherently difficult to determine because the proposal isn’t a fixed number, but this flexibility can be to the client’s benefit.

The cleaning process will vary depending on the cleaning company, the equipment used, and the specific cleaning project. Cleaning companies typically use mechanical cleaning processes to remove residual stored materials from the silo interior. Mechanical dry cleaning uses special equipment, such as whip machines or compressed-air machines, to remove residual material. These machines typically eliminate the need for confined-space entry since the equipment is inserted through silo openings and mechanically removes material buildup.

A compressed-air machine tends to be more effective than whip cleaning, which doesn’t efficiently remove material buildup and can be useless against hardened buildup. While compressed-air machines generally provide more thorough silo cleaning, the power and efficiency of specific cleaning systems can vary from company to company. When choosing a company, the cleaning equipment’s power is important to consider since it directly impacts the amount of material buildup the equipment can remove and how long the process will take. The faster and more efficiently your silo is cleaned, the greater your return on investment.

Routine cleaning is necessary to remove the residue buildup inside the silo that reduces the volume of new material that the filled silo can hold. In all silos, cleaning removes old material residue which, in turn, helps maintain the freshness and concentration of the newly introduced material. Every silo, no matter the design or whether it’s steel or concrete, will benefit from a regular cleaning schedule. The benefits of a professional cleaning every year far outweigh the initial costs as this maintenance step keeps your silo running at full capacity, allowing maximum efficiency and leading to better production schedules with no unplanned downtime. PBE

For further reading
Find more information on this topic in articles listed under “Storage” in Powder and Bulk Engineering’s article index in the December 2018 issue or the Article Archive on PBE’s website www.powderbulk.com. (All articles listed in the archive are available for free download to registered users.)

Dennis Blauser (dennis@mariettasilos.com) is the CEO of Marietta Group, which includes Marietta Silos, Marietta Inspection Services, and USA Silo Service. He has spent most of his professional career in silo development. His expertise is based on a combination of years of on-the-job experience and an academic background in environmental economics from Wright State University in Dayton, OH. He’s also an active participant in various concrete industry association committees and initiatives.

Marietta Silos
Marietta, OH
800-633-9969
www.mariettasilos.com