INSPECTING NEW TANK CONSTRUCTION

E. Crone Knoy, P.E.
Chairman and Founder
TANK INDUSTRY CONSULTANTS, INC.
7740 W. New York Street
Indianapolis, Indiana 46214
(317) 271-3100

As a prospective owner of a new steel tank, or as the consulting engineer for the construction of a new steel tank, how can you be assured that the tank you are having built complies with the specifications?

Of course, you are going to try to select a good contractor. But -- most of you are under the control of a municipal council, federal funding agency, or a public service commission, and you must select the low bidder. Even the best of contracting firms can stub their toes. What if this happens on your job?

Usually, tank contractors are left to their own devices to maintain the quality of their work. The AWWA D100 Standard gives the contractor the responsibility for designing and conducting his own welding quality program. This is a good concept, as the designing and building of tanks is a specialized field, and the equipment and knowledge required to conduct a total quality control program is also specialized. Of course, the fallacy to all this is that the contractor's organization is made up of humans communicating with humans and interfacing with technical equipment. There are bound to be shortcomings -- some which can be corrected, and some of which cannot.

Why be concerned? Either it holds water, or it doesn't. Of course, there have been catastrophic failures when the tank is first filled. A draftsman leaves off a detail. The experienced shop layout man is off work when that job goes through the shop. The erection foreman has erected hundreds of tanks, but not one like this -- the error finds its way to the field and a failure occurs... An inexperienced crew gets the job. Welding is poor. The seams burst... These kinds of immediate failures have happened, and will continue to happen. Fortunately, the industry is a good one, and one won't normally find the consequences of poor quality so immediately apparent. A good quality assurance program will always be sure to save you money in the long run, however. How? By reducing maintenance costs, and giving you a longer life span on your tank.

To establish a quality assurance program for your client (or employer), it will help to learn more about the functions that are a part of building a tank. These functions are:

1. Soil allowable stress determination
2. Design of the tank and foundation
3. Purchasing raw materials
4. Shop fabricating the tank components (including surface preparation and painting)
5. Constructing the foundation
6. Delivery of the steel
7. Erecting and welding the steel components
8. Field cleaning and painting of the steel
9. Installation of mechanical and electrical appurtenances

Soil Stability. Be at the site when the borings are being taken. You will have a better insight as to what problems might be encountered during foundation construction.

Design Responsibility. What is the consulting engineer's responsibility in checking the tank contractor's shop drawings? Do you check for capacity, diameter, height, and the size of the connecting pipe, and stamp them approved with no concern for the structural stability of the tank? It really does look like the contractor is responsible for the design (doesn't it?). Tell that to a lay jury in the county where the failure occurred. Even if you aren't responsible for the failure, who will pay for your lost time in defending yourself or your firm, or getting your name dropped from the suit? The author has no answer here.

Quality of Materials. Insist on mill test certifications on all steel components. Look for the heat numbers on the plates. (Did you know that they are stamped on them?) Examine the material. Has it been stored so long that it is pitted? Don't forget the structural members -- especially the pipe used for columns.

Shop Fabrication. Try to arrange a visit to the contractor's fabricating facility while your tank is being fabricated. You will be amazed at the behind the scenes work that goes on before you see any action at the job site. You will also be amazed at how much smoother the job will go after you have become better acquainted with the contractor's personnel. While there, look at the quality of shop welding, the type of surface preparation, and the shop painting.

Foundation Construction. Typically, most consulting firms or owners inspect the foundations with more precision and expertise than any other function of tank building. Quite likely, this is done because the normal municipal consultant does have a great deal of expertise in this area. Hopefully, this concern for quality control is because the consultant (or owner's project representative) is aware that the foundation for a tank represents the greatest opportunity for failure. The reinforced concrete foundation and the soil it bears on are made up of non-homogeneous materials, over which there is little control. Also, the foundation is frequently installed by a subcontractor or under another division, giving the tank contractor little control over this function.

First of all, the soil conditions at the bottom of each excavation should be evaluated to determine if they are the same used in developing the foundation design. If piles are being driven, one must determine if the piles are driving as predicted, and should be on the job to verify the pile driving log. Form and reinforcing steel placement should be verified and documented with photographs before allowing the concrete to be poured.

If one does not have experience with the concrete ready-mix plant, a design mix should be developed and tested. The consistency of the concrete should be evaluated as the first material comes out of the chute. Concrete test cylinders should be taken. A knowledge of American Concrete Institute Standard 301 "Specifications for Structural Concrete for Buildings" is a must. The anchor bolt placement should be checked, as well as the pier elevation(s).

Concrete quality is necessary not only for the compressive strength it must develop, but frequently, the surface of the foundation has not cured properly to protect it from the elements, and failure of the concrete occurs long before deterioration of the steel tank.

Finally, proper back filling techniques are necessary to prevent over stressing the concrete during back filling, prevent water ponding on moisture weakened soils, and to make the site more solid for the tank erection crew.

Delivery of the Steel. Try to be there when the steel is delivered to the job site. This will help resolve conflicts with neighboring property owners, document any damage occurring in the unloading process, and protect underground utilities on the site or under the access road.

Erecting and Welding the Steel. This is the one area where the expertise of the contractor really comes into play. Erecting steel is a dangerous operation, requiring skills acquired only through experience. This is the phase where you may really need outside assistance. Who do you turn to? Independent testing laboratories are usually equipped to take radiographs, but know little about steel erection and fit-up, and aren't equipped emotionally to climb the heights usually associated with water storage facilities.

Using someone from another contractor's organization never seems to work. How can a competitor be unbiased in the evaluation of another contractor's workmanship? If he is fair, how will your tank contractor accept this opinion as an unbiased one?

Before getting into evaluating the welding, let's list a few things that you can look for which will help you get a good tank. Did the foreman check the foundation(s) for differences in elevation? If not level, did he shim under the steel to make the steel erected plumb? Are you seeing slivers of steel being cut off as the seams are being fit together? Is there a too frequent need to use a large hammer to form the steel? Does the gap in the seam vary, or is it uniform and in accordance with the approved shop drawings? Are the plates aligned in accordance with AWWA D100 Standards?

Under AWWA standards, the contractor is to check the quality of the welding. It is the owner's inspector's job to monitor the contractor's quality control program. Amazingly enough, most of the large contractors are more particular about monitoring welding quality than are independent laboratories. It is still a good idea to participate in the selection of radiograph locations, watch for switching radiographs, and review the reading of the radiographs with the contractor's QA/QC person. Be aware, too, that tanks erected under Appendix C of AWWA D100 require many more radiographs than do standard tanks.

Tank appearance is possibly the most important item to many owners. It is also a difficult thing for the inspector to be aware of until it is too late, as the final

appearance often isn't known until the tank is painted. It is then that the dents and buckles become apparent and the owner becomes dissatisfied. De~ter~min~ing the compliance with the specifications and the AWWA or other applicable codes and negotiating a settlement for poor appearance is a time consuming and stressful procedure. Usually these problems will be eliminated if the erector checks to see if the tank is level, round, and plumb as it is being built. If the dimensional tolerances in API Standard 650 have been included in the specifications, there will be a "yardstick" to measure these irregularities.

Earlier it was mentioned that good inspection during construction will reduce maintenance costs. Now we are getting into the phase where this starts to pay off. Smoothness of weld contour, elimination of weld undercutting, grinding off of weld spatter, chipping and grinding smooth remains of welds used to attach erection and fit-up equipment, filling in gouged out places in the steel -- all of these items give the tank a good foundation for the proper application of the protective coating system.

Water Testing and Foundation Loading. It is a good practice to water test the tank before painting the tank. Should leaks occur, they can be repaired without having to worry about repairing the paint system too. If the tank is not filled until after painting, there always exists the possibility that small pinholes in the welds may be plugged temporarily with paint, breaking loose later to cause leaks. Water testing before painting also gives the opportunity to check the foundation settlements and make any adjustments in shimming or grouting which might be necessary. As the owner, one should see that this water is available at the time and pressure necessary to coincide with the contractor's schedule.

Field Cleaning and Painting. The elimination of irregularities in the surfaces of the tank should have been done by the erection crew. The erection crew has the equipment and scaffolding to smooth out these defects. The painting crew often is a subcontractor or at least a member of another department of the company. Their rigging is not as stable as the scaffolding of the erection crew, and they cannot perform this cleanup work as economically as the erection crew.

The steel should be free from dirt or oil, both of which get on the steel during construction. All weld seams, abraded areas, scratches, shop or field markings, or poorly adhering shop primer should be removed by abrasive blasting. AWWA D102 gives guidelines for painting. The SSPC: The Society for Protective Coatings' Steel Structures Painting Manual - Volume One - Good Painting Practice and visual standards available from SSPC give a good basis for inspecting painting. The first requirement for good painting is the cleanliness of the surface. The abrasive blasted areas should blend well into the adjoining undisturbed shop primer.

Instrumentation needed for inspecting painting includes surface cleanliness standards, profile measuring equipment, a wet film thickness gauge, a dry film thickness gauge, air temperature and humidity measuring equipment, steel temperature thermometer, and a wet sponge type "holiday" detector. If full time inspection is not conducted, a "Tooke" Gage can be used to evaluate the thickness of each coat and to get an indication of the cleanliness of the surface. The "holiday" detector is for inspecting the interior coating for voids that will cause premature coating failure.

Today's coatings require exactness in measuring and mixing components and thinners, proper selection of application equipment, and the proper combination of humidity and dew point, air temperature, and steel temperature -- not only during application, but during curing too. Proper ventilation of the tank interior is necessary for the safety of workmen and the curing of the coatings. This usually requires the use of forced air movement with fans or air horns. Proper breathing equipment is necessary for the safety of the workmen and the inspector. The tank should be force ventilated for several days after the completion of the painting to assure proper coating cure. The cure should then be verified prior to the filling of the tank.

Mechanical and Electrical Appurtenances. The list of possible items to check will vary with the equipment specified. Does the electrical wiring meet code? Do conduits, fixtures, pipes, valves, or other items interfere with the safety of the ladders or platforms. Are cathodic protection anodes properly placed? Are the cathodic protection hand hole covers in place? Did you witness the running of a potential profile on the submerged surfaces by the cathodic protection supplier? Are all hatches locked? Have the safety belts and sleeves been furnished for the ladder safety devices?

Philosophy of Inspection. As an inspector on the project, it is your duty to see that the job is finished in a timely and quality manner. If an inspector asks, "Do I have the authority to stop the job?", a good response is, "No, your responsibility is to keep the job going in a quality manner." It is the duty of the inspector to combine efforts with the contractor to construct the job in accordance with the specifications and good industry practice. Standing back and throwing rocks at the contractor usually results in a series of games being

played by both sides, with a net result of low quality, a drug out job, and many unhappy people.

Closure. Good quality control on a tank project involves the cooperation of all parties to the contract. A sound knowledge of the specifications, standards, and trade practices allows the owner's inspector to assist the contractor's management in achieving a long-lasting structure of which all can be proud.