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## Proper Maintenance Makes Tanks Last Longer

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Steel water storage tanks that are properly maintained can remain useful for decades (Figure 1). Maintenance is often performed on a regular basis, whether it is "needed" or not. In other instances, maintenance is performed only when a municipal board of directors or utility manager is warned by a maintenance contractor of imminent tank failure.

"Emergency" change orders for repairs, which are many times the price of the initial contract, may be commonplace when a system has no regular maintenance program. In the wake of emergency repairs, the water system may establish a regular maintenance program, but when municipal board members, managers, or those in authority resign and new members come on board, the cycle of improper maintenance starts again.

Additional problems with tank maintenance include inspection. Because many water tanks are high structures, there are few tank owners who have personnel who would climb a tank to check what had to be done and how it was to be done. Most of those who could climb have neither the experience nor technical background to know what to look for once they get to the top of the tank.

To correct these problems, a professional approach to tank maintenance was developed. This approach, which has proven to be very successful, will be discussed in this article.

### Tank Maintenance Program

Several qualified firms whose employees have the engineering knowledge and practical experience to assist tank owners in maintaining their

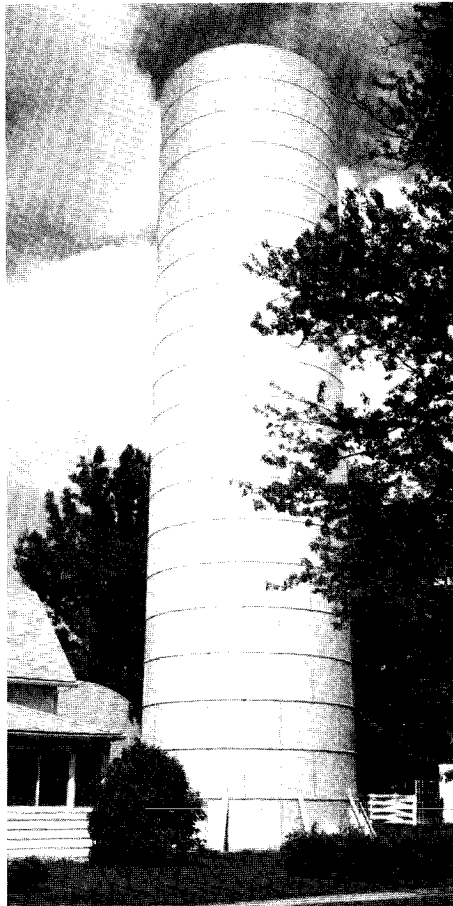


Figure 1 This AWWA landmark tank, constructed in 1902 at Wabash, Ind., still serves the community well.

tanks have developed throughout the United States. Members of these firms, who act as engineers, advisors, and inspectors, avoid entering into the contracting for the actual work operations so that they can give professional opinions without bias.

The three steps commonly used by these maintenance firms in developing and conducting an inspection and maintenance program for steel water storage tanks include

1. A prebid inspection (tank evaluation) to determine the needs of the tank(s).
2. The preparation of specifications and bid documents that are to be used by all bidders.
3. Inspection of the work as it is being accomplished to monitor compliance with the specifications.

A more complete discussion of these functions follows.

### Prebid Inspection

A regular premaintenance inspection program allows budgets to be established and gives information needed to prepare specifications for the work to be done. The purpose of the premaintenance inspection is to evaluate the present condition of the tank in the following areas:

- structural soundness of the tank, its supporting structure, and the foundation;
- sanitary condition of the tank interior and the condition of the roof, vent(s), manways, drain, and overflow piping;
- condition of ladders, platforms, entry and egress openings, railings and other working or climbing surfaces that might affect the safety of workmen, inspectors, and trespassers;
- condition of paint or other protective coating—how it is protecting the steel from corrosion, the percent failure, its aesthetic qualities, the remaining life, and its ability to be recoated;
- performance of the corrosion (cathodic) protection system as to anode placement, potential readings, and the absence of active corrosion;

*continued*

# Quality Maintenance Makes Tanks Last Longer

(continued from page 1)

- condition of accessory items, such as lighting, level gauges, and antennas; and
- environment and operating conditions, such as freezing conditions, proximity of parking lots, or the aggressiveness of the atmosphere and water, which may affect the use or maintenance of the tank.

If the utility owns more than one tank, the inspection of all tanks prior to planning the maintenance work will enable the utility to spend its money on the tank(s) in greatest need of maintenance, and delay work on tanks that is not as critical.

To perform this thorough inspection, it is necessary to drain and, often, wash out the tank to inspect the surfaces and members. Specialized rigging equipment may be needed to access portions of the tank requiring inspection. A thorough knowledge of tank construction is a necessity, because it is difficult to use a checklist at the heights and positions required during the inspection.

Steel-plate and structural-member thickness (Figure 2) should be verified by physical measurement or by use of ultrasonic equipment. Color photographs should be taken, not only to document to the tank owner the conditions found, but to assist in preparing the specifications and to help the prospective bidders analyze the project.

**Structural stability.** Prior to making recommendations, it may be necessary to analyze the structural capabilities of the tank and supporting structure based on the steel remaining after corrosion. A situation may exist in a tank whereby millions of pits that were not detrimental to a tank were welded unnecessarily. While this may occur only infrequently, it is best to give contractors specific instructions on welding or filling pits so that their efforts, and the utility's time and money, are not wasted.

There is no set rule on welding or filling pits. Scattered spot pitting usually presents no structural problem, but it can lead to leaks. When isolated spot pits reach the point that there is less than one-half the design thickness of the steel remaining, they are likely to require welding. When they are less than one-half way through the steel and the edges are sharp or the cleaning of the pits is not complete, they are likely to require filling with a solventless two-component epoxy seam sealer or filler. This epoxy sealer method does not impart additional structural strength to the plates, nor does it replace the corroded areas structurally.

Treatment of pits in a tank must be determined by looking at the present consequences of repairing or not repairing them, and at the future service life desired from the tank in question. General loss of steel thickness, pits very near to each other, or vertical groove

pitting can cause structural problems, because these defects affect the membrane strength of the container. In all cases, a structural analysis of the corroded tank steel should be made.

**Diving inspections.** In some instances, tank inspection can be performed by a qualified diver who enters the tank. The tank owner should be aware of the additional costs and limitations of this type of service. The presence of cathodic-protection anodes, interior piping, baffles, and radial rods may make a diving inspection impractical.

Even if the tank does not have to be drained for a diving inspection, there is a need to close and lock out all valves and piping leading to and from the tank. Divers have been sucked into piping when adequate lockout provisions have not been made. Consequently, the tank cannot actually be in service during the inspection.

It is difficult for a diver to evaluate the corrosion and coating condition patterns in a tank, because the diver can see only a few feet of tank surface at a time. The diver is unable to develop a feel for the overall condition of a tank until all data is compiled.

Since the diver comes in contact with potable water, the diver's suit and equipment must be thoroughly sanitized. In a drain-down inspection, the surfaces contacted can be disinfected after the inspection.

**Report of tank conditions.** A report certifying the condition of the tank along with recommendations for improvements should be prepared so it is easily understood by the decision maker(s). The report should include budget estimates for, and the life of, the recommendations; the remaining life of the tank with and without the recommendations being accomplished; and the present-day replacement cost of the tank. It is only with this information that the appropriate authority can make decisions concerning the tank.

## Preparation of Specifications

Concise, yet complete specifications allow competitive bids to be taken on the work. Qualified inspectors can then enforce these specifications to ensure that the quality of workmanship desired is achieved.

The specification writer should know the tank conditions, the coating systems available, the site and environmental



Figure 2 Evaluating a tank must include measuring steel thickness and pit depth.

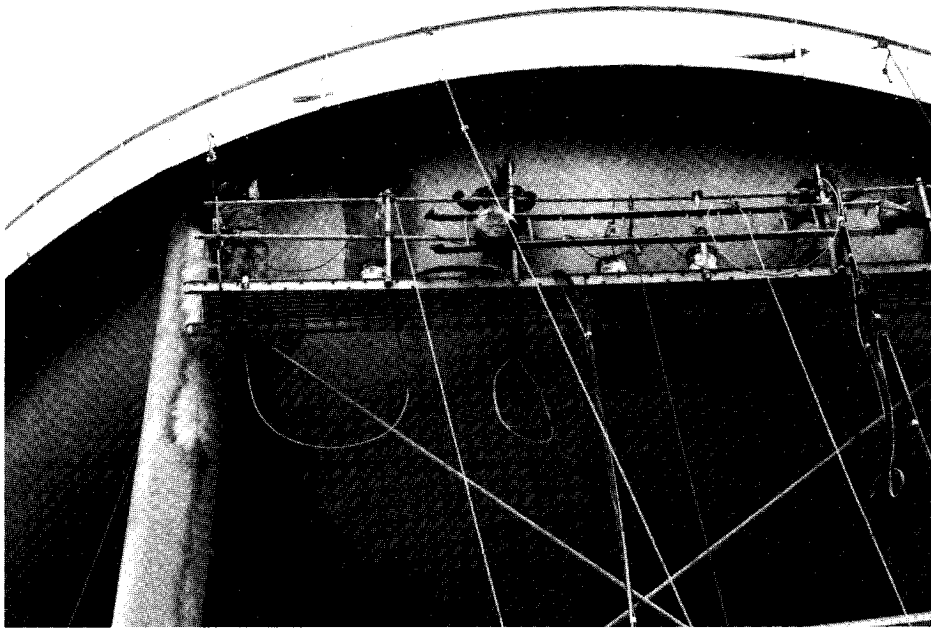


Figure 3 Abrasive blasting and painting operations should be observed closely by an experienced inspector.

conditions, the repairs required, the capabilities of potential contractors, and applicable tank standards.

The final specification should leave no loose ends. However, many times the exact condition of the steel cannot be determined until it has been abrasive blasted. If exact contract bid item quantities cannot be determined until the work is in progress, unit prices should be bid based on the work anticipated. If cathodic protection is required, provisions should be made for accomplishing any cutting or welding before cleaning and painting operations.

The specifications should state that unfair, or unbalanced, bids for contingent repair work will be cause for rejection of the bid.

Not only should the specifications contain the technical requirements for the work to be performed, they should also include requirements for performance and payment bonds, insurance, time for completion, resolution of disputes, and necessary legal documentation. The specifications should also provide that an inspection be conducted prior to expiration of the one-year bonded guarantee (per AWWA D102) that is provided by the performance bond.

After receipt of the bids, which are based on the specifications, the contractors should be analyzed as to capabilities, experience, and scheduling.

It may also be necessary to investigate a potential contractor through the inspection of the contractor's previous jobs.

### Inspection of Work in Process

The key to a long-lasting paint or repair job is the quality of workmanship. The inspectors monitoring this quality should be capable of accessing all work areas and rigging.

For the best quality, an inspector should be at the site while work is being done. This may cost from 15 to 35 percent of the contract. However, when one considers that a paint job performed without inspection might last only 10 percent as long as one with qualified full-time inspection, the expense of full-time inspection can be justified.

**Intermittent versus continuous inspection.** Inspections may be performed on a continuous or intermittent (critical phase) basis. The actual cost of inspection may be less using intermittent inspection. However, with this type of inspection it is often necessary for work to be redone to comply with the specifications. This somewhat lowers the quality of the finished product, lengthens the job, and is frequently a cause of conflict between the contractor, owner, and inspector. Resident full-time inspection minimizes the amount of rework required.

Frequently, the decision is made to have professional inspection on only an

intermittent basis. In some cases, utility personnel can perform daily inspections in coordination with periodic professional inspection. The frequency of professional intermittent inspections required is usually dictated by the dependability of the crew and the abilities and time availability of the local utility inspector. Inspections are considered necessary at no less than the following times:

- at the beginning of abrasive blasting (Figure 3) to reach an agreement on the degree of cleanliness to be obtained;
- after the application of portions of the prime coat;
- prior to the application of the finish coat; and
- at final inspection to ascertain paint thickness, lack of holidays, and aesthetic acceptability.

If repair welding on a unit-price basis is required, it should be done only in the presence of the inspector, so the quantity of the unit-price pay items is also verified.

Besides having climbing abilities and practical experience with coating application and conducting of repairs, the inspector should have a thorough knowledge of the Steel Structures Painting Council and/or National Association of Corrosion Engineers standards and recommendations, the paint manufacturer's recommendations, and the project specifications.

The ability to communicate with the crew supervisor, the owner, and the specifying engineer is also a necessity. The inspector should have the knowledge to assist the crew in overcoming problems, instead of just pointing out deficiencies.

Each inspection should be documented with a written report of the conditions and findings of each visit.

### Coordination

The best method of carrying out a tank maintenance program is to have the same firm accomplish all three of the maintenance engineering functions. Many times this is not possible within the framework of local politics or existing engineering contracts. In such cases, all involved parties must have a knowledge of the other's duties and must maintain communications at a high professional level. ♦

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