KTA-Tator, Inc.

Tank Coatings Evaluation Report

Aqua View No. 2 Water Storage Tank
Soquel Creek Water District

Project No. 230124

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April 21, 2003

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INTRODUCTION

The Soquel Creek Water District (SCWD) contracted with KTA-Tator, Inc. (KTA) to evaluate the condition of the coatings and linings on three steel water storage tanks, piping, and miscellaneous equipment operated by the District. This work was authorized under Purchase Order No. 809. One of the three tanks is the Aqua View Tank No.2 located at the end of Aqua View Drive in La Selva, CA and is the subject of this report. The focus of the survey was to provide recommendations for the most cost-effective means for maintaining the tank coatings and linings and to note any observed safety, structural, or sanitary conditions that require additional review and evaluation by the District.

KTA, a third-party consulting engineering firm specializing in protective coatings, assigned Mr. Patrick C. Sweeney, Project Manager (NACE Certified Inspector No. 4324 and SSPC Certified Protective Coating Specialist) to perform the survey and prepare the report. The field work was coordinated by the District's Mr. Adam White and was completed on Monday, March 31, 2003. The exterior shell observations were made mostly from grade level, while the exterior of the roof was examined close-up. The interior inspection was performed while the tank was drained. The majority of all observations were made from the tank bottom. Mr. Barry Barman, Senior Consultant reviewed the results of the evaluation and collaborated on the preparation of the recommendations.

SUMMARY

The exterior coatings on the Aqua View Water Storage Tank No. 2 are in overall good condition. The interior coatings are in generally poor to good condition. There are no severe corrosion concerns or areas of widespread metal loss occurring on the structure. The exterior lead-based paint system is adequately protecting the tank and should continue to do so for 5-7 years. The interior system should receive maintenance work within the next 2 to 3 years and before any substantial corrosion occurs. It is recommended that all of the coatings on the interior tank surfaces be replaced with an ANSI/NSF 61 approved epoxy system. If funds are available, the exterior should be spot repaired and overcoated to take advantage of a contractor's mobilization and demobilization costs.

In addition to the coatings work, a few appurtenance items were noted that should be addressed. The installation of the following items are recommended and this work should include the addition of a flexible coupling on the inlet/outlet pipe, a screen air-gap on the overflow pipe, a kick-board on the roof railing, and a safety climb pole on the interior ladder.

BACKGROUND

The Aqua View Tank No. 2 is a welded steel above ground structure built by American Bridge in 1977 under Contract No. K9246. The reservoir sits on a concrete ring and is approximately 25 feet in diameter by 18 feet in height providing a nominal capacity of 60,000 gallons. The tank is one of two water storage tanks on the site and is the structure farthest from the access gate.

The tank shell has two courses and a pitched roof that are connected by an upper chine with a drip edge. The tank has an approximate 30-inch center roof vent and two first course manways, which are located 180 degrees from one another. Each manway is 24 inches in diameter and has a bolt hinge cover assembly. The tank has one overflow pipe that is approximately 8 inches in diameter. The pipe exits the tank through the upper course, runs along the side of the tank shell, and goes below grade adjacent to the tank. The pipe does not have a visible screened air-gap. The interior of the overflow pipe turns 90 degrees upward within that tank to an opening that is approximately 12-18 inches below the roof plate. A hood cover protects the top of the overflow opening. There is a target-board and float water level indicator present that appears to operate properly. The common inlet/outlet is approximately 8 inches in diameter and does not have a flexible connection to the tank. The pipe enters through the first course and has a fluted opening that extends approximately four feet into the tank. The roof has a covered flange above the overflow. The roof plates are self-supporting, in that there is no roof support structure (i.e. column or rafters). The tank drain exits through the floor plate.

The tank has anchor bolts along the circumference and these bolts are positioned approximately 80 inches on center from each other. There is one interior and one exterior ladder, each leading to a roof hatch and rail assembly. The galvanized rail assembly has rail turn-back rails and is approximately 42 inch tall with a mid-rail, but does not have a lower toe rail or kick board. The roof rail assembly encloses the hatch and a galvanized grating. Due to the steep pitch in the roof, the lower approximate 38 inches of the railing system along the edge of the roof does not have a rail or protection. Each ladder is 16 inches wide with rungs spaced 12 inches on center. The exterior ladder is galvanized mild steel and is approximately 8 inches from the shell, while the interior ladder is comprised of uncoated stainless steel that is connected to the shell by coated mild steel brackets. Access to the exterior ladder is protected by a hinged vandal deterrent enclosure that extends up the ladder approximately 14 feet above grade. The exterior ladder has a safety-climb fall protection device. The interior ladder does not. Within the roof railing there is a 40-inch hinged hatch. As a point of reference, the hatch is within the northern quadrant of the tank. There is no cathodic protection system installed in this tank.

It is believed that the existing coatings are the tank's original and that no large-scale maintenance painting has taken place. It does however appear as though the upper course has had some extensive patch repairs, while the lower areas may have been recently spot repaired. The interior lining system consists of hot-applied coal-tar enamel on the tank bottom and the first (lowest) shell course up to just below the first and second course weld. A cold-applied coal-tar cut back type product (i.e. "Supertank Solution") to all areas above the hot applied enamel. The exterior roof, shell and appurtenances are painted with what

appears to be an alkyd enamel system.

FIELD EVALUATION

Although structural, sanitary, and safety items are noted for informational purposes, the focus of this survey was to evaluate the current condition of the interior and exterior coating systems. The evaluation involved visual observations, dry film thickness (DFT) measurements, and adhesion testing. Photographs were taken and are included in a Photo Summary. Overall, the coatings were rated using a scale of poor, fair, good, or excellent. Visual observations noted the degree of exterior chalking and any breaks, blisters, or other coating defects. The degree of chalking was determined in general accordance with ASTM D4214 "Standard Test Method for Evaluating the Degree of Chalking of Exterior Paint Films". Areas of rusting were quantified in accordance with ASTM D610 "Standard Test Method for Evaluating the Degree of Rusting of Painted Steel Surfaces". Dry film thickness (DFT) measurements were obtained in general accordance with SSPC: The Society of Protective Coatings' Paint Application Specification No. 2 "Measurement of Dry Film Thickness with Magnetic Gages" and coating adhesion was assessed using ASTM D3359 "Standard Test Method for Evaluating Adhesion by Tape Test", Method A on the exterior. A modified version of ASTM D6677 "Standard for… Evaluating Adhesion by Knife" was used on the interior coatings. Coating samples were obtained for subsequent heavy metal laboratory analysis from various surfaces of the interior and exterior.

Exterior

Close-up visual observation of the exterior coatings was limited to the first (lowest) shell course, upper shell areas adjacent to the ladder, and the roof. Exterior coatings are in overall good condition with moderate chalking (ASTM 4214, Grade 6). Minor spot locations of pinpoint rust were found scattered throughout the shell, bottom chine, various brackets, and roof plates. Many of these areas are the result of thrown rocks or bottles. There are also minor rust areas that are the result of holidays, or missed areas during the tank's original construction. The coating defect areas on the tank shell and roof plate were estimated to be less than 0.01% of the total surface area and rated an 9 (ASTM 610). Considerable organic growth (mostly dark green in color) is present on the roof and shell. Although the roof railing system is galvanized, many of the welded joints of the railing are rusting. The roof vent hood itself is in good condition with only a minor amount of rusting. The vent's mesh screen is tight, secure, and in good condition. The upper chine is comprised of angle iron, which is continuously welded to the roof plate and skip welded to the shell. The exterior of the hatch has stiffeners with rusting between each skip weld. The underside of the anchor bolt connections to the annular bracket has some minor rusting. The galvanized grating of the roof has some rusting along its edges and some painted galvanized piping is peeling. The exterior also some minor patch repairs notably at an area with bare wires that used to connect to a junction box.

The paint's dry film thickness was found to range between 11 and 13 mils on the roof and 10 to 15 mils on the shell. Adhesion on the roof was rated as fair, or 3A and the shell was rated as excellent, or 5A (ASTM D3359). Aside from some minor damage from thrown rocks, there were no signs of vandalism or graffiti on the tank. The coating on the roof and

shell were tested for heavy metal and the results are found below under Laboratory Analysis.

Interior

Close-up visual observations were made on the first shell course, the tank floor, and shell areas adjacent to the interior ladder. The condition of the coating on the underside of the roof and support members is in overall poor to fair condition. The coating on the roof has cracks and breaks which has resulted in some light rusting, minor rust scale, and localized areas of metal loss. The western half of the tank roof plates has the majority of all defects. It has been estimated that up to 33 percent of the roof coating has cracked and is rusting. (ASTM D610, 2). The underside of the center vent hood and the edges of the interior of the vent area is mostly rusting. The roof access hatch has rusting on its lid and along its interior and exterior throat, which does not appear to have ever been painted. Although there is some isolated rust scale, no corrosion pits greater than 1/16 of an inch are suspected to exist on the roof. Film thickness measurements obtained from areas around the roof hatch ranged between 8 and 12 mils. Coating adhesion on the roof was found to be good (ASTM D6677, 3-4) in a none-rusted area (adjacent to the hatch).

The condition of the shell is in overall good condition. The upper course is in good condition and was possibly patch repaired at some point in the past. Many of these spot repaired areas have rusting within their repair. Over the entire surface of the “supertank” lining only twenty rust spots were identified. The upper chine appears to be mostly filled with the supertank, mostly a crevice is present. The first course’s hot-applied coal tar enamel is in good condition with a minor amount of breaks. There were found to be less than approximately 75 rust spots, less than 0.1% (ASTM D610, 8). No scale or pitting was identified on the shell. Lining adhesion on the shell is believed to be good (ASTM D6677, 4). The thickness of lining was found to range between 20 and 27 mils on the second course and greater than 75 mils on the first course.

The majority of the floor is in good to excellent condition. Less than approximately 20 small rust spots were identified in all areas of the floor plates. The floor chine was found to be ion god condition. No deep (greater than 1/16 of an inch) corrosion pits are believed to be present in any part of the tank.

The access manways have minor rusting along some of their edges with significant pitting present. The outer flange on both manways was not coated. As a result, these surfaces that are exposed to the interior water has undercut the adjacent lining. The level of undercutting is considered minor. The manway lid also has some minor undercutting. The ladder is securely attached and the coatings on its mild steel brackets are in fair condition with spot rusting primarily at edges, but the connection points to the stainless ladder itself are showing signs of heavier corrosion at this junction of dissimilar metals. The interior inlet/outlet is in fair to good condition with minor corrosion on its upper surfaces and heavier rust on its underside, which does not appear to have been adequately coated. The floor drain has minor rusting along its entire floor plate connection weld.

LABORATORY ANALYSIS

The six paint chip samples were obtained from the tank and sent to our KTA-Tator, Inc. Laboratory, Pittsburgh, PA for analysis of lead, chromium, and cadmium content. One sample was obtained from the exterior shell, exterior roof, interior roof, interior roof rafter, interior upper shell, interior lower shell, and floor. Laboratory testing was accomplished in accordance with Method AOAC 974.02. This method involves digesting the chips in acid, filtering, and analyzing by atomic absorption spectroscopy. The complete laboratory report has been appended. The results measured in parts per million (ppm) follow:

Sample No.	Sample Location	Lead (ppm)	Chromium (ppm)	Cadmium (ppm)
KTA 10	Exterior Roof	34,800	3260	< 33.3
KTA 11	Exterior Shell	68,800	8190	< 33.3
KTA 12	Interior Roof	486	89	< 33.3
KTA 13	Interior Upper Shell	<184	< 73.4	< 73.3
KTA 14	Interior Lower Shell	< 83.2	< 33.3	< 33.3
KTA 15	Interior Floor	< 83.2	< 33.3	< 33.3

DISCUSSION

The condition of the coatings on the Aqua View Water Storage Tank No. 2 is in overall good condition on the exterior and poor to good condition on the interior. There are no severe corrosion concerns or significant metal loss occurring on the structure, but the upper interior system has clearly reached the end of its useful service life.

In general, the exterior paint was found to have moderate chalking, good adhesion, and minor rust spots. The exterior system was also found to contain very high levels of lead. The majority of the rust spots that are present are the result of mechanical damage. The mechanically damaged coating is primarily the result of various activities that have occurred around the tank throughout its life (i.e. equipment operations, rock throwing, etc.). The exterior shell generally only has negligible rust spots. It was noted that the overflow pipe does not have a screened air gap and that the inlet/outlet piping does not have a flexible connection. It was also noted that the lowest rail of the exterior roof rail assembly is at least 38 inches above the tank roof. This has resulted in a large gap that allows for a fall hazard to exist.

The interior tank linings are in generally poor to fair condition on the roof. Although the coating in this upper vapor space has severely cracked and the underlying steel is rusting, no significant metal loss was observed. The level of coating cracking and subsequent corrosion, primarily within the western half of the tank roof, can be attributed to the constant wetting and drying cycles that naturally occur in this vapor space. The cracking of the coating in this area after nearly 25 years of service for a tank of this size is not uncommon.

The coal-tar cutback coating on the upper shell and the hot-applied coal tar lining on the first course is in good condition with only minor coating breaks. It appears as though at some point in the tank's history coating repairs were made to patches on the upper shell and spots on the lower shell and floor. This has allowed the linings to continue to provide satisfactory performance. Despite these repairs the lining has some other spots that are rusting –nearly 100 in total.

The interior lining system on the roof and lower shell appears to have reached the end of its useful service life. This coal tar system typically provides some 30+ years of life with periodic spot maintenance touch-up coating activities. However, it does not appear that any significant maintenance activities (notably on the roof) have taken place as demonstrated by its current condition. As the coating continues to deteriorate the underlying steel will corrode, develop pitting, and eventually result in structural concerns.

There is heavy rust at the interior ladder connection brackets that can be attributed to holidays in the coating and to the difference in galvanic potentials of the ladder's two dissimilar "directly connected" metals. The ladder's rungs and rails are stainless steel, while the ladder's brackets are fabricated of mild steel. Essentially, the corrosion on the mild steel brackets is being accelerated by this direct connection. It was also noted that no safety climb protection is present on the interior ladder and that the ladder's stainless steel rungs are very smooth and presents a clear fall hazard.

Generally speaking, any maintenance painting project can include three different operations: spot repairs, spot repairs followed by a full overcoat, or complete removal and replacement. In evaluating the condition of a coating to determine the best painting approach there are a number of different factors to consider.

The first set of factors includes the determination of the coating's ability to withstand the added stress of an additional coat(s). Attributes impacting this decision include film thickness and adhesion. If the coating is too thick or has poor adhesion, the tension from the curing stresses and/or weight of the additional paint can cause the existing system to disbond.

The second set of factors to consider when determining what painting approach to take is the amount of surface area requiring repair, the overall difficulty in providing access (rigging) to the structure, and whether the coating system contains heavy metals (i.e. lead, chromium). The final factor is the condition of the substrate. When considering whether a spot repair approach is a viable option, a good rule of thumb is that up to 10 percent of the surface area requiring repair is the point at which making spot repairs with overcoat becomes a diminishing return. With 10 percent rusting, overcoating may be an option if the adhesion is fair to good. If there is more than 10 percent rusting and the substrate is free of mill scale, overcoating may be considered an option provided the adhesion is good. Once the percentage of surface area requiring repairs is much in excess of 10%, the cost of cleaning and coating the spots approaches (or exceeds) the total cost of removal and replacement.

The paint film on the exterior of this structure was found to have satisfactory thickness and good adhesion throughout all surfaces. The exterior coating should continue to adequately protect the tank for many years to come. If aesthetics are *not* a concern, then the exterior paint should be reevaluated in 5-7 years. However, if aesthetics are a concern then it would be prudent to repair the exterior surfaces under the same contract as the interior rework to take full advantage of a contractor's costs for mobilizing and demobilizing. Since the coating has only minor coating breaks and it has been found to have high levels of lead, the exterior surfaces should be spot repaired and overcoated. This should be done with power tool cleaning equipment, which must include *at least* vacuum shrouded attachments to contain the lead/chromium bearing paint debris/dust. Proper abatement controls must be put in place to assure that the contractor's workers and surrounding environment are protected. Any spot repairs should be made with a high-solids low-shrinkage material that will not cause undue stress to the adjacent overlapped existing coating system.

KTA understands that the District has had a policy in the past of requiring full containment for any exterior coatings work, including overcoating work. If this continues to be the policy, there is even more of an argument to take advantage of the cost of mobilization and demobilization and remove and replace the entire exterior system. An epoxy/urethane coating system is recommended if total removal and recoating is selected as an alternative maintenance plan.

Although the current interior condition of the tank will not significantly worsen over the next few years, it would be prudent to repair the interior roof system within the next 2 to 3 years. Since the tank is relatively small and the linings below the roof are nearing the end of their life, they too should be replaced when the roof coatings work is done to take advantage of a one-time mobilization and demobilization cost. The maintenance plan at that time should call for the removal and replacement of all linings with an NSF/ANSI 61 epoxy system. The roof plate was found to have very low levels of lead (486 PPM). It is believed that this low level will not significantly impact the total cost of interior work. The tank will act as its own containment and the abrasive blasting operations will likely dilute the level of lead in the spent abrasive media to a non-hazardous level. However the contractor should be required to acknowledge the presence of any interior heavy metals and address these concerns in their bids.

Regarding other structural observations, a few items were noted that should be addressed before or during the next maintenance painting work. A flexible coupling should be installed on the inlet/outlet pipe to avoid a break during a seismic event. A screen air-gap should be installed on the over flow pipe to avoid any backflow problems. A kick-board or toe rail should be added to the roof railing to prevent a fall from this mostly open area. A safety climb pole should be installed on the interior ladder, which should also be abrasive blasted and coated two coats of epoxy. The will reduce the likelihood of a fall and accelerated corrosion concerns regarding dissimilar metals.

RECOMMENDED WORK

1. Exterior - Spot Repair and Overcoat

Within the next 5 to 7 years spot repair and overcoat the exterior system. This work should include:

1) Power water wash all exterior coatings using a solution of trisodium-phosphate (TSP) and rinse with fresh water using 3500 psi in accordance with "Surface Preparation of Steel…by High and Ultrahigh-Pressure Water Jetting Prior to Recoating," (SSPC-SP12). Care should be made to assure that all organic growth is removed from areas to painted.

2) Remove defective coatings in accordance with Steel Structure Painting Council's "Powertool Cleaning to Bare Metal," (SSPC SP-11). Special care should be made to feather the edges of all repairs a minimum of 3 inches in each direction. Engineering controls should be used to assure that the lead-bearing film is contained and that the hazardous waste is properly disposed.

2) Apply an epoxy prime coat to all bare metal areas to a film thickness of 3-5 mils. Overcoat, all prepared surfaces with a urethane finish coat of 2-3 mils. Prior to any coatings work a small test patch should be used to test the above system to assure that the existing alkyd system will not be adversely effected by the new coatings.

1.A Alternative Exterior Coating Approach – Remove and Replace

As an alternative to the spot repair and overcoat approach and to take advantage of the costs of possibly installing containment, all exterior surfaces could be removed and replaced. This alternative approach should include the following plan:

1) Abrasive blast-clean all exterior surfaces in accordance with "Commercial Blast Cleaning" (SSPC-SP6). Engineering controls should be used to assure that the lead-bearing film is contained and that the hazardous waste is properly disposed.

2) Apply an epoxy prime coat to all prepared areas to a film thickness of 3-5 mils. Overcoat, all primed surfaces with a urethane finish coat of 2-3 mils.

2. Interior - Remove and Replace all Linings

Within the next 2-3 years all of the linings should be removed and replaced. This work should include:

1) Abrasive blast cleaning all interior surfaces, including the interior ladder, to a "Near White Metal Blast Cleaning" (SSPC-SP10).

2) Apply three coats of an ANSI/NSF 61 polyamide epoxy each at 4-6 mils for a total minimum dry film thickness of 15 mils to all bare metal areas in accordance with the manufacturer's recommendations.

3. Miscellaneous

The District should consider the following mechanical work to be completed prior to or during the above coatings work:

A) Install a flexible connection at the inlet/outlet
B) Modify the overflow pipe to include a screened air-gap
C) Install a galvanized safety climb to the interior ladder
D) Modify the existing roof rail system to include a kick rail

ESTIMATED COSTS

1. Exterior - Spot Repair and Overcoat
   $5,500 to $7,750 (2003 dollars)

   1A. Alternative Exterior Coating Approach – Remove and Replace
   $20,000 to $25,000 (2003 dollars)

2. Interior - Remove and Replace Linings
   $19,500 to $25,000

3. Miscellaneous
   A) Flexible Connection - $5000
   B) Modify Overflow - $2500
   C) Safety Climb - $500
   D) Install Kick Rail - $500

time, materials, and/or samples afforded.