STATE OF NEW YORK
EXECUTIVE DEPARTMENT - OFFICE OF GENERAL SERVICES
DESIGN AND CONSTRUCTION GROUP - DIVISION OF DESIGN

PROFESSIONAL CONSULTATION REPORT

Project No. S0560 July 30, 2004
Study of Water Service Corrosion
Five Points Correctional Facility
Star Route 96, Caller Box 400
Romulus, NY 14541

EXECUTIVE SUMMARY

An inspection of the internal water distribution system of building #12 at Five Points Correctional facility was conducted on May 5th 2004 to review the acute corrosion problem in the internal water distribution system. Subsequent to the inspection, water samples were collected and analyzed from the distribution systems in three buildings at the facility and additional sections of pipe were disconnected and inspected to determine the degree and extent of the corrosion problem. As expected, the degree of corrosion observed in Building #12 is consistent throughout the facility.

When constructed, dissimilar metals were utilized in the water distribution networks in each building, with ductile iron pipe being utilized in conjunction with galvanized, 'Victaulic' pipe and copper pipe. From the water samples collected on June 10, 2004, a copper corrosion problem is occurring whereupon dissolved copper is being deposited on the galvanized fittings and pipe. This is most pronounced in the hot water distribution systems where the higher temperature water accelerates the corrosion of the copper lines. The existing grounding system employed at the facility may also be contributing to the problem as well as the use of chloramines for disinfection by the Village of Waterloo.

It is recommended to immediately initiate a three-step program to control and mitigate the corrosion problem. First, a chemical injection system should be designed and installed at the facility to inject a blended ortho-polyphosphate agent into the water as it leaves the water storage tank. The ortho-polyphosphate will coat the interior of the water lines and provide a protective film against any further corrosion of the copper lines. Over time the compound will wear away the collected tubercules and will ultimately remove a considerable portion of the collected material. Secondly, a study should be initiated to review the electrical grounding system within the facility to determine if this is contributing to the corrosion problem. The study will similarly review the high conductivity levels. Third, an internal inspection of the plumbing system should be conducted to determine if additional dielectric couplings should be installed on certain areas within the piping network or if certain sections of the piping network or components should be replaced with an alternative type of pipe to reduce or eliminate the problems resulting from the dissimilar metals utilized in the distribution systems.

PROJECT INTENT

Five Points Correctional Facility is experiencing a serious on-going corrosion problem within the internal water distribution network. The intent of this project is to assess the degree and extent of the corrosion problem, to determine the probable cause(s) for the corrosion, and to provide recommended solutions to abate the problem.

FIELD SURVEY / FINDINGS

An inspection of the internal piping network of the Five Points Correctional Facility was conducted on May 5th, 2004 by Justin Sievers and Warren Longacker of the NYS Office of General Services (OGS) and Mr. Lindsey Sowards, Plant Utilities Engineer for Five Points. The inspection was conducted in response to concerns with numerous corrosion problems being encountered within the facility. Plumbing work conducted last fall on a 'Victualic' fitting on the hot water return loop in the mechanical room of Housing Unit Building #12 revealed an excessive accumulation of tubercules on the interior of the pipe walls. Similar problems have also been encountered at other locations within the facility. A butterfly valve in the mechanical room of Building #5 and the galvanized hot water mixing valves located throughout the facility have also been fouled by corrosion. During the May inspection a thorough review of the piping network was made within the mechanical room and also within the attic space of Building #12. The victualic fitting in Building #12 was again opened and, according to facility staff, the accumulation of material within the pipe had increased significantly over the course of the past few months.

The facility was constructed during the late 90's. During the design phase, different piping materials were specified for use within the water distribution systems of each facility building. As water first enters each building it is first conveyed through ductile iron (DI) pipe, then through galvanized, 'Victaulic' pipe, which later is connected to copper pipe. As observed during the inspection of Building #12, a combination of copper and galvanized pipe was also installed on both the hot and cold water systems within not only the mechanical room but also in the attic area. The piping material converts from one material to the other for specified lengths and fittings at different locations within each building. Dielectric couplings were presumably utilized throughout the facility to minimize or eliminate potential corrosion problems from occurring, however, with the piping insulation in place a detailed inspection of the fittings could not be conducted.

To further evaluate the problem, water samples were collected by facility staff on 6/10/04 and transmitted to Adelaide Associates, Binghamton, N.Y., for analysis. Samples were collected at various locations throughout the facility on both the hot and cold water lines and analyzed for a specific list of inorganic parameters to determine the degree of corrosivity of the potable water. The list included analysis for lead, copper, iron, manganese, hardness, Langlier's Index, conductivity, total dissolved solids, pH, and temperature. Separate samples were also collected for fluoride and chloramine residuals. The sample results are listed below. In addition, other sections of pipe were to be disconnected and inspected by facility staff to visually determine the degree and extent of corrosion at different areas within the correctional facility. As expected the degree of corrosion in Building #8 and the Administration Building was very similar to that observed in Building #12 with the greatest degree of corrosion occurring on the hot water recirculation loop.

ANALYTICAL RESULTS
FIVE POINTS CORRECTIONAL FACILITY
JUNE 10, 2004

Perameter	Method	Units	Admin. Bldg. Cold	Admin. Bldg. Hot	Bldg. #8 Cold	Bldg. #8 Hot	Bldg. #12 Cold	Bldg. #12 Hot	Elev. Water Tank
Alkalinity	SM403	mg/l	90	92	90	92	92	90	90
Calcium Hardness	SM	“	97.2	95.4	95.8	94.6	95.4	96.3	94.8
Conductivity	EPA 120.1	umhos/cm	590	569	560	580	585	580	595
Copper	SW846-6010	mg/l	0.213	0.786	0.157	0.528	0.455	0.674	0.026
Iron	“	“	0.028	0.014	0.041	0.037	0.051	0.025	0.692
Manganese	“	“	Not Detected	Not Detected	Not Detected	0.006	Not Detected	0.009	Not Detected
Lead	“	“	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	0.016
Hardness Total	SM 314B	mg/l (CaCo3)	140	138	138	137	138	139	137
Langlier’s Index	SM	“	-0.30 moderate	0.24 non-aggresive	-0.28 moderate	0.31 non-aggresive	-0.27 moderate	0.19 non-aggresive	-0.20
PH	EPA 150.1	units	7.70	7.80	7.76	7.87	7.74	7.81	7.82
Total Dissolved Solids	EPA 160.1	mg/l	350	348	339	337	310	358	353
Temperature	“	ºF	60	110	58	108	58	106	58
Chloramines	Cholorimeter	mg/l	2.55	1.05	3.13	1.21	2.81	0.77	3.05

The potable water for the facility is supplied from the Village of Waterloo’s water treatment plant located near the north end of Seneca Lake. According to Mr. Jim Bromka, the Waterloo treatment plant operator, the water leaving the facility is fairly neutral with a Langlier’s Index just slightly below zero. Other than chloramines, utilized for disinfection, no other chemicals are added to the water and no inhibitors are added for corrosion control. The water is then conveyed through

approximately seven miles of ductile iron pipe where it flows by gravity to a clearwell at the Seneca Army Depot. At a pump station located in Building #2411 on the army base, the Town of Romulus fluoridates the water and discharges the treated water to a one million gallon storage tank. Separate pumps direct a portion of the water to the elevated water storage tank at Five Points.

Although the water leaving the Waterloo plant is almost neutral, the addition of both chloramines and fluoride can cause the pH to drop slightly resulting in water that becomes somewhat more corrosive. From the analytical results of the water samples collected at the facility the Langlier's Index reported from the sample at the elevated storage tank was –0.20. In all subsequent cold water samples taken from the Administration Building, Building #8 and Building #12, the water was slightly more corrosive with Langlier's Index levels of -0.30, -0.225, and –0.27 respectively but in each case the water would still be classified as only slightly to moderately corrosive. As Langlier's Index is temperature dependent, the levels recorded for each of the hot water samples were actually all positive, ranging from +0.19 to +0.31. Water with a positive Langlier's Index would typically be considered non-corrosive. However, the copper levels in both the hot and cold water samples collected within the facility were all dramatically higher than those in the incoming water. The copper level in the elevated water storage tank as the water enters the Five Points facility was measured at 0.026 mg/l. In the three cold water samples collected at the Administration Building, Building #8 and Building #12, the measured copper levels were 0.157 mg/l, 0.213 mg/l, and 0.455 mg/l respectively, while the increases recorded in the hot water samples were even more dramatic with measured copper levels of 0.786 mg/l, 0.528 mg/l and 0.674 mg/l respectively. Each of the distribution samples was taken at a distant location within each building to maximize the contact time between the water and the piping material. Regardless of the positive Langlier's index readings on the hot water samples, these results would indicate that corrosion of the copper lines is most definitely occurring.

Scrapings of the tubercules found within the fitting on the hot water return loop in the mechanical room in Building #12 were also informally analyzed. Only a very small percentage of the collected material adhered to a magnet passed over the tubercules, indicating that the majority of the material is non-ferrous. From visual observations the material is most likely a combination of copper and zinc but with a greater concentration of copper. A more detailed analysis of this material will be conducted.

The results from all other parameters tested for are basically identical with the exception of the results for iron. Minor but consistent reductions were noted in the level of iron from the cold water to the hot water samples in all cases and a significant reduction was observed between the higher iron level measured in the storage tank and the lower readings within the facility buildings. This would further indicate that the DI lines are not being affected by corrosion.

CONCLUSIONS

A number of factors are undoubtedly contributing to the on-going corrosion problems at the facility. These can include water quality, dissimilar piping materials, and/or stray electrical current. The leading cause of the corrosion at Five Points is most likely the result of the dissimilar piping materials used throughout the internal water distribution systems, specifically the hot water systems in each of the facility buildings. Galvanic corrosion in re-circulating hot water systems with combined copper and galvanized steel piping corrosion can be very pronounced and some dissolution of the copper piping may and will occur. This is clearly evident at Five Points from the June 10 sample results where the copper levels in each building were dramatically higher in the hot water system than in the cold water lines. The free copper then in solution will absorb or react with the galvanized steel pipe and may result in rapid pitting and tuberculation of the unprotected steel pipe. The failing galvanized hot water mixing valves and plugged 'Victualic' fitting on the hot water return loop in Building #12 are clear indications of this problem.

In addition to the dissimilar metals, the corrosion problem may also be attributed to the basic water quality of the potable water supplied to the facility. The sample results indicated high levels of both total dissolved solids and conductivity. A higher conductivity increases the water's ability to complete an electrochemical circuit and to conduct a corrosive current. Accordingly, even if dielectric couplings were utilized throughout the facility corrosion of the dissimilar piping materials can still occur. Possibly stray electrical current resulting from buildings grounding system or possibly from the adjacent Loran communication tower may be contributing to the corrosion problem at Five Points. As indicated previously, the raw water supply feeding the Village of Waterloo plant is Seneca Lake. The alkalinity and hardness levels measured with the water samples are relatively low indicating that the water itself is generally soft and slightly corrosive. Further, the residual chloramine levels recorded throughout the facility are in the order of 2.55 to 3.13 mg/l in the cold water lines. Although not as corrosive as free chlorine, chloramines are extremely aggressive toward copper pipe especially at higher temperatures.

RECOMMENDATIONS

Given the increased copper levels found within the hot water re-circulation loop and the degree of tuberculation that is occurring within some of the internal pipe fitting and mixing valves, it is essential to initiate corrective actions and install corrective measures as soon as possible. It is recommended to initiate a three-step program to address the problem. First, it is recommended to initiate the design of a chemical feed system to inject a blended ortho-polyphosphate agent into the water immediately after the elevated water storage tower on corrections property. The blended zinc ortho-polyphosphate compound or a similar product, will coat the interior of the water lines and will prevent any further corrosion from occurring. Over time the compound will wear down the accumulate tubercules and will ultimately remove a considerable amount of material collected on the interior of the galvanized lines. Accordingly, flushing of certain sections of the distribution system may be initially required. After the system is in operation for a period of six months, a second round of water samples will be collected and again analyzed for the same parameters to determine how well the treatment process is performing. As there are innumerable corrosion inhibitors, if the initial compound is not working as required an alternative could be utilized. Secondly, a through review of the electrical grounding system within the facility is required to determine if the piping network is grounded and if that in itself is contributing to the problem. This study should also be expanded to determine if the to the high conductivity levels found in the water is also contributing. Based upon these inspections, modifications to the grounding system may be required. As a third step, an internal inspection of the plumbing system should be conducted to determine if additional dielectric couplings should be installed in certain areas within the piping network or if certain sections of the piping network or components should be replaced with an alternative type of pipe. This may be required in certain areas to reduce or eliminate the problems resulting from the dissimilar metals utilized in the distribution systems.

<u>Building 12</u> 4”x 1 ½”Vitualic fitting (all four above pictures)

Building # 1 Cold Water Supply

Building #8 1 ½ " Domestic Hot Water Return

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