Appendix G
Brinderson Corporation and Emtec Corporation Letters

B.13.c / T.129.A

330 A

In Reply
Refer to: 836

Engineering and Research Center
Denver Federal Center Bldg. 67
Denver, Colorado 80225

November 13, 1987

BRINDERSON CORPORATION
YUMA DESALTING PLANT
Project Office
P.O. Box 6509
Yuma, Arizona 85364
(602) 782-4701

Attention: Fritz Sattler

Subject: Specs. 4-SI-30-02520/DC-7610 -- Yuma Desalting Plant, Pretreatment Completion and Desalting Building, Desalting Complex Unit, Arizona, Title I Division, Colorado River Basin Salinity Control Project

Reference: Aluminum Bronze Pipe

Gentlemen:

Reference is made to our previous conversations concerning the subject of acceptance criteria for the welded aluminum bronze pipe we have installed on the above project.

As we have discussed, the only acceptance criteria for the field welded aluminum bronze pipe set forth in the specifications is the requirement for hydrostatic testing in paragraph 14.4.1 (c) of Division 14.

Of course the aluminum bronze pipe has also been visually inspected and approved for shipment by your inspectors at the fabricators as well as in the field for structural soundness.

We are now in the process of hydrostatic testing the east section of the clearwell manifold per our understanding. We will continue to work towards meeting your structural, visual and hydrostatic testing acceptance criteria.

Very Truly Yours
BRINDERSON CORPORATION

Ron Smith
Contract Manager

RS/sc

Enclosures
cc: O-1
John Barry (jobsite)
Tom O'Brian (Corp)

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Rocky Mountain Engineering and Materials Technology, Inc.

April 21, 1988

Harry Uyeda, D-1521
Bureau of Reclamation
P. O. Box 25007
Bldg. 56, Room 2340
Denver, CO 80225

TEST REPORT

File Number 802106

Rocky Mountain EMTEC was asked by Harry Uyeda to provide consulting services on welding procedures and quality of aluminum-bronze weld joints used in the USBR desalination plant at Yuma, Arizona.

An on-site inspection trip to the plant site was made on March 2 and 3, 1988. Fred Schwartzberg, of EMTEC, was accompanied on this trip by Harry Uyeda and John Walp, of USBR.

We inspected the 30 and 72 inch diameter piping from the interior. The visual quality of the longitudinal factory welds varied from poor to good. Some welds appeared to have incomplete penetration. The circumferential welds also varied from poor to good. Some areas had been rewelded where incomplete penetration had been found after initial proof testing. The flow of the weld metal in the repairs was of poor quality, as seen in Figure 1.

The welds in the 72-inch diameter pipe have a rust colored corrosion deposit. Samples of the deposits were removed for subsequent laboratory testing. No evidence of surface recession was found.

A circumferential weld in an 18-inch diameter pipe had broken through a weld close to its intersection with a 30-inch diameter section. The beveled section of the 18-inch joint revealed incomplete fusion near the inside of the pipe.

Short sections of pipe removed from the facility are stored in a "boneyard" for future use. Some of the longitudinal welds in these pipes showed incomplete penetration. A circumferential weld showed about 50 percent penetration, as seen in Figure 2.

Samples of two diameters of weld wire were taken for chemical analysis to confirm adherence to the specified composition.

Several sections of pipe from the "boneyard" were marked for sectioning and laboratory analysis. However, it was later learned that the contractor refused to release any of these samples for laboratory testing.

Several small samples of weldments previously obtained by Mr. Uyeda were provided to Rocky Mountain EMTEC for metallographic examination. No information was provided to permit identification of location of these samples in the system. One sample contained a longitudinal weld. The other sample was one half of a circumferential weld.

The longitudinal weld was cross-sectioned and macroetched. As seen in Figure 3, the weld appears to have incomplete penetration.

A metallographic section taken close to the macroetched area shows that the defect seen adjacent to the inside of the pipe is actually a lack of fusion defect, rather than an incomplete penetration, Figures 4 and 5.

Another piece of the same weld was broken open. The weld defect in this area is 0.10-inch deep, or 40 percent of the 1/4-inch wall thickness. Figure 6 is a photograph in which the depth of the defect can be seen.

The circumferential weld was found to have a combination of porosity, incomplete penetration and lack of fusion. Grinding marks present on a beveled surface, Figure 7, are indicative of lack of fusion and low depth of penetration. Figures 8 and 9 are additional photographs in which the weld defects can be seen.

Metallographic sections were made through two areas of the circumferential weld. Both show lack of fusion to the bevel surface. Figures 10 and 11 are views of one section at different magnifications. Figures 12 and 13 are similar photographs of the other section.

Chemical analysis of the welding wire confirmed that both samples satisfied the nominal composition of the specified RCuAl-A2 grade.

Element	Composition, wt percent		
	Large Diameter	Small Diameter	Specification
Iron	1.09	1.10	1.5 max
Aluminum	9.44	9.33	9.0-11.0

The corrosion deposit contains 2.23 weight percent iron. This level of iron is consistent with the expected weld metal resulting from dilution of the 3.5 percent iron base metal by the 1 percent iron weld metal.

Rocky Mountain EMTEC concludes that some of the factory produced longitudinal welds and some of the circumferential field welds have grossly inadequate penetration and/or fusion. It is impossible to determine the severity of the potential problem without additional inspection and laboratory analysis.

The rust colored appearance of the corrosion depsoits found at the welded joints are indicative of the presence of iron in the aluminum-bronze alloy. No evidence of surface recession was found beneath the deposits. The corrosion process produces deposits which are orders of magnitude greater than the depth of the corrosive attack. Therefore, no decrease in the life expectation of the system is predicted.

The best technique for determining where the bad welds are located is to proof test the system well above operating pressures. This technique should be used to qualify all sections of pipe, even those intended for low pressure service.

Reported by:

Fred R. Schwartzberg
Rocky Mountain EMTEC

Figure 1 Surface Appearance of Repaired Circumferential Weld

Figure 2 Lack of Penetration in Circumferential Weld

Figure 3 Apparent Lack of Penetration in Longitudinal Weld

Figure 4 Incomplete Penetration in Longitudinal Weld

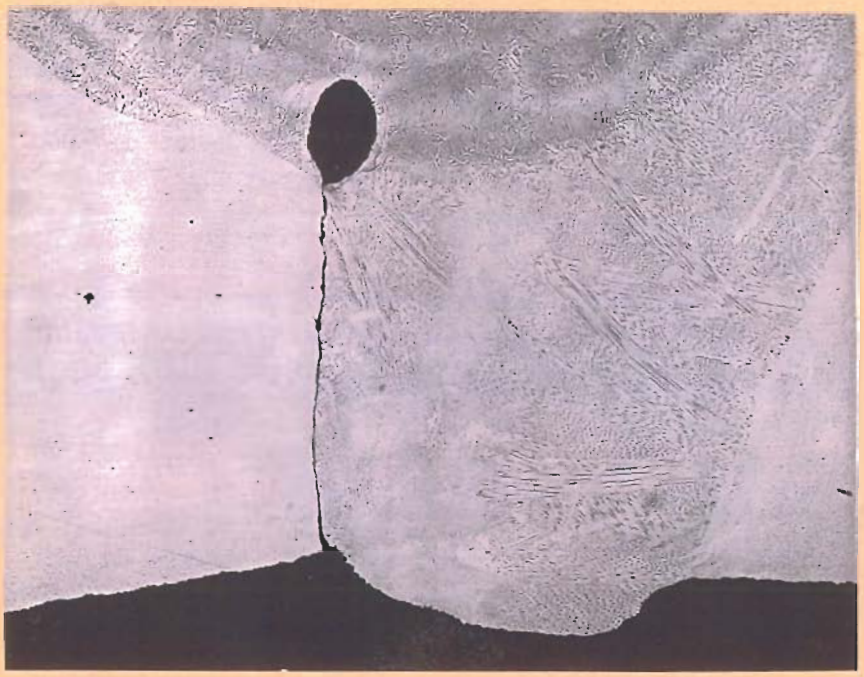

Figure 5 Close-up View of Incomplete Penetration, 25X

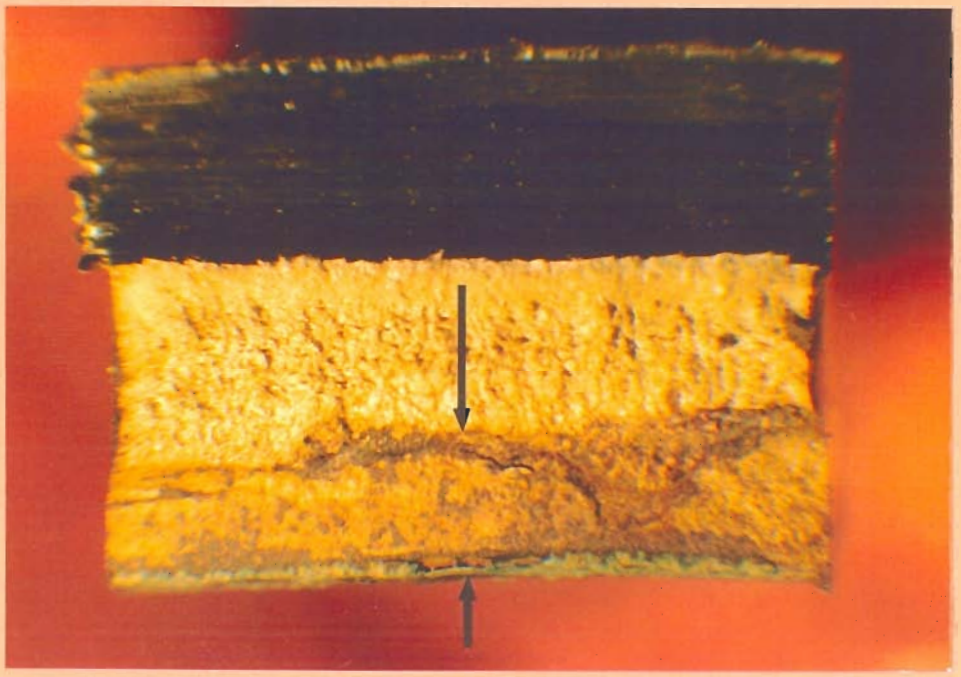

Figure 6 Depth of Defect in Longitudinal Weld, Arrows

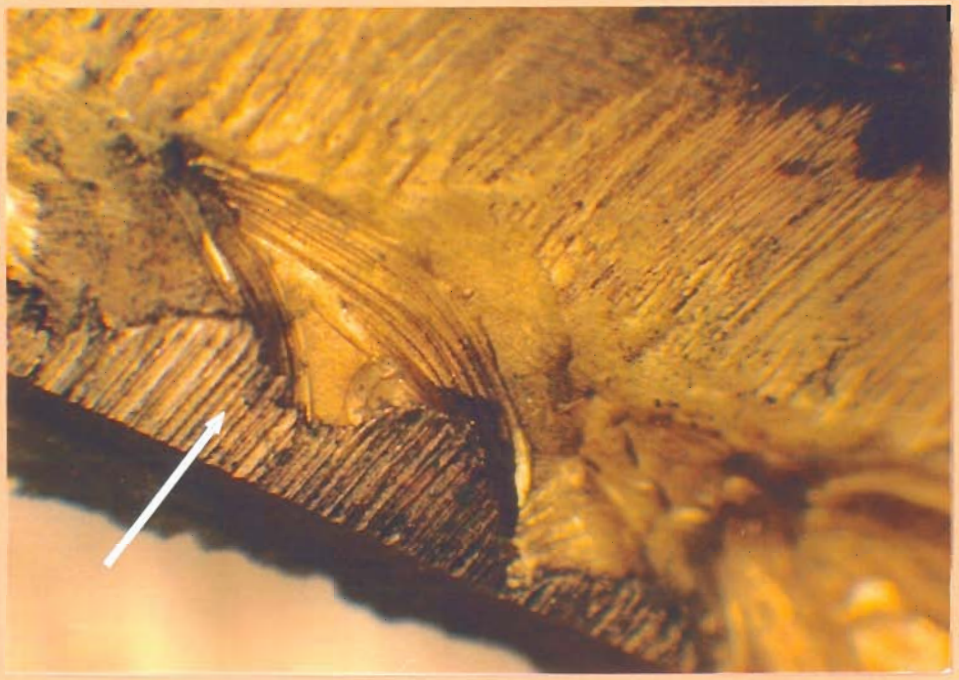

Figure 7 Grinding Marks Remaining on Bevel Surface of Circumferential Weld

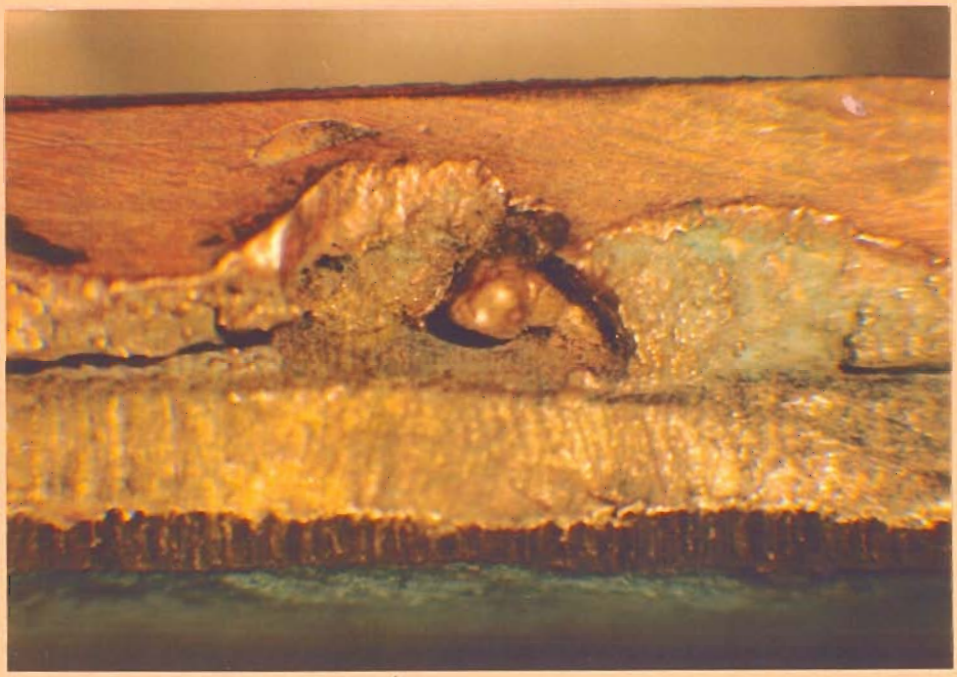

Figure 8 Close-up of Defects in Circumferential Weld

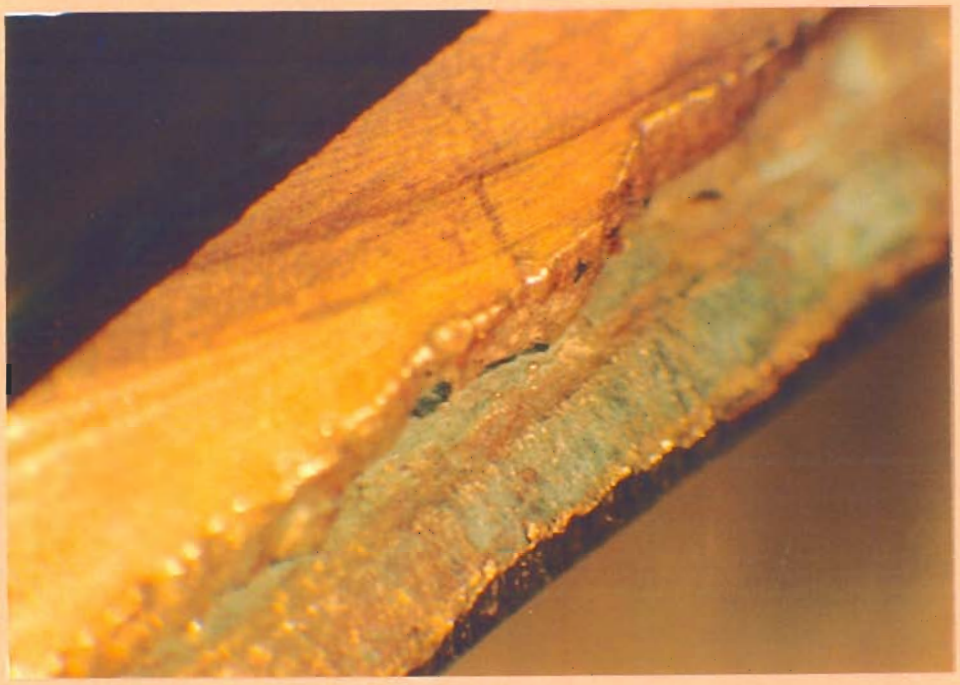

Figure 9 Another View of Incomplete Fusion in Circumferential Weld

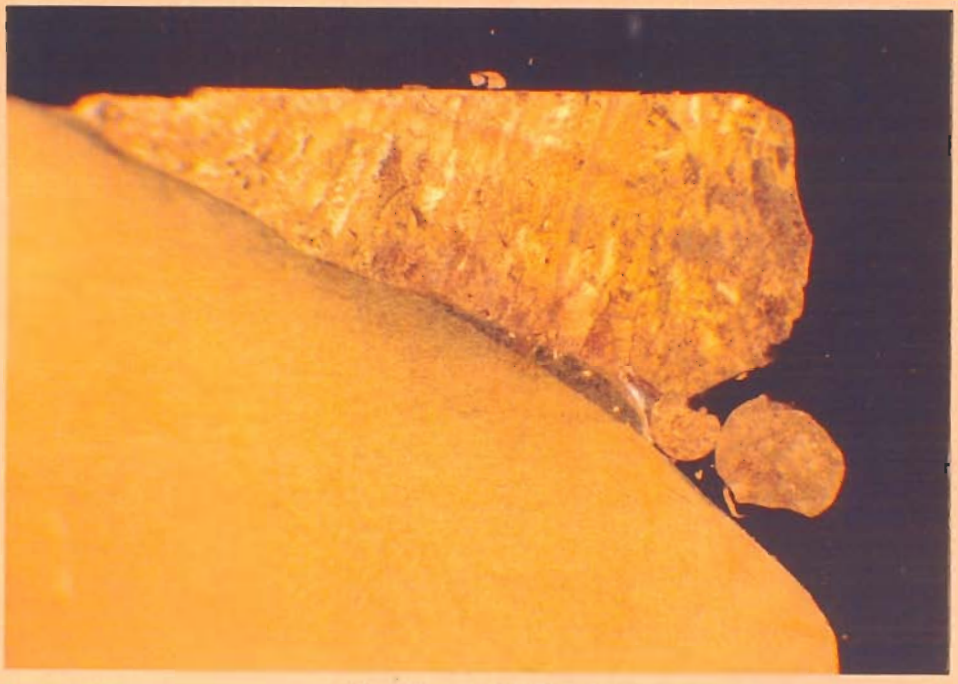

Figure 10 Cross Sectional View of Incomplete Penetration in Circumferential Weld

Figure 11 Close-up View of Previous Defect, 25X

Figure 12 Another Cross Sectional View of Incomplete Penetration in Circumferential Weld

Figure 13 Close-up View of Previous Defect, 25X

Appendix H
Test Results for Individual Pipe Sections

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Test Results for Individual Pipe Sections

CH-01

CH-01 is a 30″ diameter pipe and is part of the Hydranautics feed from the Pump Manifold to the De-Salting Building (DSB). It is located outside, above ground, just east of the DSB. It is specified to have a 3/8″ wall thickness.

The ultrasonic thickness testing revealed that all points met the specified thickness criteria.

Two circumferential and one longitudinal radiographs were taken. One of the circumferential radiographs failed due to lack of fusion. The other two radiographs met the quality requirements.

CH-02

CH-02 is an 18″ diameter pipe and is part of the Fluid Systems feed between pump number 14 and the Pump Manifold. It is located outside, above ground, just east of the DSB. It is specified to have a 7/16″ wall thickness.

The ultrasonic thickness testing revealed that all but two point met the specified thickness criteria. The two points that failed were not consecutive and failed by less than 0.001″.

One longitudinal radiograph was taken. It failed due to incomplete penetration and porosity.

CH-03

CH-03 is a 24″ diameter pipe and is part of the Fluid Systems feed between pump number 4 and the Pump Manifold. It is located outside, above ground, just east of the DSB. It is specified to have a 3/8″ wall thickness.

The ultrasonic thickness testing revealed that no points met the specified thickness criteria. The measured thickness, on average, was about 0.04″ less than acceptable.

One longitudinal radiograph was taken. It failed due to lack of fusion and porosity.

CH-04

CH-04 is a 48″ diameter pipe and is part of the Fluid Systems feed between the Pump Manifold and the DSB. It is located, outside, above ground, just east of the DSB. It is specified to have a 3/4″ wall thickness.

The ultrasonic thickness testing revealed that all points tested met the specified thickness criteria.

Two circumferential and one longitudinal radiographs were taken. The two circumferential radiographs failed due to porosity. The longitudinal radiograph met the quality requirements.

CH-05

CH-05 is a 12″ diameter cast pipe and is part of both the Fluid Systems and Hydranautics feed between pump number 4 and the Pump Manifold. It is located outside, above ground, just east of the DSB. It is specified to have a 5/16″ wall thickness.

The ultrasonic thickness testing revealed that all points are thicker than specified by about 0.06″. Based on this, it is assumed that a pipe was used with a thicker wall than specified.

One circumferential radiograph was taken. It failed due to lack of fusion and porosity.

CH-06

CH-06 is an 18″ diameter pipe that is part of the Hydranautics feed between pump number 2 and the Pump Manifold. It is located outside, above ground, just east of the DSB. It is specified to have a 7/16″ wall thickness.

The ultrasonic thickness testing revealed that all points met the specified thickness criteria.

One circumferential and one longitudinal radiographs were taken. The circumferential radiograph failed due to incomplete penetration and porosity. The longitudinal radiograph failed due to porosity.

CH-07

CH-07 is an 18″ diameter pipe that is part of the Hydranautics feed between pump number 15 and the Pump Manifold. It is located outside, above ground, just east of the DSB. It is specified to have a 7/16″ wall thickness.

The ultrasonic thickness testing revealed that all points met the specified thickness criteria. The testing done on one band was thicker than specified by about 0.14″. Based on this it is assumed that pipe was used that was thicker than specified.

Two circumferential and one longitudinal radiographs were taken. One circumferential and one longitudinal radiograph failed due to incomplete penetration and porosity. The other circumferential radiograph failed due to incomplete penetration and lack of fusion.

CH-08

CH-08 is an 18″ diameter pipe that is part of the Fluid Systems feed between pump number 9 and the Pump Manifold. It is located outside, above ground, just east of the DSB. It is specified to have a 7/16″ wall thickness.

The ultrasonic thickness testing revealed that all points on one band met the specified thickness criteria while all points on the other band failed by about 0.025″. Both bands are on the same segment of pipe.

One longitudinal radiograph was taken. It failed due to lack of fusion.

CH-09

CH-09 is an 18″ diameter pipe that is part of the Hydranautics 1st stage reject, 2nd stage feed in the Hydranautics trench. It is located inside the DSB. It is specified to have a 5/16″ wall thickness.

The ultrasonic thickness testing revealed that all but three points met the specified thickness criteria. The three points that failed were about 0.005″ less than acceptable.

One circumferential and one longitudinal radiographs were taken. Both failed due to incomplete penetration.

CH-10

CH-10 is a 30″ diameter pipe that is part of the Fluid Systems 1st stage reject, 2nd stage feed in Fluid Systems trench 1. It is located inside the DSB. It is specified to have a 7/16″ wall thickness.

No ultrasonic thickness testing was performed on this section of pipe.

Two circumferential and one longitudinal radiographs were taken. One circumferential radiograph failed due to incomplete penetration. The other circumferential radiograph failed due to incomplete penetration and porosity. The longitudinal radiograph failed due to porosity.

CH-11

CH-11 is a 30″ diameter pipe that is part of the Fluid Systems interstage to energy recovery in the collection trench between Fluid Systems trench 1 and 2. It is located inside the DSB. It is specified to have a 7/16″ wall thickness.

The ultrasonic thickness testing revealed that no points met the specified thickness criteria. The measured thickness, on average, was about 0.005″ less than acceptable.

Two circumferential and one longitudinal radiographs were taken. Both circumferential radiographs failed due to incomplete penetration and porosity. The longitudinal radiograph failed due to lack of fusion and porosity.

CH-12

CH-12 is a 16″ diameter pipe that is part of the Fluid Systems low pressure reject in the collection trench between Fluid Systems trench 1 and 2. It is located inside the DSB. It is specified to have a 1/4″ wall thickness.

The ultrasonic thickness testing revealed that all points met the specified thickness criteria.

One circumferential and one longitudinal radiographs were taken. The circumferential radiograph failed due to incomplete penetration and porosity. The longitudinal radiograph failed due to lack of fusion, incomplete penetration and porosity.

CH-14

CH-14 is a 30″ diameter pipe that is part of the Fluid Systems 1st stage feed, 2nd stage reject in Fluid Systems trench 1. It is located inside the DSB. It is specified to have a 7/16″ wall thickness.

The ultrasonic thickness testing revealed that all points met the specified thickness criteria.

No radiographs were taken for this pipe segment.

CH-15

CH-15 is a 30″ diameter pipe that is part of the Fluid Systems 1st stage feed, 2nd stage reject in Fluid Systems trench 2. It is located inside the DSB. It is specified to have a 7/16″ wall thickness.

The ultrasonic thickness testing revealed that all but one point met the specified thickness criteria. The one point that failed was about 0.0015″ less than acceptable.

One circumferential radiograph was taken. It failed due to incomplete penetration and porosity.

CH-16

CH-16 is a 30″ diameter pipe that is part of the Hydranautics feed in the Pump Manifold between pump numbers 9 and 10. It is located outside, above ground, just east of the DSB. It is specified to have a 7/16″ wall thickness.

The ultrasonic thickness testing revealed that all but four points failed the specified thickness criteria. The measured thickness, on average, was about 0.005″ less than acceptable.

No radiographs were taken for this pipe segment.

CH-17

CH-17 is a 30″ diameter pipe that is part of the Hydranautics feed manifold. It is located inside the DSB. It is specified to have a 7/16″ wall thickness.

The ultrasonic thickness testing revealed that no points met the specified thickness requirement. The measured thickness, on average, was about 0.02″ less than acceptable.

Two circumferential radiographs were taken. Both failed due to lack of fusion and porosity.

CH-18

CH-18 is a 30″ diameter pipe that is part of the Hydranautics feed manifold. It is located inside the DSB. It is specified to have a 7/16″ wall thickness.

The ultrasonic thickness testing revealed that all points met the specified thickness requirement. The measured thickness for one band was, on average, about 0.17″ greater than specified. Based on this, it is assumed that a pipe was used that was thicker than specified.

Six circumferential and one longitudinal radiographs were taken. All failed due to porosity. One circumferential radiograph also failed due to a crack and incomplete penetration and the four other circumferential radiographs also failed due to lack of fusion.

CH-19

CH-19 is a 30″ diameter pipe that is part of the Hydranautics feed manifold in the Hydranautics trench. It is located inside the DSB. It is specified to have a 7/16″ wall thickness.

The ultrasonic thickness testing revealed that no points met the specified thickness requirement. The measured thickness was, on average, about 0.01" less than acceptable.

Two circumferential and one longitudinal radiographs were taken. One circumferential radiograph failed due to lack of fusion, incomplete penetration, and porosity. The other failed due to lack of fusion. The longitudinal radiograph failed due to lack of fusion and porosity.

The interior of the pipeline was inspected after two flexible couplings were removed and the pipe was temporarily displaced. It appeared to have stood partially filled with water for some time, because a water line was evident on the sides of the pipe. Blue-green mounds of corrosion products were present, below the water line, on the circumferential welds and the longitudinal welds. The pipe wall had a few pits at the water line, and the deepest was 30 mils. When the corrosion products were removed from the welds, pits and reddish coloration indicative of dealloying were observed. These pits were 40 to 60 mils in depth.

A repair weld was discovered on the bottom of the pipe, directly above one of the pipe stands, on the longitudinal weld. A mass of aluminum bronze from the repair weld was evident inside the pipe. The mass was covered with blue-green corrosion products. When the corrosion products were removed, the mass had a reddish color but was so irregular that we could not determine if pitting was present.

CH-20

CH-20 is a 16" diameter pipe that is part of the Hydranautics 1st stage feed, 2nd stage reject in the Hydranautics trench. It is located inside the DSB. It is specified to have a 1/4" wall thickness.

The ultrasonic thickness testing revealed that all points met the specified thickness criteria.

One circumferential and one longitudinal radiograph were taken. The circumferential radiograph failed due to incomplete penetration. The longitudinal radiograph failed due to incomplete penetration and porosity.

CH-21

CH-21 is a 24" diameter pipe that is part of the Fluid Systems 1st stage feed, 2nd stage reject in the Fluid Systems trench 1. It is located inside the DSB. It is specified to have a 3/8" wall thickness.

The ultrasonic thickness testing revealed that all points met the specified thickness criteria.

No radiographs were taken for this pipe segment.

CH-22

CH-22 is a 24" diameter pipe that is part of the Fluid Systems 1st stage feed, 2nd stage reject in the Fluid Systems trench 2. It is located inside the DSB. It is specified to have a 3/8" wall thickness.

The ultrasonic thickness testing revealed that all points met the specified thickness criteria.

Two circumferential and one longitudinal radiographs were taken. All three failed due to incomplete penetration and porosity.

CH-23

CH-23 is a 36″ diameter pipe that is part of the Fluid Systems feed manifold between Fluid Systems trenches 1 and 2. It is located inside the DSB. It is specified to have a 9/16″ wall thickness.

The ultrasonic thickness testing revealed that all but one point met the specified thickness criteria. The one point that failed was about 0.0005″ less than acceptable.

Two circumferential and one longitudinal radiographs were taken. One circumferential radiograph failed due to lack of fusion, incomplete penetration, and porosity. The other failed due to lack of fusion. The longitudinal radiograph failed due to a linear indication on the base metal surface.

CH-24

CH-24 is a 36″ diameter pipe that is part of the Fluid Systems 1st stage feed, 2nd stage reject in the Fluid Systems trench 1. It is located inside the DSB. It is specified to have a 9/16″ wall thickness.

The ultrasonic thickness testing revealed that all points met the specified thickness criteria.

Two circumferential and one longitudinal radiographs were taken. The two circumferential radiographs failed due to incomplete penetration and porosity. The longitudinal radiograph failed due to porosity.

CH-25

CH-25 is a 36″ diameter pipe that is part of the Fluid Systems 1st stage feed, 2nd stage reject in the Fluid Systems trench 2. It is located inside the DSB. It is specified to have a 9/16″ wall thickness.

The ultrasonic thickness testing revealed that all points met the specified thickness criteria.

One circumferential radiograph was taken. It failed due to incomplete penetration and porosity.

CH-26

CH-26 is a 48″ diameter pipe that is part of the Fluid Systems feed in the Pump Manifold between pump numbers 9 and 10. It is located outside, above ground, just east of the DSB. It is specified to have a 3/4″ wall thickness.

The ultrasonic thickness testing revealed that no points met the specified thickness criteria. The measured thickness, on average, was about 0.0375″ less than acceptable on one side of the expansion joint and 0.01″ less than acceptable on the other.

No radiographs were taken for this pipe segment.

CH-27

CH-27 is a 48″ diameter pipe that is part of the Fluid Systems feed manifold between the Hydranautics trench and Fluid Systems trench 1. It is located inside the DSB. It is specified to have a 3/4″ wall thickness.

The ultrasonic thickness testing revealed that all but four points met the specified thickness criteria. The four points were about 0.006″ less than acceptable.

Two circumferential and one longitudinal radiographs were taken. One circumferential radiograph failed due to incomplete penetration, porosity, and had an inclusion. The other failed due to incomplete penetration and porosity. The longitudinal radiograph met the quality requirements.

CH-28

CH-28 is an 18″diameter pipe and a 24″ to 18″ diameter reducer that is part of the Fluid Systems 1st stage feed, 2nd stage reject in the Fluid Systems trench 1. It is located inside the DSB. The 18″ diameter pipe is specified to have a 5/16″ wall thickness while the reducer is specified to have a 3/8″ wall thickness.

The ultrasonic thickness testing revealed that all points met the specified thickness criteria.

Four circumferential and three longitudinal radiographs were taken. Two circumferential radiographs failed due to lack of fusion, incomplete penetration, and porosity. The other two failed due to lack of fusion and porosity. The three longitudinal radiographs failed due to incomplete penetration and porosity.

CH-29

CH-29 is a 12″ diameter cast pipe that is part of the Hydranautics 1st stage reject, 2nd stage feed in the Hydranautics trench. It is located inside the DSB. It is specified to have a 1/4″ wall thickness.

The ultrasonic thickness testing revealed that all points met the specified thickness criteria. The measured thickness was, on average, about 0.15″ greater than specified. Based on this, it is assumed that a pipe was used that was thicker than specified.

One circumferential radiograph was taken. It failed due to porosity.

CH-31

CH-31 is a 30″ diameter pipe that is part of the Fluid Systems reject to energy recovery just west of the clearwells. It is located outside, above ground, just east of the DSB. It is specified to have a 3/8″ wall thickness.

The ultrasonic thickness testing revealed that all points met the specified thickness criteria. The measured thickness was, on average, about 0.025″ greater than specified. Based on this, it is assumed that a pipe was used that was thicker than specified.

Two circumferential and one longitudinal radiographs were taken. One circumferential radiograph met the quality requirements and the other failed due to incomplete penetration. The longitudinal radiograph failed due to lack of fusion and porosity.

CH-32

CH-32 is a 30" diameter pipe that is part of the Fluid Systems reject to energy recovery just west of the clearwells. It is located outside, below ground, just east of the DSB. It is specified to have a 3/8" wall thickness.

The ultrasonic thickness testing revealed that all points met the specified thickness criteria. Ten of the twenty four test points were thicker than specified by about 0.003". The reason for the greater thickness is unknown.

Two circumferential and two longitudinal radiographs were taken. One circumferential radiograph met the quality requirements, the other failed due to lack of fusion. One longitudinal radiograph failed due to incomplete penetration, the other failed due to incomplete penetration and porosity.

CH-33

CH-33 is a 16" diameter pipe that is part of the Hydranautics reject to energy recovery just west of the clearwells. It is located outside, below ground, just east of the DSB. It is specified to have a 1/4" wall thickness.

The ultrasonic thickness testing revealed that all points met the specified thickness criteria.

One circumferential and one longitudinal radiographs were taken. The circumferential radiograph failed due to porosity and the longitudinal radiograph failed due to incomplete penetration.

CH-33B

CH-33B is a 16" diameter pipe that is part of the Hydranautics reject to energy recovery just west of the clearwells. It is located outside, above ground, just east of the DSB. It is specified to have a 1/4" wall thickness.

The ultrasonic thickness testing revealed that all points met the specified thickness criteria.

One circumferential and one longitudinal radiographs were taken. The circumferential radiograph failed due to lack of fusion, incomplete penetration, and porosity and the longitudinal radiograph failed due to lack of fusion.

CH-37

CH-42 is a 72" diameter header pipe at the Intake Pumping Plant and is buried and encased in concrete. The pipe and dished head were specified to have 5/16"minimum wall thickness.

The ultrasonic thickness testing revealed that all points met the specified thickness criteria. The thickness of the pipe was, on average, about 0.016" greater than specified minimum which suggests that 3/8" (0.375") plate was used. The dished head had an average thickness of 0.400" which also exceeded the minimum required thickness.

All circumferential welds in this pipeline had cracks visible to the unaided eye, and therefore failed the quality requirement. The longitudinal welds had some areas of light

corrosion but no visible evidence of weld flaws. Radiography was not feasible because the pipe is buried and encased in concrete.

CH-38

CH-38 is a 42″ diameter pipe that is part of the product line in between Fluid System trenches 1 and 2. It is located inside the DSB. It is specified to have a 1/4″ wall thickness.

The ultrasonic thickness testing revealed that all points met the specified thickness criteria. All but three points were thicker than specified by about 0.006″.

Two circumferential and one longitudinal radiographs were taken. The circumferential radiographs both failed due to incomplete penetration and porosity. The longitudinal radiograph failed due to lack of fusion.

CH-39A

CH-39A is a 54″ diameter pipe inside of Solids Contact Reactor (SCR) valve drop box 3 located just south of SCR 3. It is specified to have 1/4″ wall thickness.

The ultrasonic thickness testing revealed that all points met the specified thickness criteria.

Four longitudinal radiographs were taken. Two met the quality requirements. One failed due to lack of fusion and the last one failed due to incomplete penetration and porosity.

CH-39B

CH-39B is a 54″ diameter pipe inside the filter building that is connected to CH-39A. It consists of a mitered 90-degree upward bend and is partially encased in concrete where it passes through the wall of the filter building and the floor of the inlet channel above it. The pipe is specified to have 1/4″ wall thickness.

Ultrasonic thickness testing was not performed for this section of pipe except to confirm that it was 1/4″ wall. The other end of the pipeline was CH-39A which was tested and met the specified thickness criteria.

Four circumferential radiographs were taken. All four failed due to cracks, lack of fusion, incomplete penetration, and porosity. Visual examination showed that prior repairs had been made on the welded mitered joints of this pipe. Some joints had Wek-o-Seals, others had interior overlays of 1/4″ by 4″ aluminum bronze plate fillet-welded to the base metal.

CH-40

CH-40 is a 3.5″ diameter cast pipe that is part of the Fluid Systems low pressure reject between Fluid Systems control block 37 and 38 in the Fluid Systems trench 1. It is specified to have 1/4″ wall thickness.

The ultrasonic thickness testing revealed that all points met the specified thickness criteria. The measured thickness was, on average, about 0.125″ greater than specified. Based on this it is assumed that plate was used that was thicker than specified.

Two circumferential radiographs were taken. One met the quality requirements. The other failed due to porosity.

CH-41

CH-41 is a 3.5″ diameter cast pipe that is part of the Fluid Systems low pressure reject connected to Fluid Systems control block 69 in the Fluid Systems trench 2. It is specified to have a 1/4″ wall thickness.

The ultrasonic thickness testing revealed that all points met the specified thickness criteria. The measured thickness was, on average, about 0.14″ greater than specified. Based on this it is assumed that pipe was used that was thicker than specified.

One circumferential radiograph was taken. It failed due to lack of fusion.

CH-42

CH-42 is a 30″ diameter pipe connected to pump 4 in the Intake Pumping Plant. It is located above ground, northeast of the DSB. It is specified to have a 1/4″ wall thickness.

The ultrasonic thickness testing revealed that all points met the specified thickness criteria. One of the bands was, on average, about 0.016″ greater than specified. Based on this it is assumed that, for this band, pipe was used that was thicker than specified.

Four circumferential and two longitudinal radiographs were taken. One of the circumferential and one of the longitudinal radiographs met the quality requirements. Two circumferential radiographs failed due to incomplete penetration and porosity. The other circumferential radiograph failed due to a crack and incomplete penetration. The other longitudinal radiograph failed due to incomplete penetration.

CH-43

CH-43 is a 30″ diameter pipe in the vault just north of SCR 3. It is specified to have a 1/4″ wall thickness.

The ultrasonic thickness testing revealed that all points met the specified thickness criteria.

One longitudinal radiograph was taken. It failed due to incomplete penetration and porosity.

CH-44

CH-44 is a 24″ diameter pipe that is part of the Fluid Systems product line in the Fluid Systems trench 2. It is located inside the DSB. It is specified to have a 1/4″ wall thickness.

The ultrasonic thickness testing revealed that all points met the specified thickness criteria.

Two longitudinal radiographs were taken. Both failed due to lack of fusion.

CH-45

CH-45 is a 14″ diameter wrought pipe, a 14″ to 10″ diameter wrought reducer, and a 10″ diameter cast pipe that is part of the Hydranautics product line in the Hydranautics trench. It is located in the DSB. All portions are specified to have a 1/4″ wall thickness.

The ultrasonic thickness testing was done only on the 14″ diameter section and revealed that all points met the specified thickness criteria.

Three circumferential radiographs were taken on the cast portion. One failed due to a crack. One failed due to lack of fusion and the last one failed due to incomplete penetration.

The interior of the 14″ pipe was examined at the point where a 10″ vertical tee was present. The 10″ pipe had a blind cover held in place with a Victaulic coupling. The blind was temporarily removed for access. Inspection showed that corrosion was minor, although corrosion products were relatively thick on some parts of the circumferential welds.

The interior of the horizontal 10″pipe was examined after removal of the valve at the end of the pipe. Inspection showed that the pipe was crusted with deposits, and corrosion products were evident at the circumferential welds.

CH-46A

CH-46A is an 8″ diameter cast pipe that is part of the Hydranautics product line in the Hydranautics trench. It is located inside the DSB. It is specified to have a 1/4″ wall thickness.

The ultrasonic thickness testing revealed that all points met the specified thickness criteria. The measured thickness was, on average, about 0.15″ greater than specified. Based on this it is assumed that pipe was used that was thicker than specified.

One circumferential radiograph was taken. It failed due to incomplete penetration.

CH-46B

CH-46B is a 10″ diameter tee that is part of the Hydranautics product line in the Hydranautics trench. It is located inside the DSB. It is specified to have a 5/16″ wall thickness.

The ultrasonic thickness testing revealed that no points met the specified thickness criteria. The measured thickness was, on average, about 0.027″ less than acceptable.

Two radiographs were taken. They both failed due to porosity.

CH-47

CH-47 is a 30″ to 24″ diameter reducer and 24″ diameter pipe that is part of the Fluid Systems product line in Fluid Systems trench 1. It is located inside the DSB. It is specified to have a 1/4″ wall thickness.

The ultrasonic thickness testing was done on the 24″ diameter pipe and revealed that all points met the specified thickness criteria. All but three points were thicker than specified. It is not obvious that a thicker than specified pipe was used.

Three circumferential and two longitudinal radiographs were taken of the reducer. All three circumferential radiographs failed due to lack of fusion, incomplete penetration, and porosity. Two of them also had cracks. Both longitudinal radiographs failed due to incomplete penetration. One also failed due to porosity.

CH-48

CH-48 is an 18″ to 14″ diameter reducer, and short sections of pipe on either side, that is part of the Hydranautics 1st stage reject, 2nd stage feed in the Hydranautics trench. It is

located inside the DSB. The 18″ diameter pipe and the reducer are specified to have a 5/16″ wall thickness. The 14″ diameter pipe is specified to have a 1/4″ wall thickness.

The ultrasonic thickness testing revealed that all points on the 14″ diameter pipe met the specified thickness criteria while no points on the 18″ diameter pipe met the specified thickness criteria. It is unknown which data points are for which pipe diameter, but all points are thicker than 1/4″ and less than 5/16″.

Two circumferential and one longitudinal radiographs were taken of the reducer. All failed due to incomplete penetration. The longitudinal radiograph also failed due to porosity. One circumferential radiograph also failed due to porosity and lack of fill.

CH-49

CH-49 is a 30″ diameter pipe that is part of the Hydranautics product line in the Hydranautics trench. It is located inside the DSB. It is specified to have a 1/4″ wall thickness.

The ultrasonic thickness testing revealed that all points met the specified thickness criteria.

Two circumferential and two longitudinal radiographs were taken. One circumferential and one longitudinal radiograph failed due to incomplete penetration. The other circumferential radiograph failed due to lack of fusion. The other longitudinal radiograph met the quality requirements.

CH-50

CH-50 is a 16″ diameter pipe that is part of the Hydranautics low pressure reject in the Hydranautics trench. It is located inside the DSB. It is specified to have 1/4″ wall thickness.

The ultrasonic thickness testing revealed that all points met the specified thickness criteria.

One circumferential and one longitudinal radiographs were taken. Both failed due to incomplete penetration and porosity.

This pipe section was temporarily removed for inspection of the interior. Inspection showed very shallow corrosion pitting at and below the water line, which was near the centerline of the pipe. No pitting or defects were observed on the weld, which had a slight reddish tint. An adjacent 3″ cast pipe was also observed on the interior and had no evidence of corrosion on the metal surface; the casting marks were still visible on the surface of the metal.

CH-51

CH-51 is a 54″ diameter pipe that is part of the product line in the collection trench near Fluid Systems trench 2. It is located inside the DSB. It is specified to have a 1/4″ wall thickness.

The ultrasonic thickness testing revealed that all points met the specified thickness criteria. Both bands were on the same piece of pipe yet one band had greater thickness values than the other.

Two circumferential and one longitudinal radiographs were taken. The longitudinal and one circumferential radiographs failed due to lack of fusion. The other circumferential radiograph failed due to incomplete penetration and porosity.

It was planned to enter and examine this section of pipeline by entering it from the air break just outside the DSB. However, the air break piping was found full of silt and the pipe was inaccessible. This section of pipeline will be entered and examined after the silt has been removed.

CH-52

CH-52 is a 36″ diameter pipe that is part of Fluid Systems product line in the Fluid Systems trench 2. It is located inside the DSB. It is specified to have a 1/4″ wall thickness.

The ultrasonic thickness testing revealed that all points met the specified thickness criteria. The measured thickness was, on average, about 0.017″ greater than specified. Based on this it is assumed that pipe was used that was thicker than specified.

Two circumferential and one longitudinal radiographs were taken. One circumferential radiograph met the quality requirements. The other failed due to a crack and lack of fusion. The longitudinal radiograph failed due to lack of fusion.

CH-53

CH-53 is a 20″ diameter pipe and a 24″ to 20″ reducer that is part of the Fluid Systems 1st stage reject, 2nd stage feed in the Fluid Systems trench 2. It is located inside the DSB. The 20″ diameter pipe is specified to have a 5/16″ wall thickness.

The ultrasonic thickness testing was done on the 20″ diameter pipe and revealed that all points met the specified thickness criteria.

One circumferential and one longitudinal radiographs were taken. The circumferential radiograph failed due to lack of fusion and incomplete penetration. The longitudinal radiograph failed due to incomplete penetration and porosity.

CH-54

CH-54 is a 30″ diameter pipe that is part of the Hydranautics product line in the collection trench. It is located inside the DSB. It is specified to have a 1/4″ wall thickness.

The ultrasonic thickness testing revealed that all points met the specified thickness criteria.

Two circumferential and one longitudinal radiographs were taken. All failed due to lack of fusion, incomplete penetration, and porosity.

CH-55

CH-55 is a 30″ diameter pipe that is part of the Fluid Systems reject to energy recovery in the collection trench. It is located inside the DSB. It is specified to have a 7/16″ wall thickness.

The ultrasonic thickness testing revealed that all but two points met the specified thickness criteria. The two points were about 0.004″ less than acceptable.

Two circumferential and one longitudinal radiographs were taken. All failed due to incomplete penetration and porosity.

CH-56

CH-56 is a 16" diameter pipe that is part of the Fluid Systems low pressure reject in the collection trench. It is located inside the DSB. It is specified to have a 1/4" wall thickness.

The ultrasonic thickness testing revealed that all points met the specified thickness criteria.

One circumferential and one longitudinal radiographs were taken. Both failed due to lack of fusion, incomplete penetration, and porosity.

CH-57

CH-57 is a 30" diameter pipe connected to pump 2 in the Intake Pumping Plant. It is located above ground, northeast of the DSB. It is specified to have a 1/4" wall thickness.

No ultrasonic thickness testing was performed for this section of pipe, because the thickness of a parallel pipe was measured (see CH-42).

Two circumferential and one longitudinal radiographs were taken. Both circumferential radiographs failed due to incomplete penetration and porosity. The longitudinal radiograph met the quality requirements.

Appendix I
Table 341.3.2 Acceptance Criteria for Welds and Examination Methods for Evaluating Weld Imperfections

Table 341.3.2 Acceptance Criteria for Welds and Examination Methods for Evaluating Weld Imperfections

Criteria (A to M) for Types of Welds and for Service Conditions [Note (1)]											Examination Methods			
Normal and Category M Fluid Service			Severe Cyclic Conditions			Category D Fluid Service								
Type of Weld			Type of Weld			Type of Weld								
Girth, Miter Groove & Branch Connection [Note (4)]	Longitudinal Groove [Note (2)]	Fillet [Note (3)]	Girth, Miter Groove & Branch Connection [Note (4)]	Longitudinal Groove [Note (2)]	Fillet [Note (3)]	Girth and Miter Groove	Longitudinal Groove [Note (2)]	Fillet [Note (3)]	Branch Connection [Note (4)]	Weld Imperfection	Visual	Radiography	Magnetic Particle	Liquid Penetrant
A	A	A	A	A	A	A	A	A	A	Crack	✓	✓	✓	✓
A	A	A	A	A	A	C	A	N/A	A	Lack of fusion	✓	✓	...	...
B	A	N/A	A	A	N/A	C	A	N/A	B	Incomplete penetration	✓	✓	...	...
E	E	N/A	D	D	N/A	N/A	N/A	N/A	N/A	Internal porosity	...	✓	...	...
G	G	N/A	F	F	N/A	N/A	N/A	N/A	N/A	Internal slag inclusion, tungsten inclusion, or elongated indication	...	✓	...	...
H	A	H	A	A	A	I	A	H	H	Undercutting	...	✓	...	...
A	A	A	A	A	A	A	A	A	A	Surface porosity or exposed slag inclusion [Note (5)]	✓	...	...	...
N/A	N/A	N/A	J	J	J	N/A	N/A	N/A	N/A	Surface finish	✓	...	...	...
K	K	N/A	K	K	N/A	K	K	N/A	K	Concave root surface (suck up)	✓	✓	...	...
L	L	L	L	L	L	M	M	M	M	Weld reinforcement or internal protrusion	✓	...	...	...

GENERAL NOTES:

(a) Weld imperfections are evaluated by one or more of the types of examination methods given, as specified in paras. 341.4.1, 341.4.2, 341.4.3, and M341.4, or by the engineering design.

(b) "N/A" indicates the Code does not establish acceptance criteria or does not require evaluation of this kind of imperfection for this type of weld.

(c) Check (✓) indicates examination method generally used for evaluating this kind of weld imperfection.

(d) Ellipsis (. . .) indicates examination method not generally used for evaluating this kind of weld imperfection.

Criterion Value Notes for Table 341.3.2

Symbol	Criterion Measure	Acceptable Value Limits [Note (6)]
A	Extent of imperfection	Zero (no evident imperfection)
B	Depth of incomplete penetration	≤ 1 mm (1/32 in.) and ≤ $0.2\overline{T}_w$
	Cumulative length of incomplete penetration	≤ 38 mm (1.5 in.) in any 150 mm (6 in.) weld length
C	Depth of lack of fusion and incomplete penetration	≤ $0.2\overline{T}_w$
	Cumulative length of lack of fusion and incomplete penetration [Note (7)]	≤ 38 mm (1.5 in.) in any 150 mm (6 in.) weld length
D	Size and distribution of internal porosity	See BPV Code, Section VIII, Division 1, Appendix 4
E	Size and distribution of internal porosity	For $\overline{T}_w$ ≤ 6 mm (1/4 in.), limit is same as D For $\overline{T}_w$ > 6 mm (1/4 in.), limit is 1.5 × D
F	Slag inclusion, tungsten inclusion, or elongated indication	
	Individual length	≤ $\overline{T}_w/3$
	Individual width	≤ 2.5 mm (3/32 in.) and ≤ $\overline{T}_w/3$
	Cumulative length	≤ $\overline{T}_w$ in any $12\overline{T}_w$ weld length
G	Slag inclusion, tungsten inclusion, or elongated indication	
	Individual length	≤ $2\overline{T}_w$
	Individual width	≤ 3 mm (1/8 in.) and ≤ $\overline{T}_w/2$
	Cumulative length	≤ $4\overline{T}_w$ in any 150 mm (6 in.) weld length
H	Depth of undercut	≤ 1 mm (1/32 in.) and ≤ $\overline{T}_w/4$
I	Depth of undercut	≤ 1.5 mm (1/16 in.) and ≤ [$\overline{T}_w/4$ or 1 mm (1/32 in.)]
J	Surface roughness	≤ 500 min. *Ra* per ASME B46.1
K	Depth of root surface concavity	Total joint thickness, incl. weld reinf., ≥ $\overline{T}_w$
L	Height of reinforcement or internal protrusion [Note (8)] in any plane through the weld shall be within limits of the applicable height value in the tabulation at right, except as provided in Note (9). Weld metal shall merge smoothly into the component surfaces.	For $\overline{T}_w$, mm (in.) → Height, mm (in.) ≤ 6 (1/4) → ≤ 1.5 (1/16) > 6 (1/4), ≤ 13 (1/2) → ≤ 3 (1/8) > 13 (1/2), ≤ 25 (1) → ≤ 4 (5/32) > 25 (1) → ≤ 5 (3/16)
M	Height of reinforcement or internal protrusion [Note (8)] as described in L. Note (9) does not apply.	Limit is twice the value applicable for L above

Notes follow on next page

Table 341.3.2 Acceptance Criteria for Welds and Examination Methods for Evaluating Weld Imperfections (Cont'd)

NOTES:

(1) Criteria given are for required examination. More stringent criteria may be specified in the engineering design. See also paras. 341.5 and 341.5.3.

(2) Longitudinal groove weld includes straight and spiral seam. Criteria are not intended to apply to welds made in accordance with a standard listed in Table A-1 or Table 326.1. Alternative Leak Test requires examination of these welds; see para. 345.9.

(3) Fillet weld includes socket and seal welds, and attachment welds for slip-on flanges, branch reinforcement, and supports.

(4) Branch connection weld includes pressure containing welds in branches and fabricated laps.

(5) These imperfections are evaluated only for welds ≤ 5 mm ($^3/_{16}$ in.) in nominal thickness.

(6) Where two limiting values are separated by "and," the lesser of the values determines acceptance. Where two sets of values are separated by "or," the larger value is acceptable. T_w is the nominal wall thickness of the thinner of two components joined by a butt weld.

(7) Tightly butted unfused root faces are unacceptable.

(8) For groove welds, height is the lesser of the measurements made from the surfaces of the adjacent components; both reinforcement and internal protrusion are permitted in a weld. For fillet welds, height is measured from the theoretical throat, Fig. 328.5.2A; internal protrusion does not apply.

(9) For welds in aluminum alloy only, internal protrusion shall not exceed the following values:
   (a) for thickness ≤ 2 mm ($^5/_{64}$ in.): 1.5 mm ($^1/_{16}$ in.);
   (b) for thickness > 2 mm and ≤ 6 mm ($^1/_4$ in.): 2.5 mm ($^3/_{32}$ in.).
   For external reinforcement and for greater thicknesses, see the tabulation for Symbol L.

Appendix J
ASME B31.3 Mathcad Calculations

Description

Yuma Desalting Plant Straight Pipe, Tees and Mitered Bends

Define Units

References

Input Table is same as Excel Table attached to Rod's 9/26/05 E-mail...17 columns & 33 rows

	1	2	3	4	5
1	0	0	0	0	0
2	"Nominal Diameter"	"Specified Diameter"	"Indicated OD"	"Indicated Wall"	"Decimal Wall"
3	0	0	0	0	0
4	2	"2-7/8 OD"	2.875	0.188	0.188
5	3	"3-1/2 OD"	3.5	0.25	0.25
6	4	"4-1/2 OD"	4.5	0.188	0.188
7	6	"6-5/8 OD"	6.625	0.25	0.25
8	8	"8-5/8 OD"	8.625	0.25	0.25
9	10	"10-3/4 OD"	10.75	0.25	0.25
10	12	"12-3/4 OD"	12.75	0.25	0.25
11	12	"12-3/4 OD"	12.75	0.313	0.313
12	14	"14 OD"	14	0.25	0.25
13	16	"16 OD"	16	0.25	0.25
14	18	"18 OD"	18	0.25	0.25
15	18	"18 OD"	18	0.313	0.313
16	18	"18 OD"	18	0.438	0.438
17	20	"20 OD"	20	0.25	0.25

Derivations

Straight Pipe Stress Derivation

General Input

$Y := .4$ Table 304.1.1 Values of Coefficients Y for $t < \frac{D}{6}$.....other ductile metals

$W := 1.0$ Weld joint strength reduction factor for elevated temperatures

$c = \text{varies}$ corrosion allowance

$E = \text{varies}$ Pipe Quality Factor per Table A-1A or A-1B

References

Straight Pipe Calculations

Undertolerance
Published Wall
Overtolerance

$n = 1.00$

No Corrosion Allowance
1/16" Corrosion Allowance
1/8" Corrosion Allowance

$nn = 1.00$ $c := \begin{pmatrix} 0 \\ \frac{1}{16} \\ \frac{1}{8} \end{pmatrix}_{nn} \cdot \text{in}$ $c = 0.00\,\text{in}$

ASME B31.3 Prgm

Straight Pipe StressTables

Straight Pipe Stress Summary per ASME B31.3; P := 450·psi and E := .60 and c = 0.00 in

Design Pressure, psi	Pipe OD, in	Pipe ID, in	Pipe wall Thk., in	Calculated Hoop Stress, psi	B31.3 Equation	Allow. Stress, ksi	% of Allow Stress	Is This Pipe in Plant?	Is Allow. Stress per B31.3?	ASTM B608 Tolerance, in
450	6.625	6.125	0.240	10052	Eq. 3a	16.3	62	yes	OK	0.0100
450	6.625	6.125	0.240	10020	Eq. 3b	16.3	61	yes	OK	0.0100
450	8.625	8.125	0.240	13177	Eq. 3a	16.3	81	yes	OK	0.0100
450	8.625	8.125	0.240	13145	Eq. 3b	16.3	81	yes	OK	0.0100
450	10.750	10.250	0.240	16497	Eq. 3a	16.3	101	yes	exceeds B31.3	0.0100
450	10.750	10.250	0.240	16466	Eq. 3b	16.3	101	yes	exceeds B31.3	0.0100
450	12.750	12.250	0.240	19622	Eq. 3a	16.3	120	yes	exceeds B31.3	0.0100
450	12.750	12.250	0.240	19591	Eq. 3b	16.3	120	yes	exceeds B31.3	0.0100
450	12.750	12.125	0.303	15506	Eq. 3a	16.3	95	yes	OK	0.0100
450	12.750	12.125	0.303	15481	Eq. 3b	16.3	95	yes	OK	0.0100
450	16.000	15.500	0.234	25341	Eq. 3a	20	127	yes	exceeds B31.3	0.0160
450	16.000	15.500	0.234	25290	Eq. 3b	20	126	yes	exceeds B31.3	0.0160
450	18.000	17.375	0.290	23016	Eq. 3a	20	115	yes	exceeds B31.3	0.0230
450	18.000	17.375	0.290	22956	Eq. 3b	20	115	yes	exceeds B31.3	0.0230
450	18.000	17.125	0.415	15985	Eq. 3a	20	80	yes	OK	0.0230
450	18.000	17.125	0.415	15943	Eq. 3b	20	80	yes	OK	0.0230
450	24.000	23.250	0.352	25268	Eq. 3a	20	126	yes	exceeds B31.3	0.0230
450	24.000	23.250	0.352	25219	Eq. 3b	20	126	yes	exceeds B31.3	0.0230
450	30.750	30.000	0.352	32459	Eq. 3a	20	162	yes	exceeds B31.3	0.0230
450	30.750	30.000	0.352	32410	Eq. 3b	20	162	yes	exceeds B31.3	0.0230
450	30.875	30.000	0.415	27633	Eq. 3a	20	138	yes	exceeds B31.3	0.0230
450	30.875	30.000	0.415	27591	Eq. 3b	20	138	yes	exceeds B31.3	0.0230
450	37.125	36.000	0.534	25795	Eq. 3a	20	129	yes	exceeds B31.3	0.0290
450	37.125	36.000	0.534	25755	Eq. 3b	20	129	yes	exceeds B31.3	0.0290
450	49.500	48.000	0.721	25445	Eq. 3a	20	127	yes	exceeds B31.3	0.0290
450	49.500	48.000	0.721	25415	Eq. 3b	20	127	yes	exceeds B31.3	0.0290

Straight Pipe Stress Summary per ASME B31.3; P := 425·psi and E := .60 and c = 0.00 in

Design Pressure, psi	Pipe OD, in	Pipe ID, in	Pipe wall Thk., in	Calculated Hoop Stress, psi	B31.3 Equation	Allow. Stress, ksi	% of Allow Stress	Is This Pipe in Plant?	Is Allow. Stress per B31.3?	ASTM B608 Tolerance, in
425	6.625	6.125	0.240	9493	Eq. 3a	16.3	58	yes	OK	0.0100
425	6.625	6.125	0.240	9464	Eq. 3b	16.3	58	yes	OK	0.0100
425	8.625	8.125	0.240	12445	Eq. 3a	16.3	76	yes	OK	0.0100
425	8.625	8.125	0.240	12415	Eq. 3b	16.3	76	yes	OK	0.0100
425	10.750	10.250	0.240	15580	Eq. 3a	16.3	96	yes	OK	0.0100
425	10.750	10.250	0.240	15551	Eq. 3b	16.3	95	yes	OK	0.0100
425	12.750	12.250	0.240	18532	Eq. 3a	16.3	114	yes	exceeds B31.3	0.0100
425	12.750	12.250	0.240	18502	Eq. 3b	16.3	114	yes	exceeds B31.3	0.0100
425	14.000	13.500	0.234	20906	Eq. 3a	20	105	yes	exceeds B31.3	0.0160
425	14.000	13.500	0.234	20858	Eq. 3b	20	104	yes	exceeds B31.3	0.0160
425	16.000	15.500	0.234	23933	Eq. 3a	20	120	yes	exceeds B31.3	0.0160
425	16.000	15.500	0.234	23885	Eq. 3b	20	119	yes	exceeds B31.3	0.0160
425	18.000	17.500	0.234	26960	Eq. 3a	20	135	yes	exceeds B31.3	0.0160
425	18.000	17.500	0.234	26912	Eq. 3b	20	135	yes	exceeds B31.3	0.0160
425	18.000	17.375	0.290	21737	Eq. 3a	20	109	yes	exceeds B31.3	0.0230
425	18.000	17.375	0.290	21681	Eq. 3b	20	108	yes	exceeds B31.3	0.0230
425	18.000	17.125	0.415	15097	Eq. 3a	20	75	yes	OK	0.0230
425	18.000	17.125	0.415	15057	Eq. 3b	20	75	yes	OK	0.0230
425	20.000	19.375	0.290	24184	Eq. 3a	20	121	yes	exceeds B31.3	0.0230
425	20.000	19.375	0.290	24128	Eq. 3b	20	121	yes	exceeds B31.3	0.0230
425	24.000	23.250	0.352	23864	Eq. 3a	20	119	yes	exceeds B31.3	0.0230
425	24.000	23.250	0.352	23818	Eq. 3b	20	119	yes	exceeds B31.3	0.0230
425	30.750	30.000	0.352	30656	Eq. 3a	20	153	yes	exceeds B31.3	0.0230
425	30.750	30.000	0.352	30610	Eq. 3b	20	153	yes	exceeds B31.3	0.0230
425	30.875	30.000	0.415	26098	Eq. 3a	20	130	yes	exceeds B31.3	0.0230
425	30.875	30.000	0.415	26058	Eq. 3b	20	130	yes	exceeds B31.3	0.0230

Straight Pipe Stress Summary per ASME B31.3; P := 150·psi and E := .60 and c = 0.00 in

Design Pressure, psi	Pipe OD, in	Pipe ID, in	Pipe wall Thk., in	Calculated Hoop Stress, psi	B31.3 Equation	Allow. Stress, ksi	% of Allow Stress	Is This Pipe in Plant?	Is Allow. Stress per B31.3?	ASTM B608 Tolerance, in
150	2.875	2.500	0.178	1925	Eq. 3a	16.3	12	yes	OK	0.0100
150	2.875	2.500	0.178	1911	Eq. 3b	16.3	12	yes	OK	0.0100
150	3.500	3.000	0.240	1723	Eq. 3a	16.3	11	yes	OK	0.0100
150	3.500	3.000	0.240	1713	Eq. 3b	16.3	11	yes	OK	0.0100
150	4.500	4.125	0.178	3069	Eq. 3a	16.3	19	yes	OK	0.0100
150	4.500	4.125	0.178	3055	Eq. 3b	16.3	19	yes	OK	0.0100
150	6.625	6.125	0.240	3351	Eq. 3a	16.3	21	yes	OK	0.0100
150	6.625	6.125	0.240	3340	Eq. 3b	16.3	20	yes	OK	0.0100
150	8.625	8.125	0.240	4392	Eq. 3a	16.3	27	yes	OK	0.0100
150	8.625	8.125	0.240	4382	Eq. 3b	16.3	27	yes	OK	0.0100
150	10.750	10.250	0.240	5499	Eq. 3a	16.3	34	yes	OK	0.0100
150	10.750	10.250	0.240	5489	Eq. 3b	16.3	34	yes	OK	0.0100
150	16.000	15.500	0.234	8447	Eq. 3a	20	42	yes	OK	0.0160
150	16.000	15.500	0.234	8430	Eq. 3b	20	42	yes	OK	0.0160
150	24.000	23.500	0.234	12721	Eq. 3a	20	64	yes	OK	0.0160
150	24.000	23.500	0.234	12703	Eq. 3b	20	64	yes	OK	0.0160
150	42.500	42.000	0.234	22603	Eq. 3a	20	113	yes	exceeds B31.3	0.0160
150	42.500	42.000	0.234	22586	Eq. 3b	20	113	yes	exceeds B31.3	0.0160
150	60.500	60.000	0.234	32218	Eq. 3a	20	161	yes	exceeds B31.3	0.0160
150	60.500	60.000	0.234	32201	Eq. 3b	20	161	yes	exceeds B31.3	0.0160

Straight Pipe Stress Summary per ASME B31.3; P := 25·psi and E := .60 and c = 0.00 in

Design Pressure, psi	Pipe OD, in	Pipe ID, in	Pipe wall Thk., in	Calculated Hoop Stress, psi	B31.3 Equation	Allow. Stress, ksi	% of Allow Stress	Is This Pipe in Plant?	Is Allow. Stress per B31.3?	ASTM B608 Tolerance, in
25	6.625	6.125	0.240	558	Eq. 3a	16.3	3	yes	OK	0.0100
25	6.625	6.125	0.240	557	Eq. 3b	16.3	3	yes	OK	0.0100
25	8.625	8.125	0.240	732	Eq. 3a	16.3	4	yes	OK	0.0100
25	8.625	8.125	0.240	730	Eq. 3b	16.3	4	yes	OK	0.0100
25	10.750	10.250	0.240	916	Eq. 3a	16.3	6	yes	OK	0.0100
25	10.750	10.250	0.240	915	Eq. 3b	16.3	6	yes	OK	0.0100
25	14.000	13.500	0.234	1230	Eq. 3a	20	6	yes	OK	0.0160
25	14.000	13.500	0.234	1227	Eq. 3b	20	6	yes	OK	0.0160
25	16.000	15.500	0.234	1408	Eq. 3a	20	7	yes	OK	0.0160
25	16.000	15.500	0.234	1405	Eq. 3b	20	7	yes	OK	0.0160
25	18.000	17.500	0.234	1586	Eq. 3a	20	8	yes	OK	0.0160
25	18.000	17.500	0.234	1583	Eq. 3b	20	8	yes	OK	0.0160
25	20.000	19.500	0.234	1764	Eq. 3a	20	9	yes	OK	0.0160
25	20.000	19.500	0.234	1761	Eq. 3b	20	9	yes	OK	0.0160
25	24.000	23.500	0.234	2120	Eq. 3a	20	11	yes	OK	0.0160
25	24.000	23.500	0.234	2117	Eq. 3b	20	11	yes	OK	0.0160
25	30.500	30.000	0.234	2699	Eq. 3a	20	13	yes	OK	0.0160
25	30.500	30.000	0.234	2696	Eq. 3b	20	13	yes	OK	0.0160
25	30.750	30.000	0.352	1803	Eq. 3a	20	9	yes	OK	0.0230
25	30.750	30.000	0.352	1801	Eq. 3b	20	9	yes	OK	0.0230
25	36.500	36.000	0.234	3233	Eq. 3a	20	16	yes	OK	0.0160
25	36.500	36.000	0.234	3230	Eq. 3b	20	16	yes	OK	0.0160
25	42.500	42.000	0.234	3767	Eq. 3a	20	19	yes	OK	0.0160
25	42.500	42.000	0.234	3764	Eq. 3b	20	19	yes	OK	0.0160
25	48.500	48.000	0.234	4301	Eq. 3a	20	22	yes	OK	0.0160
25	48.500	48.000	0.234	4299	Eq. 3b	20	21	yes	OK	0.0160

Straight Pipe StressTables

Straight Pipe Permissible Pressure Summary Table 1, E=.60

Line Number	Pipe OD, in	Pipe Wall Nominal Thk., in	Pipe Wall, Adjusted for Tolerance, in	Permissable Design Pressure, psi			Plant Service Piping Status			
				Weld Quality Factor			Weld Quality Factor, E=.60			
				0.60	0.80	1.00	450	425	150	25
1	2.875	0.1875	0.1775	1270	1694	2117	0	0	OK	0
2	3.5	0.25	0.24	1419	1892	2365	0	0	OK	0
3	4.5	0.1875	0.1775	797	1062	1328	0	0	OK	0
4	6.625	0.25	0.24	730	973	1216	OK	OK	OK	OK
5	8.625	0.25	0.24	557	742	928	OK	OK	OK	OK
6	10.75	0.25	0.24	445	593	741	NG	OK	OK	OK
7	12.75	0.25	0.24	374	498	623	NG	NG	0	0
8	12.75	0.3125	0.3025	473	631	788	OK	0	0	0
9	14	0.25	0.234	407	542	678	0	NG	0	OK
10	16	0.25	0.234	355	474	592	NG	NG	OK	OK
11	18	0.25	0.234	315	420	525	0	NG	0	OK
12	18	0.3125	0.2895	391	521	652	NG	NG	0	0
13	18	0.4375	0.4145	563	751	938	OK	OK	0	0
14	20	0.25	0.234	283	378	472	0	0	0	OK
15	20	0.3125	0.2895	351	469	586	0	NG	0	0
16	24	0.25	0.234	236	314	393	0	0	OK	OK
17	24	0.375	0.352	356	475	594	NG	NG	0	0
18	30.5	0.25	0.234	185	247	309	0	0	0	OK
19	30.75	0.375	0.352	277	370	462	NG	NG	0	OK
20	30.875	0.4375	0.4145	326	434	543	NG	NG	0	0
21	36.5	0.25	0.234	155	206	258	0	0	0	OK
22	37.125	0.5625	0.5335	349	465	581	NG	0	0	0
23	42.5	0.25	0.234	133	177	221	0	0	NG	OK
24	48.5	0.25	0.234	116	155	194	0	0	0	OK
25	48.625	0.3125	0.2895	144	191	239	0	0	0	OK
26	49.5	0.75	0.721	354	472	589	NG	0	0	0
27	54.5	0.25	0.234	103	138	172	0	0	0	OK
28	60.5	0.25	0.234	93	124	155	0	0	NG	0
29	72.625	0.3125	0.2895	96	128	160	0	0	0	OK
30	78.625	0.3125	0.2895	89	118	148	0	0	0	OK

Straight Pipe Permissible Pressure Summary Table 1, E=.80

Line Number	Pipe OD, in	Pipe Wall Nominal Thk., in	Pipe Wall, Adjusted for Tolerance, in	Permissable Design Pressure, psi			Plant Service Piping Status			
				Weld Quality Factor			Weld Quality Factor, E=.80			
				0.60	0.80	1.00	450	425	150	25
1	2.875	0.1875	0.1775	1270	1694	2117	0	0	OK	0
2	3.5	0.25	0.24	1419	1892	2365	0	0	OK	0
3	4.5	0.1875	0.1775	797	1062	1328	0	0	OK	0
4	6.625	0.25	0.24	730	973	1216	OK	OK	OK	OK
5	8.625	0.25	0.24	557	742	928	OK	OK	OK	OK
6	10.75	0.25	0.24	445	593	741	OK	OK	OK	OK
7	12.75	0.25	0.24	374	498	623	OK	OK	0	0
8	12.75	0.3125	0.3025	473	631	788	OK	0	0	0
9	14	0.25	0.234	407	542	678	0	OK	0	OK
10	16	0.25	0.234	355	474	592	OK	OK	OK	OK
11	18	0.25	0.234	315	420	525	0	NG	0	OK
12	18	0.3125	0.2895	391	521	652	OK	OK	0	0
13	18	0.4375	0.4145	563	751	938	OK	OK	0	0
14	20	0.25	0.234	283	378	472	0	0	0	OK
15	20	0.3125	0.2895	351	469	586	0	OK	0	0
16	24	0.25	0.234	236	314	393	0	0	OK	OK
17	24	0.375	0.352	356	475	594	OK	OK	0	0
18	30.5	0.25	0.234	185	247	309	0	0	0	OK
19	30.75	0.375	0.352	277	370	462	NG	NG	0	OK
20	30.875	0.4375	0.4145	326	434	543	NG	OK	0	0
21	36.5	0.25	0.234	155	206	258	0	0	0	OK
22	37.125	0.5625	0.5335	349	465	581	OK	0	0	0
23	42.5	0.25	0.234	133	177	221	0	0	OK	OK
24	48.5	0.25	0.234	116	155	194	0	0	0	OK
25	48.625	0.3125	0.2895	144	191	239	0	0	0	OK
26	49.5	0.75	0.721	354	472	589	OK	0	0	0
27	54.5	0.25	0.234	103	138	172	0	0	0	OK
28	60.5	0.25	0.234	93	124	155	0	0	NG	0
29	72.625	0.3125	0.2895	96	128	160	0	0	0	OK
30	78.625	0.3125	0.2895	89	118	148	0	0	0	OK

Straight Pipe Permissible Pressure Summary Table 1, E=1.0

Line Number	Pipe OD, in	Pipe Wall Nominal Thk., in	Pipe Wall, Adjusted for Tolerance, in	Permissable Design Pressure, psi			Plant Service Piping Status			
				Weld Quality Factor			Weld Quality Factor, E=1.0			
				0.60	0.80	1.00	450	425	150	25
1	2.875	0.1875	0.1775	1270	1694	2117	0	0	OK	0
2	3.5	0.25	0.24	1419	1892	2365	0	0	OK	0
3	4.5	0.1875	0.1775	797	1062	1328	0	0	OK	0
4	6.625	0.25	0.24	730	973	1216	OK	OK	OK	OK
5	8.625	0.25	0.24	557	742	928	OK	OK	OK	OK
6	10.75	0.25	0.24	445	593	741	OK	OK	OK	OK
7	12.75	0.25	0.24	374	498	623	OK	OK	0	0
8	12.75	0.3125	0.3025	473	631	788	OK	0	0	0
9	14	0.25	0.234	407	542	678	0	OK	0	OK
10	16	0.25	0.234	355	474	592	OK	OK	OK	OK
11	18	0.25	0.234	315	420	525	0	OK	0	OK
12	18	0.3125	0.2895	391	521	652	OK	OK	0	0
13	18	0.4375	0.4145	563	751	938	OK	OK	0	0
14	20	0.25	0.234	283	378	472	0	0	0	OK
15	20	0.3125	0.2895	351	469	586	0	OK	0	0
16	24	0.25	0.234	236	314	393	0	0	OK	OK
17	24	0.375	0.352	356	475	594	OK	OK	0	0
18	30.5	0.25	0.234	185	247	309	0	0	0	OK
19	30.75	0.375	0.352	277	370	462	OK	OK	0	OK
20	30.875	0.4375	0.4145	326	434	543	OK	OK	0	0
21	36.5	0.25	0.234	155	206	258	0	0	0	OK
22	37.125	0.5625	0.5335	349	465	581	OK	0	0	0
23	42.5	0.25	0.234	133	177	221	0	0	OK	OK
24	48.5	0.25	0.234	116	155	194	0	0	0	OK
25	48.625	0.3125	0.2895	144	191	239	0	0	0	OK
26	49.5	0.75	0.721	354	472	589	OK	0	0	0
27	54.5	0.25	0.234	103	138	172	0	0	0	OK
28	60.5	0.25	0.234	93	124	155	0	0	OK	0
29	72.625	0.3125	0.2895	96	128	160	0	0	0	OK
30	78.625	0.3125	0.2895	89	118	148	0	0	0	OK

Tee Calculations

B31.3 Excerpts

Design of 30"x 12" Hydranautics Tee; D-1543

$P := 450 \cdot psi$ $T_h := \frac{7}{16} \cdot in$ $D_h := 30 \cdot in + 2 \cdot (T_h)$ $D_h = 30.88\ in$ run OD $d := 30 \cdot in$ run ID

$D_b := 12.75 \cdot in$ branch OD $T_b := \frac{1}{4} \cdot in$ $d_b := D_b - 2 \cdot (T_b)$ $d_b = 12.25\ in$ branch ID

$c = 0.00\ in$ $Y = 0.40$ $W = 1.0$ $\beta := 90 \cdot deg$ $T_r := \frac{3}{8} \cdot in$ pad thickness $S_h := 20 \cdot ksi$ allow. stress in run (fab. pipe)

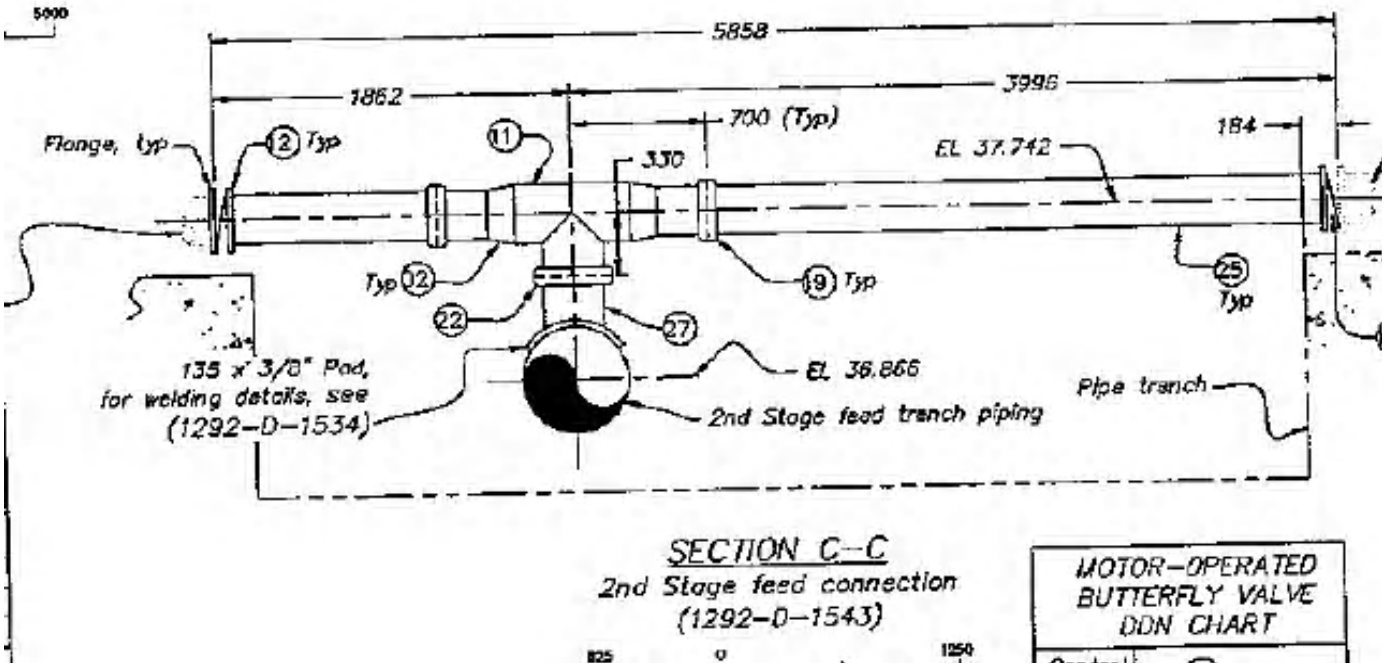
$D_r := 2 \cdot 135 \cdot mm + D_b$ $D_r = 23.38\ in$ OD of pad

$S_b := 16.3 \cdot ksi$ allow. stress in branch (casting pipe) $E = 0.60$ assumed longitudinal weld joint quality factor per Table A-1B, for copper pipe & tube alloys & Table 302.3.4

$S_r := 20 \cdot ksi$ allow. stress in run (fab. pipe) $tol_h := .023 in$ $tol_b := .016 \cdot in$ $tol_r := .023 \cdot in$ under tolerances per B608

$T_h := T_h - tol_h$ $T_h = 0.41$ in $T_b := \frac{1}{4}\cdot in - tol_b$ $T_b = 0.23$ in Note: assumed B608 under-tolerance for cast pipe

$T_r := T_r - tol_r$ $T_r = 0.35$ in note: undertolerance assumed pad was cut from B608 fab. pipe



$D_h = 30.88$ in $T_h = 0.41$ in $Y = 0.40$ $E = 0.60$ $c = 0.00$ in $S_h = 20.00$ ksi run pressure capacity

$$\begin{bmatrix} 2\cdot T_h\cdot S_h\cdot\frac{E}{(-2)\cdot T_h\cdot Y + D_h} \\ (-2)\cdot T_h\cdot S_h\cdot E\cdot\frac{W}{(-2)\cdot T_h + 2\cdot T_h\cdot Y - d - 2\cdot c} \end{bmatrix} = \begin{pmatrix} 325.70 \\ 326.19 \end{pmatrix} \text{psi} \quad \min\left[\begin{bmatrix} 2\cdot T_h\cdot S_h\cdot\frac{E}{(-2)\cdot T_h\cdot Y + D_h} \\ (-2)\cdot T_h\cdot S_h\cdot E\cdot\frac{W}{(-2)\cdot T_h + 2\cdot T_h\cdot Y - d - 2\cdot c} \end{bmatrix}\right] = 325.70 \text{ psi}$$

$t_h := \frac{P\cdot D_h}{2\cdot(S_h\cdot E + P\cdot Y)}$ $t_h = 0.57$ in req'd run thickness

$t_b := \frac{P\cdot D_b}{2\cdot(S_b\cdot E + P\cdot Y)}$ $t_b = 0.29$ in req'd branch thickness

$$\begin{bmatrix} 2.5\cdot(T_h - c) \\ 2.5\cdot(T_b - c) + T_r \end{bmatrix} = \begin{pmatrix} 1.04 \\ 0.94 \end{pmatrix} \text{in} \quad L_4 := \min\left[\begin{bmatrix} 2.5\cdot(T_h - c) \\ 2.5\cdot(T_b - c) + T_r \end{bmatrix}\right] \quad L_4 = 0.94 \text{ in}$$

height of reinforcement zone outside of run

$d_1 := \left[\frac{D_b - 2\cdot(T_b - c)}{\sin(\beta)}\right]$ $d_1 = 12.28$ in effective length removed from branch

$$\begin{bmatrix} d_1 \\ (T_b - c) + (T_h - c) + \frac{d_1}{2} \end{bmatrix} = \begin{pmatrix} 12.28 \\ 6.79 \end{pmatrix} \text{in} \qquad d_2 := \max\left[\begin{bmatrix} d_1 \\ (T_b - c) + (T_h - c) + \frac{d_1}{2} \end{bmatrix}\right] \qquad d_2 = 12.28\,\text{in}$$

half width of reinforcement zone

$$d_1 := \min\left(\begin{pmatrix} \max(d_1, d_2) \\ D_h \end{pmatrix}\right) \qquad d_1 = 12.28\,\text{in}$$

$$A_1 := t_h \cdot d_1 \cdot (2 - \sin(\beta)) \qquad A_1 = 7.01\,\text{in}^2$$

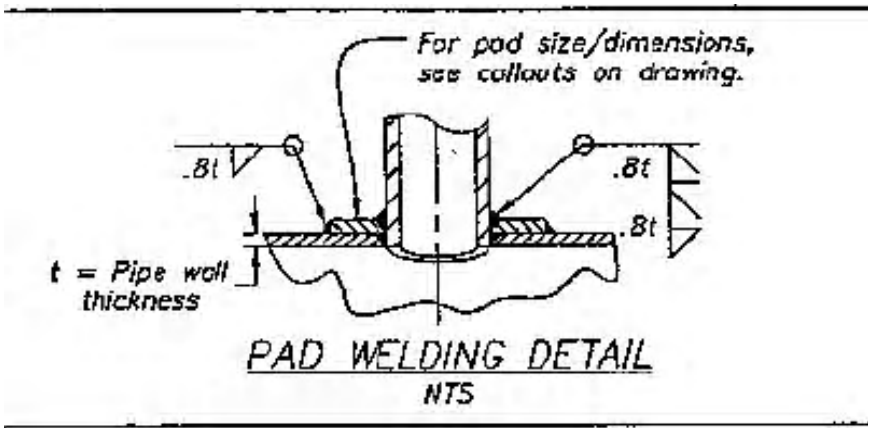
total reinforced area required

$$\begin{bmatrix} 0 \\ (2 \cdot d_2 - d_1) \cdot (T_h - t_h - c) \end{bmatrix} = \begin{pmatrix} 0.00 \\ -1.91 \end{pmatrix} \text{in}^2 \qquad A_2 := \max\left[\begin{bmatrix} 0 \\ (2 \cdot d_2 - d_1) \cdot (T_h - t_h - c) \end{bmatrix}\right] \qquad A_2 = 0.00\,\text{in}^2$$

area resulting from excess thickness in run

$$\begin{bmatrix} 0 \\ \frac{2 \cdot L_4 \cdot (T_b - t_b - c)}{\sin(\beta)} \end{bmatrix} = \begin{pmatrix} 0.00 \\ -0.10 \end{pmatrix} \text{in}^2 \qquad A_3 := \max\left[\begin{bmatrix} 0 \\ \frac{2 \cdot L_4 \cdot (T_b - t_b - c)}{\sin(\beta)} \end{bmatrix}\right] \qquad A_3 = 0.00\,\text{in}^2$$

area resulting from excess thickness in branch



$$\frac{D_b}{\sin(\beta)} + 2 \cdot 135 \cdot \text{mm} = 23.38\,\text{in}$$

$2 \cdot d_2 = 24.56\,\text{in}$ max. lgth.

$t := T_h$ pipe wall thk.

$L := .8 \cdot t \qquad L = 0.33\,\text{in}$ fillet weld size

$4 \cdot \frac{L^2}{2} = 0.22\,\text{in}^2$ area resulting from weld metal $(D_r - D_b) \cdot (T_r) = 3.74\,\text{in}^2$ area resulting from pad

$$A_4 := 4 \cdot \frac{L^2}{2} + (D_r - D_b) \cdot (T_r) \qquad A_4 = 3.96\,\text{in}^2$$

total reinforcement area resulting from weld metal + pad

req'd area $\boxed{A_1 = 7.01\,\text{in}^2}$ is not less than area provided $\boxed{A_2 + A_3 + A_4 = 3.96\,\text{in}^2}$

"OK" if $A_1 < A_2 + A_3 + A_4$ = "NG-Redesign Req'd"
"NG-Redesign Req'd" otherwise

Conclusion: 30"x12" tee is not adequate for design pressure

program to analyze a range of weld quality factors and tee pressure capacities;

f :=

for $i \in 1..9$

$E \leftarrow .60 + (i - 1) \cdot .05$

$P \leftarrow 1 \cdot psi$

$t_h \leftarrow \frac{P \cdot D_h}{2 \cdot (S_h \cdot E + P \cdot Y)}$

$t_b \leftarrow \frac{P \cdot D_b}{2 \cdot (S_b \cdot E + P \cdot Y)}$

$A_1 \leftarrow t_h \cdot d_1 \cdot (2 - \sin(\beta))$

$A_2 \leftarrow \max\left[\begin{matrix} 0 \\ (2 \cdot d_2 - d_1) \cdot (T_h - t_h - c) \end{matrix}\right]$

$A_3 \leftarrow \max\left[\begin{matrix} 0 \\ \frac{2 \cdot L_4 \cdot (T_b - t_b - c)}{\sin(\beta)} \end{matrix}\right]$

while $A_1 < (A_2 + A_3 + A_4)$

$t_h \leftarrow \frac{P \cdot D_h}{2 \cdot (S_h \cdot E + P \cdot Y)}$

$t_b \leftarrow \frac{P \cdot D_b}{2 \cdot (S_b \cdot E + P \cdot Y)}$

$A_1 \leftarrow t_h \cdot d_1 \cdot (2 - \sin(\beta))$

$A_2 \leftarrow \max\left[\begin{matrix} 0 \\ (2 \cdot d_2 - d_1) \cdot (T_h - t_h - c) \end{matrix}\right]$

$A_3 \leftarrow \max\left[\begin{matrix} 0 \\ \frac{2 \cdot L_4 \cdot (T_b - t_b - c)}{\sin(\beta)} \end{matrix}\right]$

$P \leftarrow P + 1 \cdot psi$

$v_{i,1} \leftarrow E$

$v_{i,2} \leftarrow \frac{P}{psi}$

v

Summary for 30" x12" Tee; P = *450.00* psi

ASME B31.3 Weld Quality Factor	Allow. Pressure of Tee, psi
0.60	294
0.65	318
0.70	342
0.75	367
0.80	391
0.85	415
0.90	440
0.95	464
1.00	488

Desalting Building Tees, D-1533, D-1534, D-1536, D-1537

Input Table, Part 1

	1	2	3	4	5	6	7	8
1	"OD of Run"	"Run Wall"	"OD Branch"	"Branch Wall"	"OD Pad"	"Pad Wall"	"Angle"	"Run Stress"
2	49	0.5	37.125	0.563	0	0	90	20
3	12.75	0.375	12.75	0.375	0	0	90	16.3
4	10.75	0.313	10.75	0.313	0	0	90	16.3
5	37.125	0.563	12.75	0.25	21.8	0.75	90	20
6	30.875	0.438	12.75	0.25	22.2	0.563	90	20
7	24	0.375	12.75	0.25	21.8	0.5	90	20
8	18	0.313	12.75	0.25	21.4	0.438	90	20
9	30.875	0.438	10.75	0.25	18.6	0.563	90	20
10	24	0.375	10.75	0.25	18.2	0.5	90	20
11	18	0.313	10.75	0.25	17.84	0.438	90	20
12	30.875	0.438	12.75	0.25	22.2	0.563	90	20
13	24	0.375	12.75	0.25	21.8	0.5	90	20
14	20	0.313	12.75	0.25	21.4	0.438	90	20
15	30.875	0.438	10.75	0.25	18.6	0.563	90	20
16	24	0.375	10.75	0.25	18.2	0.5	90	20
17	20	0.313	10.75	0.25	17.84	0.438	90	20

Input Table, Part 2 (note this is a continuation of Part 1 above)

Tee =

	1	2	3	4	5	6	7
1	"OD of Run"	"Run Wall"	"OD Branch"	"Branch Wall"	"OD Pad"	"Pad Wall"	"Angle"
2	49.00	0.50	37.13	0.56	0.00	0.00	90.00
3	12.75	0.38	12.75	0.38	0.00	0.00	90.00
4	10.75	0.31	10.75	0.31	0.00	0.00	90.00
5	37.13	0.56	12.75	0.25	21.80	0.75	90.00
6	30.88	0.44	12.75	0.25	22.20	0.56	90.00
7	24.00	0.38	12.75	0.25	21.80	0.50	90.00
8	18.00	0.31	12.75	0.25	21.40	0.44	90.00
9	30.88	0.44	10.75	0.25	18.60	0.56	90.00
10	24.00	0.38	10.75	0.25	18.20	0.50	90.00
11	18.00	0.31	10.75	0.25	17.84	0.44	90.00
12	30.88	0.44	12.75	0.25	22.20	0.56	90.00
13	24.00	0.38	12.75	0.25	21.80	0.50	90.00
14	20.00	0.31	12.75	0.25	21.40	0.44	90.00
15	30.88	0.44	10.75	0.25	18.60	0.56	90.00
16	24.00	0.38	10.75	0.25	18.20	0.50	90.00
17	20.00	0.31	10.75	0.25	17.84	0.44	90.00

$Tees := \left(submatrix(Tee, 2, rows(Tee), 1, cols(Tee))^{T}\right)$

$i := 1$ 48"x36" tee $Tees_{17,i} = "48x36\text{-}D1533"$

$$\begin{pmatrix} D_h \\ T_h \\ D_b \\ T_b \\ D_r \\ T_r \\ \beta \\ S_h \\ S_b \\ S_r \\ tol_h \\ tol_b \\ tol_r \\ c \\ E \\ P \end{pmatrix} := Tees^{\langle i \rangle} = \begin{pmatrix} D_h \\ T_h \\ D_b \\ T_b \\ D_r \\ T_r \\ \beta \\ S_h \\ S_b \\ S_r \\ tol_h \\ tol_b \\ tol_r \\ c \\ E \\ P \end{pmatrix}$$

	1
1	49.00
2	0.50
3	37.13
4	0.56
5	0.00
6	0.00
7	90.00
8	20.00
9	20.00
10	0.00
11	0.02
12	0.03
13	0.00
14	0.13
15	0.60
16	450.00

$$\begin{pmatrix} D_h \\ T_h \\ D_b \\ T_b \\ D_r \\ T_r \end{pmatrix} := submatrix\left(Tees^{\langle i \rangle}, 1, 6, 1, 1\right) \cdot in = \begin{pmatrix} D_h \\ T_h \\ D_b \\ T_b \\ D_r \\ T_r \end{pmatrix} = \begin{pmatrix} 49.00 \\ 0.50 \\ 37.13 \\ 0.56 \\ 0.00 \\ 0.00 \end{pmatrix} in$$

$\beta := \beta \cdot deg$ $\beta = 90.00\ deg$

$P := P \cdot psi$ $P = 450.00\ psi$

$S_h := S_h \cdot ksi$ $S_h = 20.00\ ksi$

$S_b := S_b \cdot ksi$ $S_b = 20.00\ ksi$

$S_r := S_r \cdot ksi$ $S_r = 0.00\ ksi$

$$\begin{pmatrix} tol_h \\ tol_b \\ tol_r \\ c \end{pmatrix} := \begin{pmatrix} tol_h \\ tol_b \\ tol_r \\ c \end{pmatrix} in = \begin{pmatrix} tol_h \\ tol_b \\ tol_r \\ c \end{pmatrix} = \begin{pmatrix} 0.02 \\ 0.03 \\ 0.00 \\ 0.13 \end{pmatrix} in$$

$T_h := T_h - tol_h$ $T_h = 0.48\ in$

$T_b := T_b - tol_b$ $T_b = 0.53\ in$

run & branch undertolerance thicknesses

$T_r := T_r - tol_r$ $T_r = 0.00\ in$

$$L_4 := \min\left(\begin{bmatrix} 2.5 \cdot (T_h - c) \\ 2.5 \cdot (T_b - c) + T_r \end{bmatrix}\right) \quad L_4 = 0.88\ in$$

height of reinforcement zone outside of run

$$t_h := \frac{P \cdot D_h}{2 \cdot (S_h \cdot E + P \cdot Y)} \quad t_h = 0.91\ in$$

req'd run thickness

$$t_b := \frac{P \cdot D_b}{2 \cdot (S_b \cdot E + P \cdot Y)} \quad t_b = 0.69\ in$$

req'd branch thickness

$$\begin{pmatrix} L_1 \\ L_2 \end{pmatrix} := \left| \begin{array}{l} t \leftarrow \left(Tees^{\langle i \rangle}\right)_2 \cdot in \\ L_1 \leftarrow \left| \begin{array}{ll} 0 & \text{if } D_r = 0 \\ .8 \cdot t & \text{otherwise} \end{array} \right. \\ L_2 \leftarrow .8 \cdot t \\ \begin{pmatrix} L_1 \\ L_2 \end{pmatrix} \end{array} \right. \qquad \begin{pmatrix} L_1 \\ L_2 \end{pmatrix} = \begin{pmatrix} 0.00 \\ 0.40 \end{pmatrix} in$$

branch/pad fillet weld leg size

run/pad fillet weld leg size

$$d_1 := \left[\frac{D_b - 2 \cdot (T_b - c)}{\sin(\beta)} \right] \qquad d_1 = 36.31 \text{ in}$$

effective length removed from branch

$$\begin{bmatrix} d_1 \\ (T_b - c) + (T_h - c) + \frac{d_1}{2} \end{bmatrix} = \begin{pmatrix} 36.31 \\ 18.91 \end{pmatrix} in \qquad d_2 := \max\left(\begin{bmatrix} d_1 \\ (T_b - c) + (T_h - c) + \frac{d_1}{2} \end{bmatrix} \right) \qquad d_2 = 36.31 \text{ in}$$

half width of reinforcement zone

$$d_1 := \min\left(\begin{pmatrix} \max(d_1, d_2) \\ D_h \end{pmatrix} \right) \qquad d_1 = 36.31 \text{ in}$$

$$A_1 := t_h \cdot d_1 \cdot (2 - \sin(\beta)) \qquad A_1 = 32.87 \text{ in}^2$$

total reinforced area required

$$\begin{bmatrix} 0 \\ (2 \cdot d_2 - d_1) \cdot (T_h - t_h - c) \end{bmatrix} = \begin{pmatrix} 0.00 \\ -20.08 \end{pmatrix} in^2 \qquad A_2 := \max\left(\begin{bmatrix} 0 \\ (2 \cdot d_2 - d_1) \cdot (T_h - t_h - c) \end{bmatrix} \right) \qquad A_2 = 0.00 \text{ in}^2$$

area resulting from excess thickness in run

$$\begin{bmatrix} 0 \\ \frac{2 \cdot L_4 \cdot (T_b - t_b - c)}{\sin(\beta)} \end{bmatrix} = \begin{pmatrix} 0.00 \\ -0.49 \end{pmatrix} in^2 \qquad A_3 := \max\left(\begin{bmatrix} 0 \\ \frac{2 \cdot L_4 \cdot (T_b - t_b - c)}{\sin(\beta)} \end{bmatrix} \right) \qquad A_3 = 0.00 \text{ in}^2$$

area resulting from excess thickness in branch

$$A_4 := 2 \cdot \frac{L_1^2}{2} + 2 \cdot \frac{L_2^2}{2} + (D_r - D_b) \cdot (T_r) \cdot \frac{S_r}{S_h} \qquad A_4 = 0.16 \text{ in}^2$$

req'd area $A_1 = 32.87 \text{ in}^2$ is less than area provided $A_2 + A_3 + A_4 = 0.16 \text{ in}^2$

$$\left| \begin{array}{ll} \text{"OK"} & \text{if } A_1 < A_2 + A_3 + A_4 \\ \text{"NG-Redesign Req'd"} & \text{otherwise} \end{array} \right. = \text{"NG-Redesign Req'd"}$$

program to analyze a range of weld quality factors and tee pressure capacities;

$f := \left| \begin{array}{l} \text{for } i \in 1..9 \\ \quad E \leftarrow .60 + (i - 1)\cdot.05 \\ \quad P \leftarrow 1\cdot psi \\ \quad t_h \leftarrow \dfrac{P\cdot D_h}{2\cdot\left(S_h\cdot E + P\cdot Y\right)} \\ \quad t_b \leftarrow \dfrac{P\cdot D_b}{2\cdot\left(S_b\cdot E + P\cdot Y\right)} \\ \quad A_1 \leftarrow t_h\cdot d_1\cdot(2 - \sin(\beta)) \\ \quad A_2 \leftarrow \max\left[\left[\begin{array}{c} 0 \\ \left(2\cdot d_2 - d_1\right)\cdot\left(T_h - t_h - c\right) \end{array}\right]\right] \\ \quad A_3 \leftarrow \max\left[\left[\begin{array}{c} 0 \\ \dfrac{2\cdot L_4\cdot\left(T_b - t_b - c\right)}{\sin(\beta)} \end{array}\right]\right] \\ \quad \text{while } A_1 < \left(A_2 + A_3 + A_4\right) \\ \quad\quad t_h \leftarrow \dfrac{P\cdot D_h}{2\cdot\left(S_h\cdot E + P\cdot Y\right)} \\ \quad\quad t_b \leftarrow \dfrac{P\cdot D_b}{2\cdot\left(S_b\cdot E + P\cdot Y\right)} \\ \quad\quad A_1 \leftarrow t_h\cdot d_1\cdot(2 - \sin(\beta)) \\ \quad\quad A_2 \leftarrow \max\left[\left[\begin{array}{c} 0 \\ \left(2\cdot d_2 - d_1\right)\cdot\left(T_h - t_h - c\right) \end{array}\right]\right] \\ \quad\quad A_3 \leftarrow \max\left[\left[\begin{array}{c} 0 \\ \dfrac{2\cdot L_4\cdot\left(T_b - t_b - c\right)}{\sin(\beta)} \end{array}\right]\right] \\ \quad\quad P \leftarrow P + 1\cdot psi \\ \quad v_{i,1} \leftarrow E \\ \quad v_{i,2} \leftarrow \dfrac{P}{psi} \\ v \end{array} \right.$

Summary $Tees_{17,i} = "48x36\text{-}D1533"$ Tee; $P = 450.00$ psi

ASME B31.3 Weld Quality Factor	Allow. Pressure of Tee, psi
0.60	92
0.65	100
0.70	107
0.75	115
0.80	122
0.85	130
0.90	138
0.95	145
1.00	153

f

12" x 12" tee $i := 2$ $Tees_{17,i} = "12x12\text{-}D1536"$

$$\begin{pmatrix} D_h \\ T_h \\ D_b \\ T_b \\ D_r \\ T_r \\ \beta \\ S_h \\ S_b \\ S_r \\ tol_h \\ tol_b \\ tol_r \\ c \\ E \\ P \end{pmatrix} := Tees^{\langle i \rangle} = \begin{pmatrix} D_h \\ T_h \\ D_b \\ T_b \\ D_r \\ T_r \\ \beta \\ S_h \\ S_b \\ S_r \\ tol_h \\ tol_b \\ tol_r \\ c \\ E \\ P \end{pmatrix}$$

	1
1	12.75
2	0.38
3	12.75
4	0.38
5	0.00
6	0.00
7	90.00
8	16.30
9	16.30
10	0.00
11	0.02
12	0.02
13	0.00
14	0.13
15	0.60
16	450.00

$$\begin{pmatrix} D_h \\ T_h \\ D_b \\ T_b \\ D_r \\ T_r \end{pmatrix} := submatrix\left(Tees^{\langle i \rangle}, 1, 6, 1, 1\right) \cdot in \qquad \begin{pmatrix} D_h \\ T_h \\ D_b \\ T_b \\ D_r \\ T_r \end{pmatrix} = \begin{pmatrix} 12.75 \\ 0.38 \\ 12.75 \\ 0.38 \\ 0.00 \\ 0.00 \end{pmatrix} in$$

$\beta := \beta \cdot deg$ $\quad \beta = 90.00\ deg$

$P := P \cdot psi$ $\quad P = 450.00\ psi$

$S_h := S_h \cdot ksi$ $\quad S_h = 16.30\ ksi$

$S_b := S_b \cdot ksi$ $\quad S_b = 16.30\ ksi$

$S_r := S_r \cdot ksi$ $\quad S_r = 0.00\ ksi$

$$\begin{pmatrix} tol_h \\ tol_b \\ tol_r \\ c \end{pmatrix} := \begin{pmatrix} tol_h \\ tol_b \\ tol_r \\ c \end{pmatrix} in \qquad \begin{pmatrix} tol_h \\ tol_b \\ tol_r \\ c \end{pmatrix} = \begin{pmatrix} 0.02 \\ 0.02 \\ 0.00 \\ 0.13 \end{pmatrix} in$$

$T_h := T_h - tol_h$ $\quad T_h = 0.35\ in$ $\qquad T_b := T_b - tol_b$ $\quad T_b = 0.35\ in$ $\qquad$ run & branch undertolerance thicknesses

$T_r := T_r - tol_r$ $\quad T_r = 0.00\ in$

$$L_4 := \min\left[\begin{bmatrix} 2.5 \cdot (T_h - c) \\ 2.5 \cdot (T_b - c) + T_r \end{bmatrix}\right] \qquad L_4 = 0.57\ in$$

height of reinforcement zone outside of run

$$t_h := \frac{P \cdot D_h}{2 \cdot (S_h \cdot E + P \cdot Y)} \qquad t_h = 0.29\ in$$

req'd run thickness

$$t_b := \frac{P \cdot D_b}{2 \cdot (S_b \cdot E + P \cdot Y)} \qquad t_b = 0.29\ in$$

req'd branch thickness

$$\begin{pmatrix} L_1 \\ L_2 \end{pmatrix} := \left| \begin{array}{l} t \leftarrow \left(Tees^{\langle i \rangle}\right)_2 \cdot in \\ L_1 \leftarrow \left| \begin{array}{ll} 0 & \text{if } D_r = 0 \\ .8 \cdot t & \text{otherwise} \end{array} \right. \\ L_2 \leftarrow .8 \cdot t \\ \begin{pmatrix} L_1 \\ L_2 \end{pmatrix} \end{array} \right. \qquad \begin{pmatrix} L_1 \\ L_2 \end{pmatrix} = \begin{pmatrix} 0.00 \\ 0.30 \end{pmatrix} in$$

branch/pad fillet weld leg size

run/pad fillet weld leg size

$$d_1 := \left[\frac{D_b - 2 \cdot (T_b - c)}{\sin(\beta)} \right] \qquad d_1 = 12.30\,in$$

effective length removed from branch

$$\begin{bmatrix} d_1 \\ (T_b - c) + (T_h - c) + \frac{d_1}{2} \end{bmatrix} = \begin{pmatrix} 12.30 \\ 6.60 \end{pmatrix} in \qquad d_2 := \max\left(\begin{bmatrix} d_1 \\ (T_b - c) + (T_h - c) + \frac{d_1}{2} \end{bmatrix} \right) \qquad d_2 = 12.30\,in$$

half width of reinforcement zone

$$d_1 := \min\left(\begin{pmatrix} \max(d_1, d_2) \\ D_h \end{pmatrix} \right) \qquad d_1 = 12.30\,in$$

$$A_1 := t_h \cdot d_1 \cdot (2 - \sin(\beta)) \qquad A_1 = 3.54\,in^2$$

total reinforced area required

$$\begin{bmatrix} 0 \\ (2 \cdot d_2 - d_1) \cdot (T_h - t_h - c) \end{bmatrix} = \begin{pmatrix} 0.00 \\ -0.75 \end{pmatrix} in^2 \qquad A_2 := \max\left(\begin{bmatrix} 0 \\ (2 \cdot d_2 - d_1) \cdot (T_h - t_h - c) \end{bmatrix} \right) \qquad A_2 = 0.00\,in^2$$

area resulting from excess thickness in run

$$\begin{bmatrix} 0 \\ \frac{2 \cdot L_4 \cdot (T_b - t_b - c)}{\sin(\beta)} \end{bmatrix} = \begin{pmatrix} 0.00 \\ -0.07 \end{pmatrix} in^2 \qquad A_3 := \max\left(\begin{bmatrix} 0 \\ \frac{2 \cdot L_4 \cdot (T_b - t_b - c)}{\sin(\beta)} \end{bmatrix} \right) \qquad A_3 = 0.00\,in^2$$

area resulting from excess thickness in branch

$$A_4 := 2 \cdot \frac{L_1^2}{2} + 2 \cdot \frac{L_2^2}{2} + (D_r - D_b) \cdot (T_r) \cdot \frac{S_r}{S_h} \qquad A_4 = 0.09\,in^2$$

req'd area $A_1 = 3.54\,in^2$ is less than area provided $A_2 + A_3 + A_4 = 0.09\,in^2$

$$\left| \begin{array}{ll} \text{"OK"} & \text{if } A_1 < A_2 + A_3 + A_4 \\ \text{"NG-Redesign Req'd"} & \text{otherwise} \end{array} \right. = \text{"NG-Redesign Req'd"}$$

program to analyze a range of weld quality factors and tee pressure capacities;

```
f := for i ∈ 1..9
       E ← .60 + (i − 1)·.05
       P ← 1·psi
       t_h ← P·D_h / (2·(S_h·E + P·Y))
       t_b ← P·D_b / (2·(S_b·E + P·Y))
       A_1 ← t_h·d_1·(2 − sin(β))
       A_2 ← max([[ 0 ; (2·d_2 − d_1)·(T_h − t_h − c) ]])
       A_3 ← max([[ 0 ; 2·L_4·(T_b − t_b − c) / sin(β) ]])
       while A_1 < (A_2 + A_3 + A_4)
         t_h ← P·D_h / (2·(S_h·E + P·Y))
         t_b ← P·D_b / (2·(S_b·E + P·Y))
         A_1 ← t_h·d_1·(2 − sin(β))
         A_2 ← max([[ 0 ; (2·d_2 − d_1)·(T_h − t_h − c) ]])
         A_3 ← max([[ 0 ; 2·L_4·(T_b − t_b − c) / sin(β) ]])
         P ← P + 1·psi
       v_{i,1} ← E
       v_{i,2} ← P / psi
     v
```

Summary $Tees_{17,i}$ = *"12x12-D1536"* Tee; P = *450.00* psi

ASME B31.3 Weld Quality Factor	Allow. Pressure of Tee, psi
0.60	190
0.65	206
0.70	222
0.75	237
0.80	253
0.85	269
0.90	284
0.95	300
1.00	316

f

10" x 10" tee; i := *3* $Tees_{17,i}$ = *"10x10-D1536"*

$$\begin{pmatrix} D_h \\ T_h \\ D_b \\ T_b \\ D_r \\ T_r \\ \beta \\ S_h \\ S_b \\ S_r \\ tol_h \\ tol_b \\ tol_r \\ c \\ E \\ P \end{pmatrix} := Tees^{\langle i \rangle} = \begin{pmatrix} D_h \\ T_h \\ D_b \\ T_b \\ D_r \\ T_r \\ \beta \\ S_h \\ S_b \\ S_r \\ tol_h \\ tol_b \\ tol_r \\ c \\ E \\ P \end{pmatrix}$$

	1
1	10.75
2	0.31
3	10.75
4	0.31
5	0.00
6	0.00
7	90.00
8	16.30
9	16.30
10	0.00
11	0.02
12	0.02
13	0.00
14	0.13
15	0.60
16	450.00

$$\begin{pmatrix} D_h \\ T_h \\ D_b \\ T_b \\ D_r \\ T_r \end{pmatrix} := submatrix\left(Tees^{\langle i \rangle}, 1, 6, 1, 1\right) \cdot in = \begin{pmatrix} D_h \\ T_h \\ D_b \\ T_b \\ D_r \\ T_r \end{pmatrix} = \begin{pmatrix} 10.75 \\ 0.31 \\ 10.75 \\ 0.31 \\ 0.00 \\ 0.00 \end{pmatrix} in$$

$\beta := \beta \cdot deg$ $\beta = 90.00\ deg$

$P := P \cdot psi$ $P = 450.00\ psi$

$S_h := S_h \cdot ksi$ $S_h = 16.30\ ksi$

$S_b := S_b \cdot ksi$ $S_b = 16.30\ ksi$

$S_r := S_r \cdot ksi$ $S_r = 0.00\ ksi$

$$\begin{pmatrix} tol_h \\ tol_b \\ tol_r \\ c \end{pmatrix} := \begin{pmatrix} tol_h \\ tol_b \\ tol_r \\ c \end{pmatrix} in = \begin{pmatrix} tol_h \\ tol_b \\ tol_r \\ c \end{pmatrix} = \begin{pmatrix} 0.02 \\ 0.02 \\ 0.00 \\ 0.13 \end{pmatrix} in$$

$T_h := T_h - tol_h$ $T_h = 0.29\ in$

$T_b := T_b - tol_b$ $T_b = 0.29\ in$

run & branch undertolerance thicknesses

$T_r := T_r - tol_r$ $T_r = 0.00\ in$

$$L_4 := \min\left(\begin{bmatrix} 2.5 \cdot (T_h - c) \\ 2.5 \cdot (T_b - c) + T_r \end{bmatrix}\right) \quad L_4 = 0.41\ in$$

height of reinforcement zone outside of run

$$t_h := \frac{P \cdot D_h}{2 \cdot (S_h \cdot E + P \cdot Y)} \quad t_h = 0.24\ in$$

req'd run thickness

$$t_b := \frac{P \cdot D_b}{2 \cdot (S_b \cdot E + P \cdot Y)} \quad t_b = 0.24\ in$$

req'd branch thickness

$$\begin{pmatrix} L_1 \\ L_2 \end{pmatrix} := \left| \begin{array}{l} t \leftarrow \left(Tees^{\langle i \rangle}\right)_2 \cdot in \\ L_1 \leftarrow \left| \begin{array}{ll} 0 & \text{if } D_r = 0 \\ .8 \cdot t & \text{otherwise} \end{array} \right. \\ L_2 \leftarrow .8 \cdot t \\ \begin{pmatrix} L_1 \\ L_2 \end{pmatrix} \end{array} \right. \qquad \begin{pmatrix} L_1 \\ L_2 \end{pmatrix} = \begin{pmatrix} 0.00 \\ 0.25 \end{pmatrix} in$$

branch/pad fillet weld leg size

run/pad fillet weld leg size

$$d_1 := \left[\frac{D_b - 2 \cdot (T_b - c)}{\sin(\beta)} \right] \qquad d_1 = 10.42 \text{ in}$$

effective length removed from branch

$$\begin{bmatrix} d_1 \\ (T_b - c) + (T_h - c) + \frac{d_1}{2} \end{bmatrix} = \begin{pmatrix} 10.42 \\ 5.54 \end{pmatrix} in \qquad d_2 := \max\left[\begin{bmatrix} d_1 \\ (T_b - c) + (T_h - c) + \frac{d_1}{2} \end{bmatrix} \right] \qquad d_2 = 10.42 \text{ in}$$

half width of reinforcement zone

$$d_1 := \min\left(\begin{pmatrix} \max(d_1, d_2) \\ D_h \end{pmatrix} \right) \qquad d_1 = 10.42 \text{ in}$$

$$A_1 := t_h \cdot d_1 \cdot (2 - \sin(\beta)) \qquad A_1 = 2.53 \text{ in}^2$$

total reinforced area required

$$\begin{bmatrix} 0 \\ (2 \cdot d_2 - d_1) \cdot (T_h - t_h - c) \end{bmatrix} = \begin{pmatrix} 0.00 \\ -0.82 \end{pmatrix} in^2 \qquad A_2 := \max\left[\begin{bmatrix} 0 \\ (2 \cdot d_2 - d_1) \cdot (T_h - t_h - c) \end{bmatrix} \right] \qquad A_2 = 0.00 \text{ in}^2$$

area resulting from excess thickness in run

$$\begin{bmatrix} 0 \\ \frac{2 \cdot L_4 \cdot (T_b - t_b - c)}{\sin(\beta)} \end{bmatrix} = \begin{pmatrix} 0.00 \\ -0.06 \end{pmatrix} in^2 \qquad A_3 := \max\left[\begin{bmatrix} 0 \\ \frac{2 \cdot L_4 \cdot (T_b - t_b - c)}{\sin(\beta)} \end{bmatrix} \right] \qquad A_3 = 0.00 \text{ in}^2$$

area resulting from excess thickness in branch

$$A_4 := 2 \cdot \frac{L_1^2}{2} + 2 \cdot \frac{L_2^2}{2} + (D_r - D_b) \cdot (T_r) \cdot \frac{S_r}{S_h} \qquad A_4 = 0.06 \text{ in}^2$$

req'd area $A_1 = 2.53 \text{ in}^2$ is less than area provided $A_2 + A_3 + A_4 = 0.06 \text{ in}^2$

$$\left| \begin{array}{ll} \text{"OK"} & \text{if } A_1 < A_2 + A_3 + A_4 \\ \text{"NG-Redesign Req'd"} & \text{otherwise} \end{array} \right. = \text{"NG-Redesign Req'd"}$$

program to analyze a range of weld quality factors and tee pressure capacities;

$f :=$ for $i \in 1..9$

$E \leftarrow .60 + (i - 1)\cdot.05$

$P \leftarrow 1\cdot psi$

$$t_h \leftarrow \frac{P\cdot D_h}{2\cdot\left(S_h\cdot E + P\cdot Y\right)}$$

$$t_b \leftarrow \frac{P\cdot D_b}{2\cdot\left(S_b\cdot E + P\cdot Y\right)}$$

$A_1 \leftarrow t_h\cdot d_1\cdot(2 - \sin(\beta))$

$$A_2 \leftarrow \max\left(\begin{bmatrix} 0 \\ \left(2\cdot d_2 - d_1\right)\cdot\left(T_h - t_h - c\right) \end{bmatrix}\right)$$

$$A_3 \leftarrow \max\left(\begin{bmatrix} 0 \\ \frac{2\cdot L_4\cdot\left(T_b - t_b - c\right)}{\sin(\beta)} \end{bmatrix}\right)$$

while $A_1 < \left(A_2 + A_3 + A_4\right)$

$$t_h \leftarrow \frac{P\cdot D_h}{2\cdot\left(S_h\cdot E + P\cdot Y\right)}$$

$$t_b \leftarrow \frac{P\cdot D_b}{2\cdot\left(S_b\cdot E + P\cdot Y\right)}$$

$A_1 \leftarrow t_h\cdot d_1\cdot(2 - \sin(\beta))$

$$A_2 \leftarrow \max\left(\begin{bmatrix} 0 \\ \left(2\cdot d_2 - d_1\right)\cdot\left(T_h - t_h - c\right) \end{bmatrix}\right)$$

$$A_3 \leftarrow \max\left(\begin{bmatrix} 0 \\ \frac{2\cdot L_4\cdot\left(T_b - t_b - c\right)}{\sin(\beta)} \end{bmatrix}\right)$$

$P \leftarrow P + 1\cdot psi$

$v_{i,1} \leftarrow E$

$$v_{i,2} \leftarrow \frac{P}{psi}$$

v

Summary $Tees_{17,i} = "10x10\text{-}D1536"$ Tee; $P = 450.00$ psi

ASME B31.3 Weld Quality Factor	Allow. Pressure of Tee, psi
0.60	163
0.65	177
0.70	190
0.75	204
0.80	217
0.85	231
0.90	244
0.95	257
1.00	271

f

36" x 12" tee; $i := 4$ $Tees_{17,i} = "36X12\text{-}D1536"$

$$\begin{pmatrix} D_h \\ T_h \\ D_b \\ T_b \\ D_r \\ T_r \\ \beta \\ S_h \\ S_b \\ S_r \\ tol_h \\ tol_b \\ tol_r \\ c \\ E \\ P \end{pmatrix} := Tees^{\langle i \rangle} = \begin{pmatrix} D_h \\ T_h \\ D_b \\ T_b \\ D_r \\ T_r \\ \beta \\ S_h \\ S_b \\ S_r \\ tol_h \\ tol_b \\ tol_r \\ c \\ E \\ P \end{pmatrix}$$

	1
1	37.13
2	0.56
3	12.75
4	0.25
5	21.80
6	0.75
7	90.00
8	20.00
9	16.30
10	20.00
11	0.03
12	0.02
13	0.03
14	0.13
15	0.60
16	450.00

$$\begin{pmatrix} D_h \\ T_h \\ D_b \\ T_b \\ D_r \\ T_r \end{pmatrix} := submatrix\left(Tees^{\langle i \rangle}, 1, 6, 1, 1\right) \cdot in = \begin{pmatrix} D_h \\ T_h \\ D_b \\ T_b \\ D_r \\ T_r \end{pmatrix} = \begin{pmatrix} 37.13 \\ 0.56 \\ 12.75 \\ 0.25 \\ 21.80 \\ 0.75 \end{pmatrix} in$$

$\beta := \beta \cdot deg$ $\beta = 90.00\ deg$

$P := P \cdot psi$ $P = 450.00\ psi$

$S_h := S_h \cdot ksi$ $S_h = 20.00\ ksi$

$S_b := S_b \cdot ksi$ $S_b = 16.30\ ksi$

$S_r := S_r \cdot ksi$ $S_r = 20.00\ ksi$

$$\begin{pmatrix} tol_h \\ tol_b \\ tol_r \\ c \end{pmatrix} := \begin{pmatrix} tol_h \\ tol_b \\ tol_r \\ c \end{pmatrix} in = \begin{pmatrix} tol_h \\ tol_b \\ tol_r \\ c \end{pmatrix} = \begin{pmatrix} 0.03 \\ 0.02 \\ 0.03 \\ 0.13 \end{pmatrix} in$$

$T_h := T_h - tol_h$ $T_h = 0.53\ in$ $T_b := T_b - tol_b$ $T_b = 0.23\ in$ run & branch undertolerance thicknesses

$T_r := T_r - tol_r$ $T_r = 0.72\ in$

$$L_4 := \min\left(\begin{bmatrix} 2.5 \cdot (T_h - c) \\ 2.5 \cdot (T_b - c) + T_r \end{bmatrix}\right)$$

$L_4 = 0.99\ in$ height of reinforcement zone outside of run

$$t_h := \frac{P \cdot D_h}{2 \cdot (S_h \cdot E + P \cdot Y)}$$

$t_h = 0.69\ in$ req'd run thickness

$$t_b := \frac{P \cdot D_b}{2 \cdot (S_b \cdot E + P \cdot Y)}$$

$t_b = 0.29\ in$ req'd branch thickness

$$\begin{pmatrix} L_1 \\ L_2 \end{pmatrix} := \left| \begin{array}{l} t \leftarrow \left(Tees^{\langle i \rangle}\right)_2 \cdot in \\ L_1 \leftarrow \left| \begin{array}{ll} 0 & \text{if } D_r = 0 \\ .8 \cdot t & \text{otherwise} \end{array} \right. \\ L_2 \leftarrow .8 \cdot t \\ \begin{pmatrix} L_1 \\ L_2 \end{pmatrix} \end{array} \right. \qquad \begin{pmatrix} L_1 \\ L_2 \end{pmatrix} = \begin{pmatrix} 0.45 \\ 0.45 \end{pmatrix} in$$

branch/pad fillet weld leg size

run/pad fillet weld leg size

$$d_1 := \left[\frac{D_b - 2 \cdot (T_b - c)}{\sin(\beta)} \right] \qquad d_1 = 12.53 \text{ in}$$

effective length removed from branch

$$\begin{bmatrix} d_1 \\ (T_b - c) + (T_h - c) + \frac{d_1}{2} \end{bmatrix} = \begin{pmatrix} 12.53 \\ 6.78 \end{pmatrix} in \qquad d_2 := \max\left(\begin{bmatrix} d_1 \\ (T_b - c) + (T_h - c) + \frac{d_1}{2} \end{bmatrix} \right) \qquad d_2 = 12.53 \text{ in}$$

half width of reinforcement zone

$$d_1 := \min\left(\begin{pmatrix} \max(d_1, d_2) \\ D_h \end{pmatrix} \right) \qquad d_1 = 12.53 \text{ in}$$

$$A_1 := t_h \cdot d_1 \cdot (2 - \sin(\beta)) \qquad A_1 = 8.59 \text{ in}^2$$

total reinforced area required

$$\begin{bmatrix} 0 \\ (2 \cdot d_2 - d_1) \cdot (T_h - t_h - c) \end{bmatrix} = \begin{pmatrix} 0.00 \\ -3.48 \end{pmatrix} in^2 \qquad A_2 := \max\left(\begin{bmatrix} 0 \\ (2 \cdot d_2 - d_1) \cdot (T_h - t_h - c) \end{bmatrix} \right) \qquad A_2 = 0.00 \text{ in}^2$$

area resulting from excess thickness in run

$$\begin{bmatrix} 0 \\ \frac{2 \cdot L_4 \cdot (T_b - t_b - c)}{\sin(\beta)} \end{bmatrix} = \begin{pmatrix} 0.00 \\ -0.36 \end{pmatrix} in^2 \qquad A_3 := \max\left(\begin{bmatrix} 0 \\ \frac{2 \cdot L_4 \cdot (T_b - t_b - c)}{\sin(\beta)} \end{bmatrix} \right) \qquad A_3 = 0.00 \text{ in}^2$$

area resulting from excess thickness in branch

$$A_4 := 2 \cdot \frac{L_1^2}{2} + 2 \cdot \frac{L_2^2}{2} + (D_r - D_b) \cdot (T_r) \cdot \frac{S_r}{S_h} \qquad A_4 = 6.93 \text{ in}^2$$

req'd area $A_1 = 8.59 \text{ in}^2$ is less than area provided $A_2 + A_3 + A_4 = 6.93 \text{ in}^2$

$$\left| \begin{array}{ll} \text{"OK"} & \text{if } A_1 < A_2 + A_3 + A_4 \\ \text{"NG-Redesign Req'd"} & \text{otherwise} \end{array} \right. = \text{"NG-Redesign Req'd"}$$

program to analyze a range of weld quality factors and tee pressure capacities;

```
f := for i ∈ 1..9
       E ← .60 + (i − 1)·.05
       P ← 1·psi
       t_h ← P·D_h / (2·(S_h·E + P·Y))
       t_b ← P·D_b / (2·(S_b·E + P·Y))
       A_1 ← t_h·d_1·(2 − sin(β))
       A_2 ← max([[ 0 ; (2·d_2 − d_1)·(T_h − t_h − c) ]])
       A_3 ← max([[ 0 ; 2·L_4·(T_b − t_b − c)/sin(β) ]])
       while A_1 < (A_2 + A_3 + A_4)
         t_h ← P·D_h / (2·(S_h·E + P·Y))
         t_b ← P·D_b / (2·(S_b·E + P·Y))
         A_1 ← t_h·d_1·(2 − sin(β))
         A_2 ← max([[ 0 ; (2·d_2 − d_1)·(T_h − t_h − c) ]])
         A_3 ← max([[ 0 ; 2·L_4·(T_b − t_b − c)/sin(β) ]])
         P ← P + 1·psi
       v_{i,1} ← E
       v_{i,2} ← P/psi
     v
```

Summary $Tees_{17,i}$ = "36X12-D1536" Tee; P = 450.00 psi

ASME B31.3 Weld Quality Factor	Allow. Pressure of Tee, psi
0.60	363
0.65	393
0.70	424
0.75	454
0.80	484
0.85	514
0.90	544
0.95	574
1.00	604

f

Tee Summary Prgm

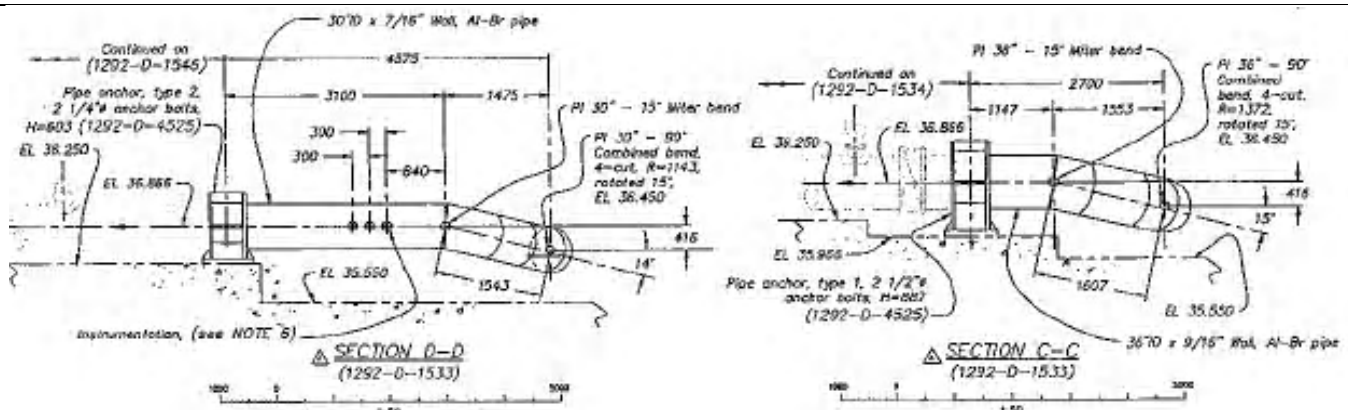
Tee Designation/Sheet No.	Permissible Design Pressure, psi			Tee Design Stataus at 450 psi		
	Weld Quality Factor, E			Weld Quality Factor, E		
0	0.60	0.80	1.00	0.60	0.80	1.00
48x36-D1533	92	122	153	NG	NG	NG
12x12-D1536	190	253	316	NG	NG	NG
10x10-D1536	163	217	271	NG	NG	NG
36X12-D1536	363	484	604	NG	OK	OK
30x12-D1536	333	444	554	NG	NG	OK
24x12-D1536	365	486	607	NG	OK	OK
18x12-D1536	402	535	668	NG	OK	OK
30x10-D1536	332	443	553	NG	NG	OK
24x10-D1536	360	480	599	NG	OK	OK
18x10-D1536	394	525	656	NG	OK	OK
30x12-D1537	333	444	554	NG	NG	OK
24x12-D1537	365	486	607	NG	OK	OK
20x12-D1537	361	481	601	NG	OK	OK
30x10-D1537	332	443	553	NG	NG	OK
24x10-D1537	360	480	599	NG	OK	OK
20x10-D1537	355	472	590	NG	OK	OK

Conclusion: The first three Tees in the list
are not adequate for 450 psi design pressure regardless of what Weld Quality Factor is assumed.

Mitered Bend Calculations

Mitered Bends per ASME B31.3, 304.2.3

References



36"x 90 Bend, Sheet D-1534, Section C-C

$D := 37.125 \cdot in$ $T := \frac{9}{16} \cdot in - .029 \cdot in$ $T = 0.53\ in$ $r_2 := \frac{D - T}{2}$ $r_2 = 18.30\ in$

$S := 20 \cdot ksi$ $E = 0.60$ $W = 1.00$ $c = 0.13\ in$

$R_1 := 1372 \cdot mm$ $R_1 = 54.02\ in$ $\frac{R_1}{D} = 1.45$ $n := 4$ number of cuts

$\theta := \frac{90 \cdot deg}{2 \cdot n}$ $\theta = 11.25\ deg$

maximum allowable pressure is lesser of Eq. 4a or Eq. 4b

$$\begin{bmatrix} \frac{S \cdot E \cdot W \cdot (T - c)}{r_2} \cdot \left[\frac{T - c}{(T - c) + .643 \cdot \tan(\theta) \cdot \sqrt{r_2 \cdot (T - c)}} \right] \\ \frac{S \cdot E \cdot W \cdot (T - c)}{r_2} \cdot \left(\frac{R_1 - r_2}{R_1 - .5 \cdot r_2} \right) \end{bmatrix} = \begin{pmatrix} 144.36 \\ 213.30 \end{pmatrix} psi$$

$$P := \min\left(\begin{bmatrix} \frac{S \cdot E \cdot W \cdot (T - c)}{r_2} \cdot \left[\frac{T - c}{(T - c) + .643 \cdot \tan(\theta) \cdot \sqrt{r_2 \cdot (T - c)}} \right] \\ \frac{S \cdot E \cdot W \cdot (T - c)}{r_2} \cdot \left(\frac{R_1 - r_2}{R_1 - .5 \cdot r_2} \right) \end{bmatrix} \right)$$

$P = 144.36\ psi$

Weld Quality Factor E	Permissible Design Pressure, psi
0.60	144
0.80	192
1.00	241

30"x 90 Bend, Sheet D-1534, Section D-D

$D := 30.875 \cdot in$ $T := \frac{7}{16} \cdot in - .023 \cdot in$ $T = 0.41\ in$ $r_2 := \frac{D - T}{2}$ $r_2 = 15.23\ in$

$S := 20 \cdot ksi$ $E = 0.60$ $W = 1.00$ $c = 0.13\ in$

$R_1 := 1143 \cdot mm$ $R_1 = 45.00\ in$ $\frac{R_1}{D} = 1.46$ $n := 4$ number of cuts

$\theta := \frac{90 \cdot deg}{2 \cdot n}$ $\theta = 11.25\ deg$

maximum allowable pressure is lesser of Eq. 4a or Eq. 4b

$$\begin{bmatrix} \frac{S \cdot E \cdot W \cdot (T - c)}{r_2} \cdot \left[\frac{T - c}{(T - c) + .643 \cdot \tan(\theta) \cdot \sqrt{r_2 \cdot (T - c)}} \right] \\ \frac{S \cdot E \cdot W \cdot (T - c)}{r_2} \cdot \left(\frac{R_1 - r_2}{R_1 - .5 \cdot r_2} \right) \end{bmatrix} = \begin{pmatrix} 118.33 \\ 181.64 \end{pmatrix} psi$$

$$P := \min\left[\begin{bmatrix} \frac{S \cdot E \cdot W \cdot (T - c)}{r_2} \cdot \left[\frac{T - c}{(T - c) + .643 \cdot \tan(\theta) \cdot \sqrt{r_2 \cdot (T - c)}} \right] \\ \frac{S \cdot E \cdot W \cdot (T - c)}{r_2} \cdot \left(\frac{R_1 - r_2}{R_1 - .5 \cdot r_2} \right) \end{bmatrix}\right]$$

$P = 118.33\ psi$

Weld Quality Factor E	Permissible Design Pressure, psi
0.60	118
0.80	158
1.00	197

Conclusion: Mitered Bends on D-1534 fail to meet 450 design pressure regardless of assumption of weld quality factor, E

Appendix K
Galvanic Corrosion Considerations for the Partial Replacement of Aluminum Bronze Piping

Galvanic Corrosion Considerations

for the

Partial Replacement of Aluminum Bronze Piping

at the

Yuma Desalting Plant

Prepared by James F. Jenkins. P.E.

for CH2MHill

30 July, 2007

Introduction

Due to weld flaws in the high pressure aluminum bronze piping at the Yuma Desalting Plant (YDP) replacement of portions of the high pressure aluminum bronze piping with alternative materials is being considered. Type 316L stainless steel is currently being considered as a material for the replacement piping. The use of other stainless steels with improved corrosion resistance compared to Type 316 stainless steel for replacement piping is also possible.

Galvanic corrosion between existing aluminum bronze piping and the replacement piping is one consideration for the development of a design for partial piping replacement at the YDP. Galvanic corrosion on the interior of the piping while the pipes are full or partially full of liquid is of concern. If the replacement piping is to be buried, galvanic corrosion between the replacement piping and other buried metals is also of concern. The variability of internal galvanic corrosion with the different chemical conditions and velocities inside the piping system is another important consideration.

Galvanic Corrosion Basics

Galvanic corrosion can occur when different metals are in electrical contact and exposed to an electrolyte such as soil or water. If only two metals are involved one metal acts as an anode and its corrosion rate is increased over its uncoupled corrosion rate and the other metal acts as a cathode and its corrosion rate is usually reduced. This activity is reflected in the Galvanic Series shown in Figure 1. More active (anodic) metals are listed above the less active (noble) metals.

The acceleration of the corrosion of the more anodic material is dependent on many factors such as the potential difference between the metals involved, the electrochemical characteristics of the metals involved, the relative areas of the anode and the cathode and characteristics of the environment, particularly environmental resistivity.

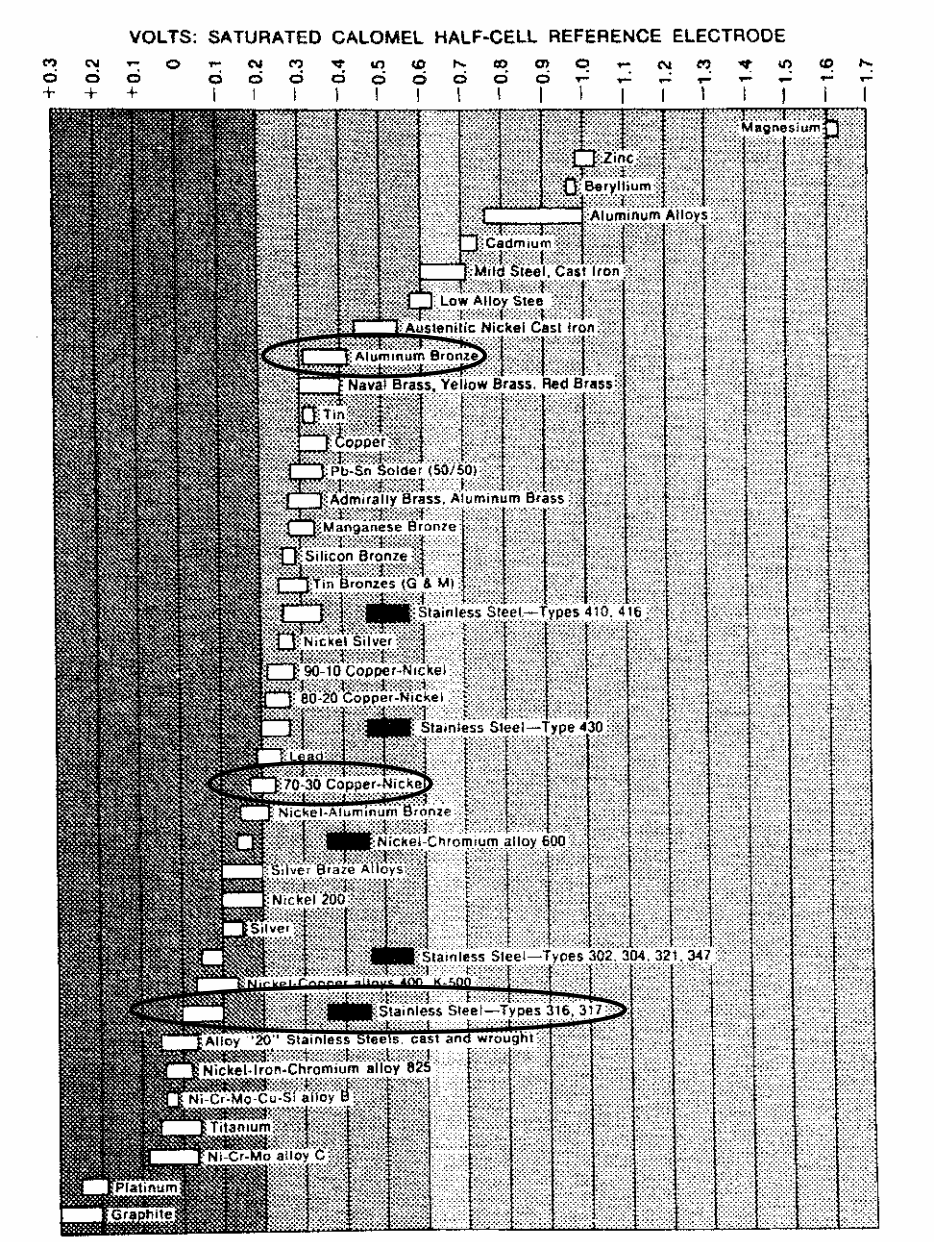
Most of the quantitative data on the galvanic corrosion of materials has been developed for high salinity waters such as seawater. While this data is useful in making qualitative predictions of the galvanic interactions between aluminum bronze and stainless steels in the relatively low salinity water at the YDP, particularly where chemical additions have modified the water in terms of pH, salinity and other chemical additions, quantitative predictions of performance may require in-plant or pilot plant testing.

Galvanic Corrosion Between Aluminum Bronze and Type 316 Stainless Steel Piping

When aluminum bronze and Type 316 are electrically coupled and exposed to an electrolyte, the aluminum bronze will act as an anode with respect to the stainless steel if the stainless steel remains passive. However, if the stainless steel becomes active, the active areas on the stainless steel may be anodic with respect to the aluminum bronze. This is shown in Figure 1 (Reference 1).

The potential ranges for active Type 316 stainless steel and the aluminum bronze overlap. Thus, any active sites on the Type 316 stainless steel may or may not be anodic with respect to the aluminum bronze.

This may be significant at the YDP if any sites on the stainless steel become active as would be the case if microbiological corrosion of the stainless steel is initiated. The potential difference between the anodic sites on the stainless steel and the adjoining passive stainless steel would be greater than the potential difference between the active sites on the stainless steel and the aluminum bronze, but corrosion between the active sites and the aluminum bronze might be significant because the surface of the passive stainless steel is not a very effective cathode (as will be described later) but the aluminum bronze is a very effective cathode.



Alloys are listed in the order of the potential they exhibit in flowing sea water. Certain alloys indicated by the symbol: ■ in low-velocity or poorly aerated water, and at shielded areas, may become active and exhibit a potential near −0.5 volts.

Figure 6-1. Galvanic series in seawater.

Figure 1. Galvanic Series in Seawater

This leads to the possibility that the coupling of the stainless steel to the aluminum bronze could be detrimental to both the aluminum bronze and the stainless steel. The corrosion of the aluminum bronze would be accelerated while the stainless steel remains passive, but the corrosion of the stainless steel might be accelerated if corrosion on the stainless steel initiates at active sites.

If the assumption is made that the stainless steel will remain passive, the electrochemical characteristics of the stainless steel make the couple between the aluminum bronze and stainless steel relatively innocuous (but possibly still be significant) compared to coupling of the aluminum bronze to a more cathodic material with different electrochemical characteristics such as 70-30 copper-nickel. In the YDP, it is likely that the stainless steel, if properly cleaned and passivated, will remain passive under conditions of continuous flow. However, primarily due to the effect of oxygen depletion and micro-biological effects, the stainless steel may become locally active during periods of low flow or stagnation.

A potential of around -400 mV for couples between Type 316 stainless and aluminum bronze, where the area ratio between the aluminum bronze and stainless steel is effectively about 1 to 1 as would be expected in a piping system, can be expected as the passive nature of the Type 316 stainless steel results in the couple taking a potential close to the non-passive material.

Effect of Chlorination

Biofilms increase the efficiency of stainless steel acting as a cathode in a galvanic couple. If the formation of biofilms is inhibited, as in the case of chlorinated waters, the efficiency of stainless steels acting as a cathode, and the resultant galvanic corrosion of the anodic material is reduced. This is shown in Figure 2 (Reference 2).

Without chlorine, the electrode efficiency is about 30 μA/cm^2 at a potential of -400 mV(the anticipated potential of the aluminum bronze/Type 316 stainless steel couple with a 1 to 1 area ratio). With chorination at a level of 0.5 mg/L (and indeed with no biofilm at all) the electrode efficiency is is about 0.30 μA/cm^2, a 100 fold decrease in electode efficiency and, all else being equal, a 100 fold decrease in corrosion of the anodic material.

Thus ahcieving and maintaining sufficient chlorination to inhibit biofilm formation inside the piping where stainless steel and aluminum bronze are connected will be very valuable. Of course, this chlorination level must be maintained, or the system should be drained and dried.

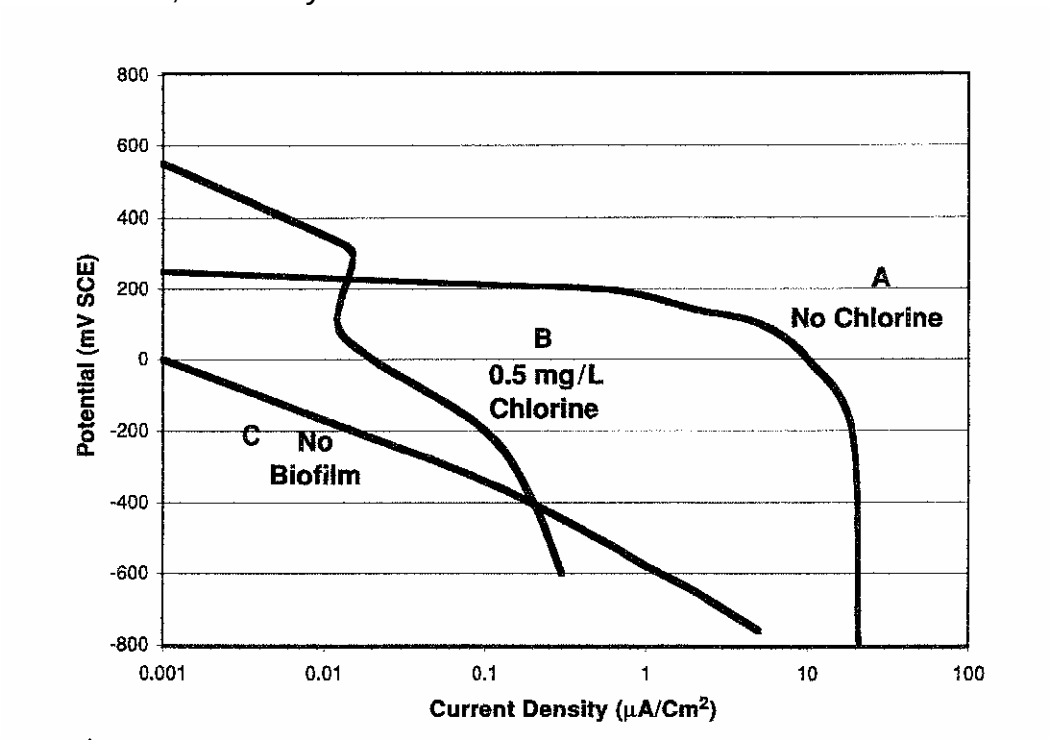


Figure 2. Effect of chlorination on cathodic efficiency of a stainless steel in seawater.

Factors Affecting the Intensity of Galvanic Attack

The intensity of galvanic attack on the anode in a galvanic couple is a function of the current density on the anode in terms of Amperes per unit area.

Stainless steels are relatively poor cathodes in terms of the current density that can be supported on their surfaces. This is due to the presence of an oxide film that serves as an electrical insulator between the surface of the stainless steel metallic structure and the electrolyte. As described above, biofilm formation also has a large effect on the efficiency of stainless steels as a cathode.

Effect of Area Ratio

In piping systems, the range of current flow is limited and galvanic corrosion is limited to a zone a few pipe diameters from the junction. Thus the effective area ratio inside pipes is about 1 to 1. The range of galvanic corrosion inside piping is limited as shown in Figure 3 (Reference 3).

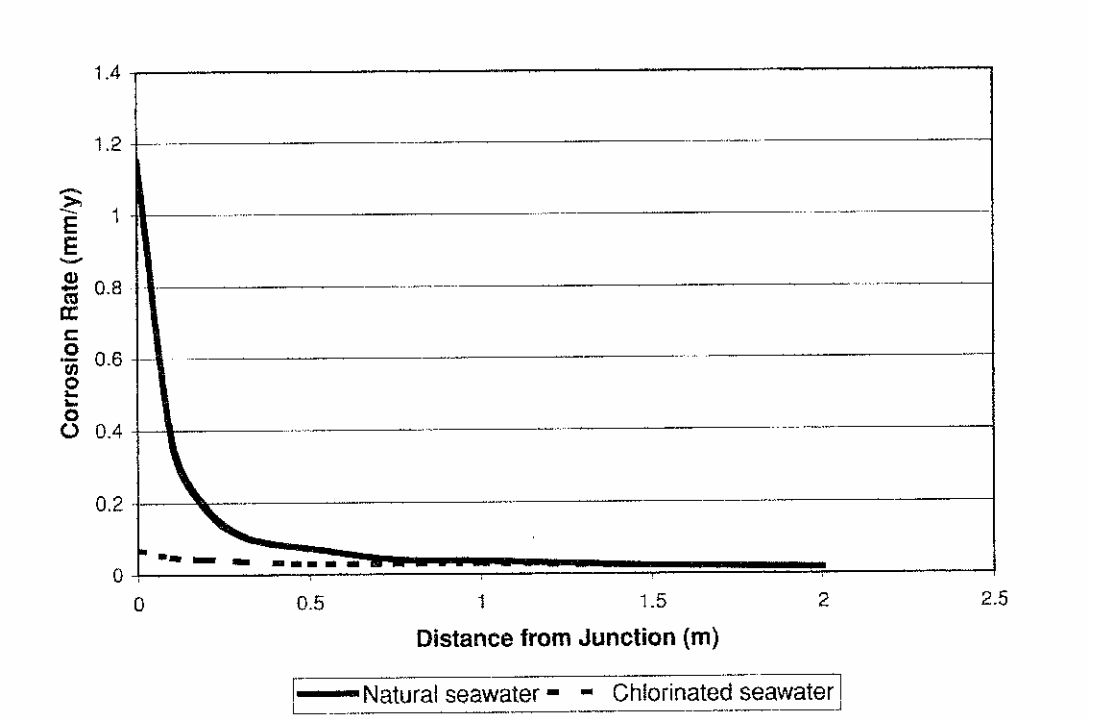


Figure 3. Range of galvanic corrosion - 90/10 Copper-Nickel and stainless steel pipe couples.

One method of mitigating galvanic corrosion on the inside of piping is to insert a short “spool piece” of well coated stainless steel, or (preferred) a non-metallic metarial between the aluminum bronze and stainelss steel piping. A spool piece that is five times as long as the pipe diameter is commonly used.

The effect of area ratio on a couple similar to the aluminum bronze/316 SS couple being considered is shown in Figure 4 (Reference 4) which is for aluminum bronze (solid line) and a 6% Molybdenum stainless steel.

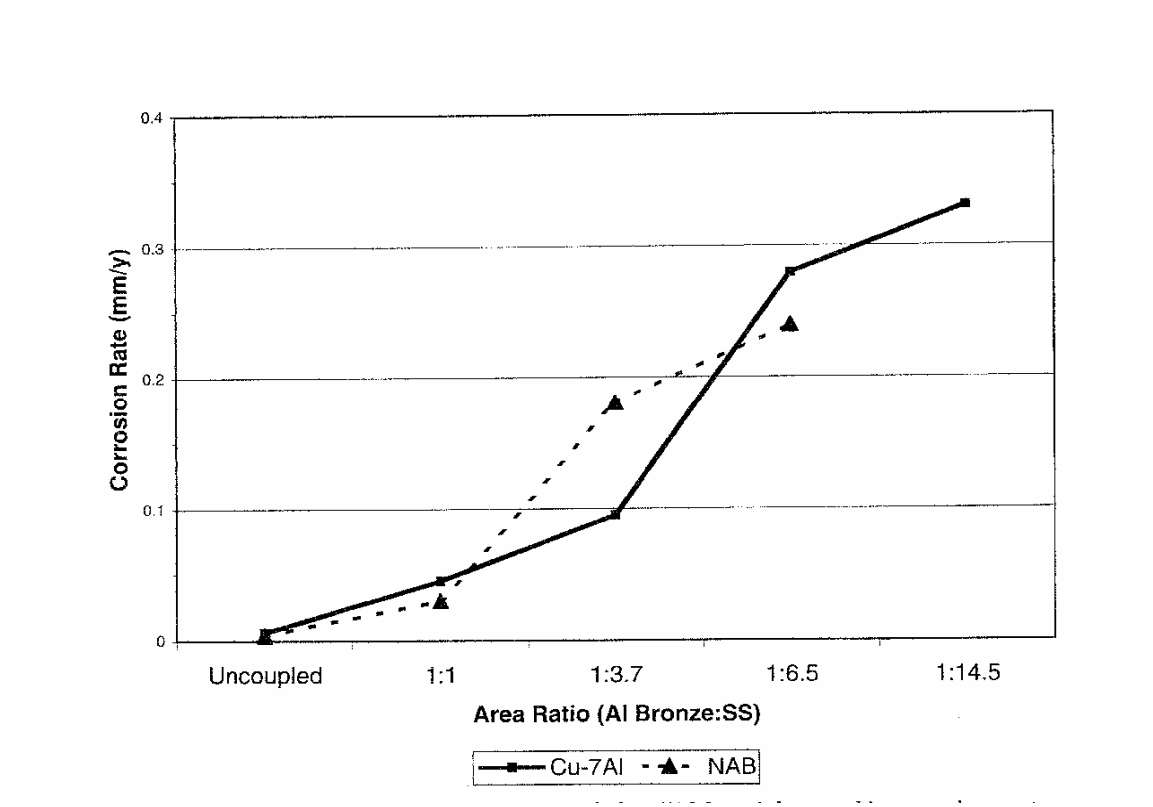


Figure 4. Galvanic corrosion between aluminum bronze (solid line) and 6% Mo stainless steel in natural seawater as a function of area ratio.

However, the primary consideration of area ratio is for pipe exteriors if both the aluminum bronze and stainless steel are buried. In this case, the total exposed area of the aluminum bronze and stainless steel exposed to the soil must be considered. The worst condition occurs when the effective exposed area of the anodic material is small with respect to the cathodic material. In addition, under burial conditions, the beneficial effect of chlorination is absent. This can be seen in Figure 4 which shows a dramatic increase in the corrosion rate of the aluminum bronze with increasing area ratio. Thus, galvanic corrosion may be more of a problem for the exterior of buried piping than for the interior of the piping.

Fortunately, the galvanic corrosion on external surfaces can be mitigated by coating or wrapping the cathodic material, or by cathodic protection. However, in the case of Type 316 stainless steel, coating may be difficult to apply, and wrapping (such as a loose polyethylene wrap) may create oxygen depletion next to the stainless steel which could result in localized attack on the stainless steel. Cathodic protection is probably the best solution to galvanic corrosion between buried aluminum bronze and

stainless steel piping at the YDP if the stainless steel replacement piping is buried. Placing below grade stainless steel piping in lined vaults should also be considered.

Environmental Factors / Need for Testing

Quantitative data on galvanic corrosion is widely available for natural and chlorinated seawater, but not for waters that reflect the conditions at the YDP. At the YDP there are various conditions in various locations in the plant with respect to salinity, pH, chlorination levels and other chemical additions. In order to determine the actual levels of galvanic corrosion that are likely to occur if portions of the aluminum bronze piping at the YDP is replaced with stainless steel, it is recommended that validation testing be performed before piping replacement is planned. Testing of aluminum bronze/Type 316 stainless steel couples in the various anticipated environments using tests such as ASTM D2688 should be considered in order to generate quantitative measures of the galvanic corrosion that can be anticipated in various locations in the plant. In ASTM B2688, Method B, cylindrical pipe sections are exposed to a flow of the environment being considered. In order to evaluate galvanic corrosion of aluminum bronze/stainless steel couples, sections of stainless steel and aluminum bronze tubes would be electrically coupled and exposed to the environment being considered. The specimens would be evaluated by weight loss (aluminum bronze) and pit depth measurements (stainless steel) after exposure.

References

1. Marine Corrosion- Causes and Prevention, by F.L LaQue, John Wiley & Sons, 1975, page 179.

2. Galvanic Corrosion: A Practical Guide for Engineers, by Roger Francis, NACE International, 2001, page 14.

3. Galvanic Corrosion: A Practical Guide for Engineers, by Roger Francis, NACE International, 2001, page 69.

4. Galvanic Corrosion: A Practical Guide for Engineers, by Roger Francis, NACE International, 2001, page 50.

Appendix L
Cost Estimate

Aluminum Bronze Piping Rehabilitation
Yuma Desalting Plant
Cost Estimate Summary for Pipes 22 and 27-36

Summary of Items or Facilities	Lump Sum Cost	Total (Range)
- Pipes 22 & 27 (Inspect & Repair or Inspect & CIPP)		$158,900 - $661,040
+ Allowance for inspection and planning	$130,900	
+ Alt 1 - Butt Welded Plates	$40,000	
+ Alt 2 - Weko-Seals	$28,000	
+ Alt 3 - Cured-In-Place Pipe	$530,140	
- Pipes 28 & 33 (Pressure Test & Repair or Pressure Test & Replace)		$78,200 - $981,438
+ Allowance for testing and planning	$50,200	
+ Alt 1 - Butt Welded Plates	$40,000	
+ Alt 2 - Weko-Seals	$28,000	
+ Alt 3 - Replace with 316 Stainless Steel	$931,238	
(From Estimate Page 47 - B Rehabilitation, Col D.; 07 Pretreatment; D Exterior)		
- Pipe 29 (Pressure Test & Repair)		$49,400 - $57,400
+ Allowance for testing and planning	$37,400	
+ Alt 1 - Butt Welded Plates	$20,000	
+ Alt 2 - Weko-Seals	$12,000	
- Pipes 30, 31, 32, 34 (Inspect & Repair)		$99,700 - $113,700
+ Allowance for inspection and planning	$78,700	
+ Alt 1 - Butt Welded Plates	$35,000	
+ Alt 2 - Weko-Seals	$21,000	
- Pipe 35 & 36 (Pressure Test & Replace or Inspect & CIPP)		$163,825 - $192,673
+ Allowance for testing, inspection, and planning	$44,200	
+ Alt 1 - Replace with 316 Stainless Steel	$119,625	
(From Estimate Page 49 - B Rehabilitation, Col D.; 08 Other; D1 Exterior, WQIC)		
+ Alt 2 - Cured-In-Place Pipe	$148,473	
- Mobilization (4.5% of Total Cost)		$24,751.13 - $90,281.30
Total Cost for Rehabilitation		**$574,776 - $2,096,532**

Yuma Desalting Plant
Aluminum Bronze Piping Rehabilitation

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

PROJECT: Piping Rehabilitation for YDP
CLIENT: United States Bereau of Reclamation
DESIGN STAGE: Preliminary Design, Class 3 Estimate
PROJ MGR: Bruce Johnson/LAS
CLIENT PROJ NO.:

ENR CCI: November 2007 ENR for Los Angeles at 8871.09
ESTIMATOR: Robert Lawson/RDD
REVIEWED BY: Robert Lawson/RDD
EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY	UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
01 Rehabilitation, Col. B										
Mobilization										
GENERAL CONDITIONS										
		Unit Costs---->						625000.00	625000.00	
Mobilization & Demobilization (Approx. 7.5% Total)	1.00	LS						$625,000	$625,000	**$625,000**
TOTAL 01000 GENERAL CONDITIONS								**$625,000**	**$625,000**	**$625,000**
1.00 LS										
1.00 LS										***$625,000.00***

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

PROJECT: Piping Rehabilitation for YDP
CLIENT: United States Bereau of Reclamation
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CLIENT PROJ NO.:

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REVIEWED BY: Robert Lawson/RDD
EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
A 1st St. Feed/2nd St. Reject Fluid Systems CONCRETE									
	Unit Costs---->	0.01						0.01	
Fluid Systems	1.00								
	Unit Costs---->	0.01						0.01	
Line 1 - High Pressure Pump Discharge	1.00								
030551100070A	Unit Costs---->		B9	10.000	218.56	50.28		268.84	470.34
Selective concrete demolition, break into small pieces, maximum reinforcing	275.00 C.Y.		21.86	2,750	$60,105	$13,827		$73,932	**$129,342**
022203505000	Unit Costs---->		B34B	0.010	0.25	0.73		0.97	1.71
Rubbish handling, lding & trucking, haul, per MI, up to 8 c.y truck	2,750.00 C.Y.		24.62	28	$677	$2,004		$2,681	**$4,691**
031104552000	Unit Costs---->	2.49	C2	0.160	4.72			7.36	12.87
C.I.P. concrete forms, wall, job built, plywood, below grade, to 8' high, 1 use,	1,820.00 SFCA	$4,804	29.48	291	$8,586			$13,390	**$23,425**
032106001050	Unit Costs---->	1099.91	RODM	15.237	598.27			1764.18	3086.40
Reinforcing, A615 Gr 60, typical in place, average, 10 - 60 tons, #3 to #7	30.94 Ton	$36,073	39.27	471	$18,511			$54,584	**$95,493**
032106002000	Unit Costs---->		C5	0.560	21.02	8.13		29.15	51.00
Reinforcing in place, unloading & sorting, add to above	30.94 Ton		37.54	17	$650	$252		$902	**$1,578**
032106002210	Unit Costs---->		C5	0.609	22.86	8.85		31.70	55.47
Reinforcing in place, crane cost for handling, add to above, average	30.94 Ton		37.54	19	$707	$274		$981	**$1,716**
033102200300	Unit Costs---->	120.00						127.20	222.53
Concrete, ready mix, regular weight, 4000 psi	275.00 C.Y.	$34,980						$34,980	**$61,197**

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

PROJECT: Piping Rehabilitation for YDP
CLIENT: United States Bereau of Reclamation
DESIGN STAGE: Preliminary Design, Class 3 Estimate
PROJ MGR: Bruce Johnson/LAS
CLIENT PROJ NO.:

ENR CCI: November 2007 ENR for Los Angeles at 8871.09
ESTIMATOR: Robert Lawson/RDD
REVIEWED BY: Robert Lawson/RDD
EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
A 1st St. Feed/2nd St. Reject									
Fluid Systems									
CONCRETE									
033107002950	Unit Costs---->		C20	0.350	8.59	4.78		13.37	23.39
Placing conc, incl vib, foundation mats, over 20 CY, pumped	275.00 C.Y.		24.55	96	$2,363	$1,314		$3,677	**$6,432**
Subtotal		$75,857			$91,599	$17,670		$185,126	
Markups using CH-MK		$56,853			$68,652	$13,244			$138,748
TOTAL 03000 CONCRETE		**$132,710**		**3,673**	**$160,251**	**$30,914**		**$185,126**	**$323,874**
1.00 LS									
1.00 LS									***$323,874.30***
A 1st St. Feed/2nd St. Reject									
Fluid Systems									
MECHANICAL									
	Unit Costs---->	0.01						0.01	
Fluid Systems	1.00								
	Unit Costs---->	0.01						0.01	
Line 1 - High Pressure Pump Discharge	1.00								
152101301140A	Unit Costs---->	120.51	PIPE04S	1.500	61.53	3.90		193.17	337.95
12" SST 316-L, pipe assembly, shop fabricated	50.00 LF	$6,387	41.02	75	$3,077	$195		$9,659	**$16,898**
152101901170A	Unit Costs---->	198.29	PIPE04S	1.700	69.74	4.42		284.34	497.45
18" SST 316-L, pipe assembly, shop fabricated	158.00 LF	$33,210	41.02	269	$11,018	$698		$44,926	**$78,597**
152102301170A	Unit Costs---->	334.83	PIPE04S	1.800	73.84	4.68		433.44	758.29
24" SST 316-L, pipe assembly, shop fabricated	9.00 LF	$3,194	41.02	16	$665	$42		$3,901	**$6,825**
152103101170A	Unit Costs---->	1064.70	PIPE04S	3.100	127.17	8.06		1263.81	2211.00
48" SST 316-L, pipe assembly, shop fabricated	254.00 LF	$286,660	41.02	787	$32,300	$2,047		$321,007	**$561,595**
	Unit Costs---->	0.01						0.01	
Line 1 - Fittings & Work Req'd, Ref Dwg. -4489, -4499, & 4500	1.00								
152101401130A	Unit Costs---->	470.00	PIPE04S	9.600	393.80	24.96		916.96	
12" Stainless Steel Tee	1.00 EA	$498	41.02	10	$394	$25		$917	**$1,604**

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

PROJECT: Piping Rehabilitation for YDP
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CLIENT PROJ NO.:

ENR CCI: November 2007 ENR for Los Angeles at 8871.09
ESTIMATOR: Robert Lawson/RDD
REVIEWED BY: Robert Lawson/RDD
EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY	UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
A 1st St. Feed/2nd St. Reject										
Fluid Systems										
MECHANICAL										
152101443140B		Unit Costs---->	824.00	PIPE04S	6.000	246.13	15.60		1135.17	1985.95
12" Stainless Steel, Weld on Cone Saddle	3.00	EA	$2,620	41.02	18	$738	$47		$3,406	**$5,958**
152101401210A		Unit Costs---->	659.00	PIPE04S	9.836	403.48	25.57		1127.60	1972.71
12" Stainless Steel, Slip-On Flange	3.00	EA	$2,096	41.02	30	$1,210	$77		$3,383	**$5,918**
152102041110A		Unit Costs---->	2066.00	PIPE04S	14.754	605.23	38.36		2833.55	4957.23
18" Stainless Steel, Slip-On Flange	17.00	EA	$37,229	41.02	251	$10,289	$652		$48,170	**$84,273**
152102044140A		Unit Costs---->	1240.00	PIPE04S	16.000	656.34	41.60		2012.34	3520.54
18" Stainless Steel, Weld on Cone Saddle	10.00	EA	$13,144	41.02	160	$6,563	$416		$20,123	**$35,205**
152102441110		Unit Costs---->	3583.00	PIPE04S	19.762	810.66	51.38		4660.02	
24" Stainless Steel, Slip-On Flange	1.00	EA	$3,798	41.02	20	$811	$51		$4,660	**$8,153**
152103201140A		Unit Costs---->	3014.00	PIPE04S	30.900	1267.56	80.33		4542.73	
48" x 24" Stainless Steel Reducer	1.00	EA	$3,195	41.02	31	$1,268	$80		$4,543	**$7,947**
		Unit Costs---->	0.01						0.01	
Line 2 - From Pump Manifold to DSB	1.00									
152103101170A		Unit Costs---->	1064.70	PIPE04S	3.100	127.17	8.06		1263.81	2211.00
48" SST 316-L, pipe assembly, shop fabricated	43.00	LF	$48,529	41.02	133	$5,468	$347		$54,344	**$95,073**
		Unit Costs---->	0.01						0.01	
Line 2 - Fittings & Work Req'd, Ref Dwg. -4501	1.00									
152103201110A		Unit Costs---->	3280.00	PIPE04S	30.900	1267.56	80.33		4824.69	8440.69
48" Stainless Steel Elbow, 15 degree (1 Miter Elbow)	2.00	EA	$6,954	41.02	62	$2,535	$161		$9,649	**$16,881**
		Unit Costs---->	0.01						0.01	
Line 3 - DSB Supply Trench Upstream of Valves	1.00									
152102701170A		Unit Costs---->	772.09	PIPE04S	2.600	106.66	6.76		931.83	1630.22
36" SST 316-L, pipe assembly, shop fabricated	143.00	LF	$117,033	41.02	372	$15,252	$967		$133,252	**$233,121**
152103101170A		Unit Costs---->	1064.70	PIPE04S	3.100	127.17	8.06		1263.81	2211.00
48" SST 316-L, pipe assembly, shop fabricated	214.00	LF	$241,517	41.02	663	$27,213	$1,725		$270,455	**$473,155**
		Unit Costs---->	0.01						0.01	
Line 3 - Fittings & Work Req'd, Ref Dwg. -1533 & 1534	1.00									
152102801110A		Unit Costs---->	2089.00	PIPE04S	23.400	959.89	60.84		3235.07	5659.69
36" Stainless Steel Elbow, 15 degree (1 Miter Elbow)	2.00	EA	$4,429	41.02	47	$1,920	$122		$6,470	**$11,319**
152102801110A		Unit Costs---->	9170.00	PIPE04S	23.400	959.90	60.84		10740.94	
36" Stainless Steel Elbow, 90 degree (4 Miter Elbow)	1.00	EA	$9,720	41.02	23	$960	$61		$10,741	**$18,791**
152103201140A		Unit Costs---->	3014.00	PIPE04S	30.900	1267.56	80.33		4542.73	
48" x 36" Stainless Steel Reducer	1.00	EA	$3,195	41.02	31	$1,268	$80		$4,543	**$7,947**

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

PROJECT: Piping Rehabilitation for YDP
CLIENT: United States Bereau of Reclamation
DESIGN STAGE: Preliminary Design, Class 3 Estimate
PROJ MGR: Bruce Johnson/LAS
CLIENT PROJ NO.:

ENR CCI: November 2007 ENR for Los Angeles at 8871.09
ESTIMATOR: Robert Lawson/RDD
REVIEWED BY: Robert Lawson/RDD
EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
A 1st St. Feed/2nd St. Reject Fluid Systems MECHANICAL									
152103201130A	Unit Costs---->	11259.00	PIPE04S	41.200	1690.07	107.11		13731.72	
48" x 36" Stainless Steel Reducer Tee	1.00 EA	$11,935	41.02	41	$1,690	$107		$13,732	**$24,023**
151076605632A	Unit Costs---->	17.50	Q15	0.727	32.38	3.07		54.00	94.48
Nozzle, stainless steel, T-O-L, weld-on, 1/2" pipe	3.00 Ea.	$56	44.54	2	$97	$9		$162	**$283**
	Unit Costs---->	50.00	PIPE04S	2.000	82.04	5.20		140.24	
3" Stainless Steel Nozzle, Pe x Pe, Weld to Main Line	1.00 EA	$53	41.02	2	$82	$5		$140	**$245**
	Unit Costs---->	0.01						0.01	
Line 4 - DSB Control Block Trench No. 1 (East)	1.00								
152100701110A	Unit Costs---->	45.48	PIPE04S	1.100	45.12	2.86		96.19	168.29
6" SST 316-L, pipe assembly, shop fabricated	75.00 LF	$3,616	41.02	83	$3,384	$214		$7,214	**$12,621**
152100901110A	Unit Costs---->	69.97	PIPE04S	1.300	53.33	3.38		130.88	228.96
8" SST 316-L, pipe assembly, shop fabricated	273.00 LF	$20,248	41.02	355	$14,558	$923		$35,729	**$62,507**
152101101110A	Unit Costs---->	97.62	PIPE04S	1.300	53.33	3.38		160.18	280.24
10" SST 316-L, pipe assembly, shop fabricated	66.00 LF	$6,829	41.02	86	$3,520	$223		$10,572	**$18,496**
152101301140A	Unit Costs---->	120.51	PIPE04S	1.500	61.53	3.90		193.17	337.95
12" SST 316-L, pipe assembly, shop fabricated	61.00 LF	$7,792	41.02	92	$3,753	$238		$11,783	**$20,615**
152101901170A	Unit Costs---->	198.29	PIPE04S	1.700	69.74	4.42		284.34	497.45
18" SST 316-L, pipe assembly, shop fabricated	139.00 LF	$29,216	41.02	236	$9,693	$614		$39,524	**$69,146**
152102301170A	Unit Costs---->	334.83	PIPE04S	1.800	73.84	4.68		433.44	758.29
24" SST 316-L, pipe assembly, shop fabricated	89.00 LF	$31,588	41.02	160	$6,572	$416		$38,576	**$67,488**
152102501170A	Unit Costs---->	646.21	PIPE04S	2.400	98.45	6.24		789.67	1381.52
30" SST 316-L, pipe assembly, shop fabricated	60.00 LF	$41,099	41.02	144	$5,907	$374		$47,380	**$82,891**
152102701170A	Unit Costs---->	772.09	PIPE04S	2.600	106.66	6.76		931.83	1630.22
36" SST 316-L, pipe assembly, shop fabricated	68.00 LF	$55,652	41.02	177	$7,253	$460		$63,364	**$110,855**
	Unit Costs---->	0.01						0.01	
Line 4 - Fittings & Work Req'd, Ref Dwg. -1536	1.00								
152100841110	Unit Costs---->	176.00	PIPE04S	4.233	173.64	11.01		371.21	649.42
6" Stainless Steel, Slip-On Flange	11.00 EA	$2,052	41.02	47	$1,910	$121		$4,083	**$7,144**
152100842320A	Unit Costs---->	360.00	PIPE04S	0.750	30.77	1.95		414.32	724.84
6" Grooved Coupling	11.00 EA	$4,198	41.02	8	$338	$21		$4,557	**$7,973**
152101001140A	Unit Costs---->	78.00	PIPE04S	3.600	147.68	9.36		239.72	419.38
8" x 6" Stainless Steel Reducer	11.00 EA	$909	41.02	40	$1,624	$103		$2,637	**$4,613**
152101041110	Unit Costs---->	290.00	PIPE04S	6.557	268.98	17.05		593.42	1038.18
8" Stainless Steel, Slip-On Flange	46.00 EA	$14,140	41.02	302	$12,373	$784		$27,297	**$47,756**

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

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PROJ MGR: Bruce Johnson/LAS
CLIENT PROJ NO.:

ENR CCI: November 2007 ENR for Los Angeles at 8871.09
ESTIMATOR: Robert Lawson/RDD
REVIEWED BY: Robert Lawson/RDD
EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY	UNIT	MATERIALS	CREW	RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
A 1st St. Feed/2nd St. Reject											
Fluid Systems											
MECHANICAL											
152101042320A		Unit Costs---->	735.00	PIPE04S		1.713	70.27	4.45		853.82	1493.74
8" Grooved Coupling	22.00	EA	$17,140	41.02		38	$1,546	$98		$18,784	**$32,862**
152101243110A		Unit Costs---->	444.00	PIPE04S		4.400	180.49	11.44		662.57	1159.16
10" Stainless Steel, Weld on Saddle	6.00	EA	$2,824	41.02		26	$1,083	$69		$3,975	**$6,955**
152101201140A		Unit Costs---->	115.00	PIPE04S		6.600	270.74	17.16		409.80	716.93
10" x 8" Stainless Steel Reducer	12.00	EA	$1,463	41.02		79	$3,249	$206		$4,918	**$8,603**
152101201130A		Unit Costs---->	328.00	PIPE04S		8.800	360.99	22.88		731.54	1279.82
10" Stainless Steel Tee	6.00	EA	$2,086	41.02		53	$2,166	$137		$4,389	**$7,679**
152101242320A		Unit Costs---->	875.00	PIPE04S		2.058	84.42	5.35		1017.27	1779.70
10" Grooved Coupling	6.00	EA	$5,565	41.02		12	$507	$32		$6,104	**$10,678**
152101401140A		Unit Costs---->	182.00	PIPE04S		7.200	295.35	18.72		506.99	886.97
12" x 8" Stainless Steel Reducer	22.00	EA	$4,244	41.02		158	$6,498	$412		$11,154	**$19,513**
152101401130A		Unit Costs---->	470.00	PIPE04S		9.600	393.80	24.96		916.96	1604.21
12" Stainless Steel Tee	11.00	EA	$5,480	41.02		106	$4,332	$275		$10,087	**$17,646**
152101443140A		Unit Costs---->	659.00	PIPE04S		4.800	196.90	12.48		907.92	1588.39
12" Stainless Steel, Weld on Saddle	12.00	EA	$8,382	41.02		58	$2,363	$150		$10,895	**$19,061**
152101442320A		Unit Costs---->	1225.00	PIPE04S		2.250	92.30	5.85		1396.65	2443.40
12" Grooved Coupling	12.00	EA	$15,582	41.02		27	$1,108	$70		$16,760	**$29,321**
152101442120A		Unit Costs---->	146.00	PIPE04S		2.400	98.45	6.24		259.45	
12" Stainless Steel Grooved End Cap	1.00	EA	$155	41.02		2	$98	$6		$259	**$454**
152102041110A		Unit Costs---->	2066.00	PIPE04S		14.754	605.23	38.36		2833.55	4957.23
18" Stainless Steel, Slip-On Flange	2.00	EA	$4,380	41.02		30	$1,210	$77		$5,667	**$9,914**
152102401140A		Unit Costs---->	997.00	PIPE04S		19.800	812.22	51.48		1920.52	3359.90
24" x 18" Stainless Steel Reducer	2.00	EA	$2,114	41.02		40	$1,624	$103		$3,841	**$6,720**
152102401120A		Unit Costs---->	3925.00	PIPE04S		19.800	812.22	51.48		5024.19	8789.72
24" Stainless Steel Elbow, 90 degree (4 Miter Elbow)	2.00	EA	$8,321	41.02		40	$1,624	$103		$10,048	**$17,579**
152102441110		Unit Costs---->	3583.00	PIPE04S		19.762	810.66	51.38		4660.02	8152.60
24" Stainless Steel, Slip-On Flange	2.00	EA	$7,596	41.02		40	$1,621	$103		$9,320	**$16,305**
152102601140A		Unit Costs---->	1994.00	PIPE04S		21.000	861.45	54.60		3029.69	
30" x 24" Stainless Steel Reducer	1.00	EA	$2,114	41.02		21	$861	$55		$3,030	**$5,300**
152102801140A		Unit Costs---->	2643.00	PIPE04S		23.400	959.90	60.84		3822.32	
36" x 30" Stainless Steel Reducer	1.00	EA	$2,802	41.02		23	$960	$61		$3,822	**$6,687**
152102841110		Unit Costs---->	12494.00	PIPE04S		29.508	1210.45	76.72		14530.81	25421.34
36" Stainless Steel, Slip-On Flange	2.00	EA	$26,487	41.02		59	$2,421	$153		$29,062	**$50,843**

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

PROJECT: Piping Rehabilitation for YDP
CLIENT: United States Bereau of Reclamation
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PROJ MGR: Bruce Johnson/LAS
CLIENT PROJ NO.:

ENR CCI: November 2007 ENR for Los Angeles at 8871.09
ESTIMATOR: Robert Lawson/RDD
REVIEWED BY: Robert Lawson/RDD
EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
A 1st St. Feed/2nd St. Reject									
Fluid Systems									
MECHANICAL									
151076605632A	Unit Costs---->	17.50	Q15	0.727	32.38	3.07		54.00	94.48
Nozzle, stainless steel, T-O-L, weld-on, 1/2" pipe	3.00 Ea.	$56		44.54	2	$97	$9	$162	**$283**
	Unit Costs---->	0.01						0.01	
Line 5 - DSB Control Block Trench No. 2 (West)	1.00								
152100701110A	Unit Costs---->	45.48	PIPE04S	1.100	45.12	2.86		96.19	168.29
6" SST 316-L, pipe assembly, shop fabricated	65.00 LF	$3,134		41.02	72	$2,933	$186	$6,252	**$10,939**
152100901110A	Unit Costs---->	69.97	PIPE04S	1.300	53.33	3.38		130.88	228.96
8" SST 316-L, pipe assembly, shop fabricated	110.00 LF	$8,159		41.02	143	$5,866	$372	$14,396	**$25,186**
152101101110A	Unit Costs---->	97.62	PIPE04S	1.300	53.33	3.38		160.18	280.24
10" SST 316-L, pipe assembly, shop fabricated	40.00 LF	$4,139		41.02	52	$2,133	$135	$6,407	**$11,210**
152101301140A	Unit Costs---->	120.51	PIPE04S	1.500	61.53	3.90		193.17	337.95
12" SST 316-L, pipe assembly, shop fabricated	20.00 LF	$2,555		41.02	30	$1,231	$78	$3,863	**$6,759**
152101901170A	Unit Costs---->	198.29	PIPE04S	1.700	69.74	4.42		284.34	497.45
18" SST 316-L, pipe assembly, shop fabricated	139.00 LF	$29,216		41.02	236	$9,693	$614	$39,524	**$69,146**
152102301170A	Unit Costs---->	334.83	PIPE04S	1.800	73.84	4.68		433.44	758.29
24" SST 316-L, pipe assembly, shop fabricated	89.00 LF	$31,588		41.02	160	$6,572	$416	$38,576	**$67,488**
152102501170A	Unit Costs---->	646.21	PIPE04S	2.400	98.45	6.24		789.67	1381.52
30" SST 316-L, pipe assembly, shop fabricated	60.00 LF	$41,099		41.02	144	$5,907	$374	$47,380	**$82,891**
152102701170A	Unit Costs---->	772.09	PIPE04S	2.600	106.66	6.76		931.83	1630.22
36" SST 316-L, pipe assembly, shop fabricated	68.00 LF	$55,652		41.02	177	$7,253	$460	$63,364	**$110,855**
	Unit Costs---->	0.01						0.01	
Line 5 - Fittings & Work Req'd, Ref Dwg. -1536	1.00								
152100841110	Unit Costs---->	176.00	PIPE04S	4.233	173.64	11.01		371.21	649.42
6" Stainless Steel, Slip-On Flange	4.00 EA	$746		41.02	17	$695	$44	$1,485	**$2,598**
152101043110A	Unit Costs---->	400.00	PIPE04S	4.000	164.09	10.40		598.48	1047.04
8" Stainless Steel, Weld on Saddle	18.00 EA	$7,632		41.02	72	$2,954	$187	$10,773	**$18,847**
152101001140A	Unit Costs---->	78.00	PIPE04S	3.600	147.68	9.36		239.72	419.38
8" x 6" Stainless Steel Reducer	4.00 EA	$331		41.02	14	$591	$37	$959	**$1,678**
152101001110A	Unit Costs---->	300.00	PIPE04S	3.600	147.68	9.36		475.04	831.06
8" Stainless Steel, Fab'd 90 Elbow	12.00 EA	$3,816		41.02	43	$1,772	$112	$5,700	**$9,973**
152101041110	Unit Costs---->	290.00	PIPE04S	6.557	268.98	17.05		593.42	1038.18
8" Stainless Steel, Slip-On Flange	16.00 EA	$4,918		41.02	105	$4,304	$273	$9,495	**$16,611**
152101042320A	Unit Costs---->	735.00	PIPE04S	1.713	70.27	4.45		853.82	1493.74
8" Grooved Coupling	18.00 EA	$14,024		41.02	31	$1,265	$80	$15,369	**$26,887**

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

PROJECT: Piping Rehabilitation for YDP
CLIENT: United States Bereau of Reclamation
DESIGN STAGE: Preliminary Design, Class 3 Estimate
PROJ MGR: Bruce Johnson/LAS
CLIENT PROJ NO.:

ENR CCI: November 2007 ENR for Los Angeles at 8871.09
ESTIMATOR: Robert Lawson/RDD
REVIEWED BY: Robert Lawson/RDD
EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
A 1st St. Feed/2nd St. Reject Fluid Systems MECHANICAL									
152101042320A	Unit Costs---->	78.00	PIPE04S	1.200	49.23	3.12		135.03	236.22
8" Stainless Steel Grooved End Plug	6.00 EA	$496	41.02	7	$295	$19		$810	**$1,417**
152102041110A	Unit Costs---->	2066.00	PIPE04S	14.754	605.23	38.36		2833.55	4957.23
18" Stainless Steel, Slip-On Flange	2.00 EA	$4,380	41.02	30	$1,210	$77		$5,667	**$9,914**
152102401140A	Unit Costs---->	997.00	PIPE04S	19.800	812.22	51.48		1920.52	3359.90
24" x 18" Stainless Steel Reducer	2.00 EA	$2,114	41.02	40	$1,624	$103		$3,841	**$6,720**
152102401120A	Unit Costs---->	3925.00	PIPE04S	19.800	812.22	51.48		5024.19	8789.72
24" Stainless Steel Elbow, 90 degree (4 Miter Elbow)	2.00 EA	$8,321	41.02	40	$1,624	$103		$10,048	**$17,579**
152102441110	Unit Costs---->	3583.00	PIPE04S	19.762	810.66	51.38		4660.02	8152.60
24" Stainless Steel, Slip-On Flange	2.00 EA	$7,596	41.02	40	$1,621	$103		$9,320	**$16,305**
152102601140A	Unit Costs---->	1994.00	PIPE04S	21.000	861.45	54.60		3029.69	
30" x 24" Stainless Steel Reducer	1.00 EA	$2,114	41.02	21	$861	$55		$3,030	**$5,300**
152102801140A	Unit Costs---->	2643.00	PIPE04S	23.400	959.90	60.84		3822.32	
36" x 30" Stainless Steel Reducer	1.00 EA	$2,802	41.02	23	$960	$61		$3,822	**$6,687**
152102841110	Unit Costs---->	12494.00	PIPE04S	29.508	1210.45	76.72		14530.81	25421.34
36" Stainless Steel, Slip-On Flange	2.00 EA	$26,487	41.02	59	$2,421	$153		$29,062	**$50,843**
151076605632A	Unit Costs---->	17.50	Q15	0.727	32.38	3.07		54.00	94.48
Nozzle, stainless steel, T-O-L, weld-on, 1/2" pipe	3.00 Ea.	$56	44.54	2	$97	$9		$162	**$283**
	Unit Costs---->	25000.00	PIPE04S	600.000	24612.73	1559.88		52672.61	
Allowance for Re-Use of Exist Supports & Brackets, Plus Additional	1.00 L.S.	$26,500	41.02	600	$24,613	$1,560		$52,673	**$92,150**
Subtotal		$1,457,454			$317,567	$20,136		$1,795,157	
Markups using CH-MK		$1,092,330			$238,010	$15,091			$1,345,431
TOTAL 15000 MECHANICAL		**$2,549,784**		**7,741**	**$555,577**	**$35,227**		**$1,795,157**	**$3,140,588**
1.00 LS									
1.00 LS									***$3,140,588.20***

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

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EST NO. / REV NO.: 2007-REL-L072 // 0
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PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
A 1st St. Feed/2nd St. Reject									
Fluid Systems									
ELECTRICAL									
	Unit Costs---->	0.01						0.01	
Fluid Systems	1.00								
	Unit Costs---->	0.01						0.01	
Line 1 - High Pressure Pump Discharge	1.00								
161367007050A	Unit Costs---->	50.00	ELEC	5.000	161.36			214.36	375.02
Disconnect/Reconnect Valves & Flow meters	15.00 Ea.	$795	32.27	75	$2,420			$3,215	**$5,625**
Subtotal		$795			$2,420			$3,215	
Markups using CH-MK		$596			$1,814				$2,410
TOTAL 16000 ELECTRICAL		**$1,391**		**75**	**$4,234**			**$3,215**	**$5,625**
1.00 LS									
1.00 LS									***$5,625.30***
B 1st St. Feed/2nd St. Reject									
Hydranautics									
CONCRETE									
	Unit Costs---->	0.01						0.01	
Hydranautics	1.00								
	Unit Costs---->	0.01						0.01	
Line 6 - High Pressure Pump Discharge	1.00								
030551100070A	Unit Costs---->		B9	10.000	218.56	50.28		268.84	470.34
Selective concrete demolition, break into small pieces, maximum reinforcing	275.00 C.Y.		21.86	2,750	$60,105	$13,827		$73,932	**$129,342**
022203505000	Unit Costs---->		B34B	0.010	0.25	0.73		0.97	1.71
Rubbish handling, lding & trucking, haul, per MI, up to 8 c.y truck	2,750.00 C.Y.		24.62	28	$677	$2,004		$2,681	**$4,691**
031104552000	Unit Costs---->	2.49	C2	0.160	4.72			7.36	12.87
C.I.P. concrete forms, wall, job built, plywood, below grade, to 8' high, 1 use,	1,820.00 SFCA	$4,804	29.48	291	$8,586			$13,390	**$23,425**

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DESCRIPTION	QTY UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
B 1st St. Feed/2nd St. Reject									
Hydranautics									
CONCRETE									
032106001050	Unit Costs---->	1099.91	RODM	15.237	598.27			1764.18	3086.40
Reinforcing, A615 Gr 60, typical in place, average, 10 - 60 tons, #3 to #7	30.94 Ton	$36,073	39.27	471	$18,511			$54,584	**$95,493**
032106002000	Unit Costs---->		C5	0.560	21.02	8.13		29.15	51.00
Reinforcing in place, unloading & sorting, add to above	30.94 Ton		37.54	17	$650	$252		$902	**$1,578**
032106002210	Unit Costs---->		C5	0.609	22.86	8.85		31.70	55.47
Reinforcing in place, crane cost for handling, add to above, average	30.94 Ton		37.54	19	$707	$274		$981	**$1,716**
033102200300	Unit Costs---->	120.00						127.20	222.53
Concrete, ready mix, regular weight, 4000 psi	275.00 C.Y.	$34,980						$34,980	**$61,197**
033107002950	Unit Costs---->		C20	0.350	8.59	4.78		13.37	23.39
Placing conc, incl vib, foundation mats, over 20 CY, pumped	275.00 C.Y.		24.55	96	$2,363	$1,314		$3,677	**$6,432**
Subtotal		$75,857			$91,599	$17,670		$185,126	
Markups using CH-MK		$56,853			$68,652	$13,244			$138,748
TOTAL 03000 CONCRETE		**$132,710**		**3,673**	**$160,251**	**$30,914**		**$185,126**	**$323,874**
1.00 LS									
1.00 LS									***$323,874.30***

DESCRIPTION	QTY UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
B 1st St. Feed/2nd St. Reject									
Hydranautics									
MECHANICAL									
	Unit Costs---->	0.01						0.01	
Hydranautics	1.00								
	Unit Costs---->	0.01						0.01	
Line 6 - High Pressure Pump Discharge	1.00								
152101301140A	Unit Costs---->	120.51	PIPE04S	1.500	61.53	3.90		193.17	337.95
12" SST 316-L, pipe assembly, shop fabricated	72.00 LF	$9,197	41.02	108	$4,430	$281		$13,908	**$24,332**

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FILE NAME: YDP_AB to SST Piping 2007.PWS
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DESCRIPTION	QTY	UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
B 1st St. Feed/2nd St. Reject										
Hydranautics										
MECHANICAL										
152101901170A		Unit Costs---->	198.29	PIPE04S	1.700	69.74	4.42		284.34	497.45
18" SST 316-L, pipe assembly, shop fabricated	78.00	LF	$16,395	41.02	133	$5,439	$345		$22,179	**$38,801**
152102301170A		Unit Costs---->	334.83	PIPE04S	1.800	73.84	4.68		433.44	758.29
24" SST 316-L, pipe assembly, shop fabricated	8.00	LF	$2,839	41.02	14	$591	$37		$3,468	**$6,066**
152102501170A		Unit Costs---->	646.21	PIPE04S	2.400	98.45	6.24		789.67	1381.52
30" SST 316-L, pipe assembly, shop fabricated	313.00	LF	$214,400	41.02	751	$30,815	$1,953		$247,168	**$432,415**
		Unit Costs---->	0.01						0.01	
Line 6 - Fittings & Work Req'd, Ref Dwg. -4489, -4499, & 4500	1.00									
152101401130A		Unit Costs---->	470.00	PIPE04S	9.600	393.80	24.96		916.96	
12" Stainless Steel Tee	1.00	EA	$498	41.02	10	$394	$25		$917	**$1,604**
152101443140B		Unit Costs---->	824.00	PIPE04S	6.000	246.13	15.60		1135.17	1985.95
12" Stainless Steel, Weld on Cone Saddle	2.00	EA	$1,747	41.02	12	$492	$31		$2,270	**$3,972**
152101401210A		Unit Costs---->	659.00	PIPE04S	9.836	403.49	25.57		1127.60	1972.71
12" Stainless Steel, Slip-On Flange	4.00	EA	$2,794	41.02	39	$1,614	$102		$4,510	**$7,891**
152102041110A		Unit Costs---->	2066.00	PIPE04S	14.754	605.23	38.36		2833.55	4957.23
18" Stainless Steel, Slip-On Flange	4.00	EA	$8,760	41.02	59	$2,421	$153		$11,334	**$19,829**
152102044140A		Unit Costs---->	1240.00	PIPE04S	16.000	656.34	41.60		2012.34	
18" Stainless Steel, Weld on Cone Saddle	1.00	EA	$1,314	41.02	16	$656	$42		$2,012	**$3,521**
152102001120A		Unit Costs---->	1468.00	PIPE04S	14.700	603.01	38.22		2197.30	3844.14
18" Stainless Steel Elbow, 90 degree (4 Miter Elbow)	2.00	EA	$3,112	41.02	29	$1,206	$76		$4,395	**$7,688**
152102401140A		Unit Costs---->	997.00	PIPE04S	19.800	812.22	51.48		1920.52	
24" x 18" Stainless Steel Reducer	1.00	EA	$1,057	41.02	20	$812	$51		$1,921	**$3,360**
152102401130A		Unit Costs---->	2444.00	PIPE04S	26.400	1082.96	68.63		3742.23	
24" Stainless Steel Tee	1.00	EA	$2,591	41.02	26	$1,083	$69		$3,742	**$6,547**
152102601140A		Unit Costs---->	1994.00	PIPE04S	21.000	861.45	54.60		3029.69	
30" x 18" Stainless Steel Reducer	1.00	EA	$2,114	41.02	21	$861	$55		$3,030	**$5,300**
152102601140A		Unit Costs---->	1994.00	PIPE04S	21.000	861.45	54.60		3029.69	
30" x 24" Stainless Steel Reducer	1.00	EA	$2,114	41.02	21	$861	$55		$3,030	**$5,300**
152102601130A		Unit Costs---->	4484.00	PIPE04S	28.000	1148.59	72.79		5974.42	
30" Stainless Steel Tee	1.00	EA	$4,753	41.02	28	$1,149	$73		$5,974	**$10,452**
		Unit Costs---->	0.01						0.01	
Line 7 - From Pump Manifold to DSB	1.00									
152102501170A		Unit Costs---->	646.21	PIPE04S	2.400	98.45	6.24		789.67	1381.52
30" SST 316-L, pipe assembly, shop fabricated	43.00	LF	$29,454	41.02	103	$4,233	$268		$33,956	**$59,405**

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CLIENT PROJ NO.:

ENR CCI: November 2007 ENR for Los Angeles at 8871.09
ESTIMATOR: Robert Lawson/RDD
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EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
B 1st St. Feed/2nd St. Reject Hydranautics MECHANICAL									
	Unit Costs---->	0.01						0.01	
Line 7 - Fittings & Work Req'd, Ref Dwg. -4501	1.00								
152102601120A	Unit Costs---->	1342.00	PIPE04S	21.000	861.45	54.59		2338.56	4091.26
30" Stainless Steel Elbow, 15 degree (1 Miter Elbow)	2.00 EA	$2,845	41.02	42	$1,723	$109		$4,677	**$8,183**
	Unit Costs---->	0.01						0.01	
Line 8 - DSB Supply Trench Upstream of Valves	1.00								
152102501170A	Unit Costs---->	646.21	PIPE04S	2.400	98.45	6.24		789.67	1381.52
30" SST 316-L, pipe assembly, shop fabricated	12.00 LF	$8,220	41.02	29	$1,181	$75		$9,476	**$16,578**
	Unit Costs---->	0.01						0.01	
Line 8 - Fittings & Work Req'd, Ref Dwg. -1533 & -1534	1.00								
152102641110	Unit Costs---->	8261.00	PIPE04S	24.590	1008.71	63.93		9829.30	
30" Stainless Steel, Slip-On Flange	1.00 EA	$8,757	41.02	25	$1,009	$64		$9,829	**$17,196**
	Unit Costs---->	50.00	PIPE04S	2.000	82.04	5.20		140.24	
3" Stainless Steel Nozzle, Pe x Pe, Weld to Main Line	1.00 EA	$53	41.02	2	$82	$5		$140	**$245**
	Unit Costs---->	0.01						0.01	
Line 9 - DSB Supply Trench Downstream of Valve to 90 Elbow	1.00								
152102501170A	Unit Costs---->	646.21	PIPE04S	2.400	98.45	6.24		789.67	1381.52
30" SST 316-L, pipe assembly, shop fabricated	80.00 LF	$54,799	41.02	192	$7,876	$499		$63,174	**$110,521**
	Unit Costs---->	0.01						0.01	
Line 9 - Fittings & Work Req'd, Ref Dwg. -1533 & -1534	1.00								
152102601120A	Unit Costs---->	1342.00	PIPE04S	21.000	861.45	54.60		2338.57	
30" Stainless Steel Elbow, 15 degree (1 Miter Elbow)	1.00 EA	$1,423	41.02	21	$861	$55		$2,339	**$4,091**
152102601120A	Unit Costs---->	5882.00	PIPE04S	21.000	861.45	54.60		7150.97	
30" Stainless Steel Elbow, 90 degree (4 Miter Elbow)	1.00 EA	$6,235	41.02	21	$861	$55		$7,151	**$12,510**
152102641110	Unit Costs---->	8261.00	PIPE04S	24.590	1008.71	63.93		9829.30	
30" Stainless Steel, Slip-On Flange	1.00 EA	$8,757	41.02	25	$1,009	$64		$9,829	**$17,196**
151076605632A	Unit Costs---->	17.50	Q15	0.727	32.38	3.07		54.01	94.48
Nozzle, stainless steel, T-O-L, weld-on, 1/2" pipe	7.00 Ea.	$130	44.55	5	$227	$22		$378	**$661**
	Unit Costs---->	0.01						0.01	
Line 10 - DSB Control Block Trench	1.00								

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DESCRIPTION	QTY	UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
B 1st St. Feed/2nd St. Reject										
Hydranautics										
MECHANICAL										
152100901110A		Unit Costs---->	69.97	PIPE04S	1.300	53.33	3.38		130.88	228.96
8" SST 316-L, pipe assembly, shop fabricated	61.00	LF	$4,524	41.02	79	$3,253	$206		$7,983	**$13,967**
152101101110A		Unit Costs---->	97.62	PIPE04S	1.300	53.33	3.38		160.18	280.24
10" SST 316-L, pipe assembly, shop fabricated	118.00	LF	$12,210	41.02	153	$6,293	$399		$18,902	**$33,068**
152101301140A		Unit Costs---->	120.51	PIPE04S	1.500	61.53	3.90		193.17	337.95
12" SST 316-L, pipe assembly, shop fabricated	33.00	LF	$4,215	41.02	50	$2,031	$129		$6,375	**$11,152**
152101701170A		Unit Costs---->	172.55	PIPE04S	1.600	65.63	4.16		252.70	442.09
16" SST 316-L, pipe assembly, shop fabricated	171.00	LF	$31,276	41.02	274	$11,223	$711		$43,211	**$75,597**
152102301170A		Unit Costs---->	334.83	PIPE04S	1.800	73.84	4.68		433.44	758.29
24" SST 316-L, pipe assembly, shop fabricated	110.00	LF	$39,041	41.02	198	$8,122	$515		$47,678	**$83,412**
152102501170A		Unit Costs---->	646.21	PIPE04S	2.400	98.45	6.24		789.67	1381.52
30" SST 316-L, pipe assembly, shop fabricated	65.00	LF	$44,524	41.02	156	$6,399	$406		$51,329	**$89,799**
		Unit Costs---->	0.01						0.01	
Line 10 - Fittings & Work Req'd, Ref Dwg. -1545 & -1546	1.00									
152101041110		Unit Costs---->	290.00	PIPE04S	6.557	268.98	17.05		593.42	1038.18
8" Stainless Steel, Slip-On Flange	30.00	EA	$9,222	41.02	197	$8,069	$511		$17,803	**$31,145**
152101042320A		Unit Costs---->	735.00	PIPE04S	1.713	70.27	4.45		853.82	1493.74
8" Grooved Coupling	20.00	EA	$15,582	41.02	34	$1,405	$89		$17,076	**$29,875**
152101201140A		Unit Costs---->	115.00	PIPE04S	6.600	270.74	17.16		409.80	716.93
10" x 8" Stainless Steel Reducer	10.00	EA	$1,219	41.02	66	$2,707	$172		$4,098	**$7,169**
152101201130A		Unit Costs---->	328.00	PIPE04S	8.800	360.99	22.88		731.54	1279.82
10" Stainless Steel Tee	5.00	EA	$1,738	41.02	44	$1,805	$114		$3,658	**$6,399**
152101242320A		Unit Costs---->	875.00	PIPE04S	2.058	84.42	5.35		1017.27	1779.70
10" Grooved Coupling	13.00	EA	$12,058	41.02	27	$1,097	$70		$13,225	**$23,136**
152101241110A		Unit Costs---->	444.00	PIPE04S	8.197	336.25	21.31		828.20	1448.92
10" Stainless Steel, Slip-On Flange	6.00	EA	$2,824	41.02	49	$2,018	$128		$4,969	**$8,694**
152101243110A		Unit Costs---->	444.00	PIPE04S	4.400	180.49	11.44		662.57	1159.16
10" Stainless Steel, Weld on Saddle	7.00	EA	$3,294	41.02	31	$1,263	$80		$4,638	**$8,114**
152101401140A		Unit Costs---->	151.00	PIPE04S	7.200	295.35	18.72		474.13	829.48
12" x 10" Stainless Steel Reducer	6.00	EA	$960	41.02	43	$1,772	$112		$2,845	**$4,977**
152101401130A		Unit Costs---->	470.00	PIPE04S	9.600	393.80	24.96		916.96	1604.20
12" Stainless Steel Tee	3.00	EA	$1,495	41.02	29	$1,181	$75		$2,751	**$4,813**
152101443140A		Unit Costs---->	659.00	PIPE04S	4.800	196.90	12.48		907.92	1588.39
12" Stainless Steel, Weld on Saddle	4.00	EA	$2,794	41.02	19	$788	$50		$3,632	**$6,354**

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

PROJECT: Piping Rehabilitation for YDP
CLIENT: United States Bereau of Reclamation
DESIGN STAGE: Preliminary Design, Class 3 Estimate
PROJ MGR: Bruce Johnson/LAS
CLIENT PROJ NO.:

ENR CCI: November 2007 ENR for Los Angeles at 8871.09
ESTIMATOR: Robert Lawson/RDD
REVIEWED BY: Robert Lawson/RDD
EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
B 1st St. Feed/2nd St. Reject Hydranautics MECHANICAL									
152101442320A	Unit Costs---->	1225.00	PIPE04S	2.250	92.30	5.85		1396.65	2443.40
12" Grooved Coupling	4.00 EA	$5,194	41.02	9	$369	$23		$5,587	**$9,774**
152101801120A	Unit Costs---->	975.00	PIPE04S	12.300	504.56	31.98		1570.04	2746.75
16" Stainless Steel Elbow, 45 degree (3 Miter Elbow)	2.00 EA	$2,067	41.02	25	$1,009	$64		$3,140	**$5,494**
15120030010016	Unit Costs---->	248.78	PIPE06	5.500	275.89	29.52		569.11	995.65
Pipe Specialties, Flexible Couplings - Dresser #38, 16" Dia	4.00 EA	$1,055	50.16	22	$1,104	$118		$2,276	**$3,983**
152101841110A	Unit Costs---->	1716.00	PIPE04S	13.115	538.00	34.09		2391.05	4183.09
16" Stainless Steel, Slip-On Flange	2.00 EA	$3,638	41.02	26	$1,076	$68		$4,782	**$8,366**
152102401140A	Unit Costs---->	997.00	PIPE04S	19.800	812.22	51.48		1920.52	
24" x 16" Stainless Steel Reducer	1.00 EA	$1,057	41.02	20	$812	$51		$1,921	**$3,360**
15120030010024	Unit Costs---->	590.00	PIPE06	8.300	416.34	44.54		1086.28	1900.42
Pipe Specialties, Flexible Couplings - Dresser #38, 24" Dia	4.00 EA	$2,502	50.16	33	$1,665	$178		$4,345	**$7,602**
152102601140A	Unit Costs---->	1994.00	PIPE04S	21.000	861.45	54.60		3029.69	
30" x 24" Stainless Steel Reducer	1.00 EA	$2,114	41.02	21	$861	$55		$3,030	**$5,300**
152102601120A	Unit Costs---->	1342.00	PIPE04S	21.000	861.45	54.60		2338.57	
30" Stainless Steel Elbow, 15 degree (1 Miter Elbow)	1.00 EA	$1,423	41.02	21	$861	$55		$2,339	**$4,091**
15120030010030	Unit Costs---->	439.72	PIPE07	11.500	574.93	113.85		1154.89	2020.45
Pipe Specialties, Flexible Couplings - Dresser #38, 30" Dia	2.00 EA	$932	49.99	23	$1,150	$228		$2,310	**$4,041**
	Unit Costs---->	15000.00	PIPE04S	300.000	12306.36	779.94		28986.30	
Allowance for Re-Use of Exist Supports & Brackets, Plus Additional	1.00 L.S.	$15,900	41.02	300	$12,306	$780		$28,986	**$50,711**
Subtotal		$617,214			$152,531	$9,950		$779,694	
Markups using CH-MK		$462,589			$114,318	$7,457			$584,364
TOTAL 15000 MECHANICAL		**$1,079,803**		**3,701**	**$266,849**	**$17,407**		**$779,694**	**$1,364,058**
1.00 LS									
1.00 LS									***$1,364,058.30***

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

PROJECT: Piping Rehabilitation for YDP
CLIENT: United States Bereau of Reclamation
DESIGN STAGE: Preliminary Design, Class 3 Estimate
PROJ MGR: Bruce Johnson/LAS
CLIENT PROJ NO.:

ENR CCI: November 2007 ENR for Los Angeles at 8871.09
ESTIMATOR: Robert Lawson/RDD
REVIEWED BY: Robert Lawson/RDD
EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
B 1st St. Feed/2nd St. Reject									
Hydranautics									
ELECTRICAL									
	Unit Costs---->	0.01						0.01	
Hydranautics	1.00								
	Unit Costs---->	0.01						0.01	
Line 6 - High Pressure Pump Discharge	1.00								
161367007050A	Unit Costs---->	50.00	ELEC	5.000	161.36			214.36	375.02
Disconnect/Reconnect Valves & Flow meters	15.00 Ea.	$795	32.27	75	$2,420			$3,215	**$5,625**
Subtotal		$795			$2,420			$3,215	
Markups using CH-MK		$596			$1,814				$2,410
TOTAL 16000 ELECTRICAL		**$1,391**		**75**	**$4,234**			**$3,215**	**$5,625**
1.00 LS									
1.00 LS									***$5,625.30***

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

PROJECT: Piping Rehabilitation for YDP
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EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY	UNIT	MATERIALS	CREW	RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
A 1st St. Reject/2nd St. Feed											
Fluid Systems											
MECHANICAL											
		Unit Costs---->	0.01							0.01	
Fluid Systems	1.00										
		Unit Costs---->	0.01							0.01	
Line 11 - DSB Control Block Trench No. 1 (East)	1.00										
152100701110A		Unit Costs---->	45.48	PIPE04S		1.100	45.12	2.86		96.19	168.29
6" SST 316-L, pipe assembly, shop fabricated	157.00	LF	$7,569	41.02		173	$7,084	$449		$15,102	**$26,421**
152100901110A		Unit Costs---->	69.97	PIPE04S		1.300	53.33	3.38		130.88	228.96
8" SST 316-L, pipe assembly, shop fabricated	169.00	LF	$12,534	41.02		220	$9,012	$571		$22,118	**$38,695**
152101101110A		Unit Costs---->	97.62	PIPE04S		1.300	53.33	3.38		160.19	280.24
10" SST 316-L, pipe assembly, shop fabricated	120.00	LF	$12,417	41.02		156	$6,399	$406		$19,222	**$33,629**
152101301140A		Unit Costs---->	120.51	PIPE04S		1.500	61.53	3.90		193.17	337.95
12" SST 316-L, pipe assembly, shop fabricated	33.00	LF	$4,215	41.02		50	$2,031	$129		$6,375	**$11,152**
152102101170A		Unit Costs---->	251.20	PIPE04S		1.700	69.74	4.42		340.43	595.57
20" SST 316-L, pipe assembly, shop fabricated	37.00	LF	$9,852	41.02		63	$2,580	$164		$12,596	**$22,036**
152102301170A		Unit Costs---->	334.83	PIPE04S		1.800	73.84	4.68		433.44	758.29
24" SST 316-L, pipe assembly, shop fabricated	114.00	LF	$40,461	41.02		205	$8,418	$533		$49,412	**$86,445**
152102501170A		Unit Costs---->	646.21	PIPE04S		2.400	98.45	6.24		789.67	1381.52
30" SST 316-L, pipe assembly, shop fabricated	85.00	LF	$58,224	41.02		204	$8,368	$530		$67,122	**$117,429**
		Unit Costs---->	0.01							0.01	
Line 11 - Fittings & Work Req'd, Ref Dwg. -1537	1.00										
152100841110		Unit Costs---->	176.00	PIPE04S		4.233	173.64	11.01		371.21	649.42
6" Stainless Steel, Slip-On Flange	12.00	EA	$2,239	41.02		51	$2,084	$132		$4,454	**$7,793**
152101001140A		Unit Costs---->	78.00	PIPE04S		3.600	147.68	9.36		239.72	419.38
8" x 6" Stainless Steel Reducer	8.00	EA	$661	41.02		29	$1,181	$75		$1,918	**$3,355**
152101042320A		Unit Costs---->	735.00	PIPE04S		1.713	70.27	4.45		853.82	1493.74
8" Grooved Coupling	8.00	EA	$6,233	41.02		14	$562	$36		$6,831	**$11,950**
152101201110A		Unit Costs---->	356.00	PIPE04S		6.600	270.74	17.16		665.26	
10" Stainless Steel, Fab'd 90 Elbow	1.00	EA	$377	41.02		7	$271	$17		$665	**$1,164**
152101243110A		Unit Costs---->	444.00	PIPE04S		4.400	180.49	11.44		662.57	1159.16
10" Stainless Steel, Weld on Saddle	9.00	EA	$4,236	41.02		40	$1,624	$103		$5,963	**$10,432**
152101201110A		Unit Costs---->	356.00	PIPE04S		6.600	270.74	17.16		665.26	1163.85
10" Stainless Steel, Fab'd 90 Elbow	4.00	EA	$1,509	41.02		26	$1,083	$69		$2,661	**$4,655**
152101201140A		Unit Costs---->	115.00	PIPE04S		6.600	270.74	17.16		409.80	716.93
10" x 6" Stainless Steel Reducer	4.00	EA	$488	41.02		26	$1,083	$69		$1,639	**$2,868**

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

PROJECT: Piping Rehabilitation for YDP
CLIENT: United States Bereau of Reclamation
DESIGN STAGE: Preliminary Design, Class 3 Estimate
PROJ MGR: Bruce Johnson/LAS
CLIENT PROJ NO.:

ENR CCI: November 2007 ENR for Los Angeles at 8871.09
ESTIMATOR: Robert Lawson/RDD
REVIEWED BY: Robert Lawson/RDD
EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY	UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
A 1st St. Reject/2nd St. Feed Fluid Systems MECHANICAL										
152101242320A		Unit Costs---->	875.00	PIPE04S	2.058	84.42	5.35		1017.27	1779.69
10" Grooved Coupling	9.00	EA	$8,348	41.02	19	$760	$48		$9,155	**$16,017**
152101242320A		Unit Costs---->	110.00	PIPE04S	2.200	90.25	5.72		212.57	371.88
10" Stainless Steel Grooved End Plug	6.00	EA	$700	41.02	13	$541	$34		$1,275	**$2,231**
152101401140A		Unit Costs---->	182.00	PIPE04S	7.200	295.35	18.72		506.99	886.97
12" x 8" Stainless Steel Reducer	8.00	EA	$1,543	41.02	58	$2,363	$150		$4,056	**$7,096**
152101401120A		Unit Costs---->	394.00	PIPE04S	7.200	295.35	18.72		731.71	1280.11
12" Stainless Steel, Fab'd 90 Elbow	8.00	EA	$3,341	41.02	58	$2,363	$150		$5,854	**$10,241**
152101443140A		Unit Costs---->	659.00	PIPE04S	4.800	196.90	12.48		907.92	1588.39
12" Stainless Steel, Weld on Saddle	8.00	EA	$5,588	41.02	38	$1,575	$100		$7,263	**$12,707**
152101442320A		Unit Costs---->	1225.00	PIPE04S	2.250	92.30	5.85		1396.65	2443.40
12" Grooved Coupling	8.00	EA	$10,388	41.02	18	$738	$47		$11,173	**$19,547**
152102201140A		Unit Costs---->	791.00	PIPE04S	18.600	762.99	48.36		1649.81	
20" x 10" Stainless Steel Reducer	1.00	EA	$838	41.02	19	$763	$48		$1,650	**$2,886**
152102201120A		Unit Costs---->	3047.00	PIPE04S	18.600	763.00	48.35		4041.17	7069.94
20" Stainless Steel Elbow, 90 degree (4 Miter Elbow)	2.00	EA	$6,460	41.02	37	$1,526	$97		$8,082	**$14,140**
152102241110A		Unit Costs---->	2661.00	PIPE04S	16.393	672.46	42.62		3535.74	6185.70
20" Stainless Steel, Slip-On Flange	2.00	EA	$5,641	41.02	33	$1,345	$85		$7,071	**$12,371**
152102401140A		Unit Costs---->	997.00	PIPE04S	19.800	812.22	51.48		1920.52	3359.90
24" x 20" Stainless Steel Reducer	2.00	EA	$2,114	41.02	40	$1,624	$103		$3,841	**$6,720**
152102601140A		Unit Costs---->	1994.00	PIPE04S	21.000	861.45	54.59		3029.68	5300.36
30" x 24" Stainless Steel Reducer	2.00	EA	$4,227	41.02	42	$1,723	$109		$6,059	**$10,601**
		Unit Costs---->	0.01						0.01	
Line 12 - DSB Control Block Trench No. 2 (West)	1.00									
152100701110A		Unit Costs---->	45.48	PIPE04S	1.100	45.12	2.86		96.19	168.29
6" SST 316-L, pipe assembly, shop fabricated	22.00	LF	$1,061	41.02	24	$993	$63		$2,116	**$3,702**
152100901110A		Unit Costs---->	69.97	PIPE04S	1.300	53.33	3.38		130.88	228.96
8" SST 316-L, pipe assembly, shop fabricated	40.00	LF	$2,967	41.02	52	$2,133	$135		$5,235	**$9,159**
152101101110A		Unit Costs---->	97.62	PIPE04S	1.300	53.33	3.38		160.19	280.24
10" SST 316-L, pipe assembly, shop fabricated	53.00	LF	$5,484	41.02	69	$2,826	$179		$8,490	**$14,853**
152101301140A		Unit Costs---->	120.51	PIPE04S	1.500	61.53	3.90		193.17	337.95
12" SST 316-L, pipe assembly, shop fabricated	14.00	LF	$1,788	41.02	21	$861	$55		$2,704	**$4,731**
152102101170A		Unit Costs---->	251.20	PIPE04S	1.700	69.74	4.42		340.43	595.57
20" SST 316-L, pipe assembly, shop fabricated	37.00	LF	$9,852	41.02	63	$2,580	$164		$12,596	**$22,036**

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

PROJECT: Piping Rehabilitation for YDP
CLIENT: United States Bereau of Reclamation
DESIGN STAGE: Preliminary Design, Class 3 Estimate
PROJ MGR: Bruce Johnson/LAS
CLIENT PROJ NO.:

ENR CCI: November 2007 ENR for Los Angeles at 8871.09
ESTIMATOR: Robert Lawson/RDD
REVIEWED BY: Robert Lawson/RDD
EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY	UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
A 1st St. Reject/2nd St. Feed										
Fluid Systems										
MECHANICAL										
152102301170A		Unit Costs---->	334.83	PIPE04S	1.800	73.84	4.68		433.44	758.29
24" SST 316-L, pipe assembly, shop fabricated	114.00	LF	$40,461	41.02	205	$8,418	$533		$49,412	**$86,445**
152102501170A		Unit Costs---->	646.21	PIPE04S	2.400	98.45	6.24		789.67	1381.52
30" SST 316-L, pipe assembly, shop fabricated	85.00	LF	$58,224	41.02	204	$8,368	$530		$67,122	**$117,429**
		Unit Costs---->	0.01						0.01	
Line 12 - Fittings & Work Req'd, Ref Dwg. -1537	1.00									
152100841110		Unit Costs---->	176.00	PIPE04S	4.233	173.64	11.01		371.21	649.42
6" Stainless Steel, Slip-On Flange	22.00	EA	$4,104	41.02	93	$3,820	$242		$8,167	**$14,287**
152100842320A		Unit Costs---->	360.00	PIPE04S	0.750	30.77	1.95		414.32	724.84
6" Grooved Coupling	22.00	EA	$8,395	41.02	17	$677	$43		$9,115	**$15,946**
152101041110		Unit Costs---->	290.00	PIPE04S	6.557	268.98	17.05		593.42	1038.18
8" Stainless Steel, Slip-On Flange	55.00	EA	$16,907	41.02	361	$14,794	$938		$32,638	**$57,100**
152101001140A		Unit Costs---->	78.00	PIPE04S	3.600	147.68	9.36		239.72	419.38
8" x 6" Stainless Steel Reducer	22.00	EA	$1,819	41.02	79	$3,249	$206		$5,274	**$9,226**
152101042320A		Unit Costs---->	735.00	PIPE04S	1.713	70.27	4.45		853.82	1493.74
8" Grooved Coupling	12.00	EA	$9,349	41.02	21	$843	$53		$10,246	**$17,925**
152101042320A		Unit Costs---->	78.00	PIPE04S	1.200	49.23	3.12		135.03	
8" Stainless Steel Grooved End Plug	1.00	EA	$83	41.02	1	$49	$3		$135	**$236**
152101201110A		Unit Costs---->	356.00	PIPE04S	6.600	270.74	17.16		665.26	
10" Stainless Steel, Fab'd 90 Elbow	1.00	EA	$377	41.02	7	$271	$17		$665	**$1,164**
152101242320A		Unit Costs---->	110.00	PIPE04S	2.200	90.25	5.72		212.57	
10" Stainless Steel Cap	1.00	EA	$117	41.02	2	$90	$6		$213	**$372**
152101201140A		Unit Costs---->	115.00	PIPE04S	6.600	270.74	17.16		409.80	716.93
10" x 8" Stainless Steel Reducer	22.00	EA	$2,682	41.02	145	$5,956	$377		$9,016	**$15,773**
152101201130A		Unit Costs---->	328.00	PIPE04S	8.800	360.99	22.88		731.54	1279.82
10" Stainless Steel Tee	11.00	EA	$3,824	41.02	97	$3,971	$252		$8,047	**$14,078**
152101243110A		Unit Costs---->	444.00	PIPE04S	4.400	180.49	11.44		662.57	1159.16
10" Stainless Steel, Weld on Saddle	11.00	EA	$5,177	41.02	48	$1,985	$126		$7,288	**$12,751**
152101242320A		Unit Costs---->	875.00	PIPE04S	2.058	84.42	5.35		1017.27	1779.70
10" Grooved Coupling	11.00	EA	$10,203	41.02	23	$929	$59		$11,190	**$19,577**
152101401140A		Unit Costs---->	182.00	PIPE04S	7.200	295.35	18.72		506.99	886.97
12" x 8" Stainless Steel Reducer	12.00	EA	$2,315	41.02	86	$3,544	$225		$6,084	**$10,644**
152101401130A		Unit Costs---->	470.00	PIPE04S	9.600	393.80	24.96		916.96	1604.20
12" Stainless Steel Tee	6.00	EA	$2,989	41.02	58	$2,363	$150		$5,502	**$9,625**

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

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PROJ MGR: Bruce Johnson/LAS
CLIENT PROJ NO.:

ENR CCI: November 2007 ENR for Los Angeles at 8871.09
ESTIMATOR: Robert Lawson/RDD
REVIEWED BY: Robert Lawson/RDD
EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
A 1st St. Reject/2nd St. Feed									
Fluid Systems									
MECHANICAL									
152101443140A	Unit Costs---->	659.00	PIPE04S	4.800	196.90	12.48		907.92	1588.39
12" Stainless Steel, Weld on Saddle	6.00 EA	$4,191	41.02	29	$1,181	$75		$5,448	**$9,530**
152101442320A	Unit Costs---->	1225.00	PIPE04S	2.250	92.30	5.85		1396.65	2443.41
12" Grooved Coupling	6.00 EA	$7,791	41.02	14	$554	$35		$8,380	**$14,660**
152102201140A	Unit Costs---->	791.00	PIPE04S	18.600	762.99	48.36		1649.81	
20" x 10" Stainless Steel Reducer	1.00 EA	$838	41.02	19	$763	$48		$1,650	**$2,886**
152102201120A	Unit Costs---->	3047.00	PIPE04S	18.600	763.00	48.35		4041.17	7069.94
20" Stainless Steel Elbow, 90 degree (4 Miter Elbow)	2.00 EA	$6,460	41.02	37	$1,526	$97		$8,082	**$14,140**
152102241110A	Unit Costs---->	2661.00	PIPE04S	16.393	672.46	42.62		3535.74	6185.70
20" Stainless Steel, Slip-On Flange	2.00 EA	$5,641	41.02	33	$1,345	$85		$7,071	**$12,371**
152102401140A	Unit Costs---->	997.00	PIPE04S	19.800	812.22	51.48		1920.52	3359.90
24" x 20" Stainless Steel Reducer	2.00 EA	$2,114	41.02	40	$1,624	$103		$3,841	**$6,720**
152102601140A	Unit Costs---->	1994.00	PIPE04S	21.000	861.45	54.59		3029.68	5300.36
30" x 24" Stainless Steel Reducer	2.00 EA	$4,227	41.02	42	$1,723	$109		$6,059	**$10,601**
	Unit Costs---->	15000.00	PIPE04S	200.000	8204.24	519.96		24624.20	
Allowance for Re-Use of Exist Supports & Brackets, Plus Additional	1.00 L.S.	$15,900	41.02	200	$8,204	$520		$24,624	**$43,080**
Subtotal		$445,544			$152,744	$9,681		$607,969	
Markups using CH-MK		$333,926			$114,479	$7,255			$455,660
TOTAL 15000 MECHANICAL		**$779,470**		**3,724**	**$267,223**	**$16,936**		**$607,969**	**$1,063,629**
1.00 LS									
1.00 LS									***$1,063,629.00***
B 1st St. Reject/2nd St. Feed									
Hydranautics									
MECHANICAL									
	Unit Costs---->	0.01						0.01	
Hydranautics	1.00								

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

PROJECT: Piping Rehabilitation for YDP
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CLIENT PROJ NO.:

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ESTIMATOR: Robert Lawson/RDD
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EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY	UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
B 1st St. Reject/2nd St. Feed										
Hydranautics										
MECHANICAL										
		Unit Costs---->	0.01						0.01	
Line 13 - DSB Control Block Trench	1.00									
152100901110A		Unit Costs---->	69.97	PIPE04S	1.300	53.33	3.38		130.88	228.96
8" SST 316-L, pipe assembly, shop fabricated	120.00	LF	$8,900	41.02	156	$6,399	$406		$15,705	**$27,476**
152101101110A		Unit Costs---->	97.62	PIPE04S	1.300	53.33	3.38		160.19	280.24
10" SST 316-L, pipe assembly, shop fabricated	58.00	LF	$6,002	41.02	75	$3,093	$196		$9,291	**$16,254**
152101301140A		Unit Costs---->	120.51	PIPE04S	1.500	61.53	3.90		193.17	337.95
12" SST 316-L, pipe assembly, shop fabricated	136.00	LF	$17,373	41.02	204	$8,368	$530		$26,271	**$45,961**
152101501170A		Unit Costs---->	150.13	PIPE04S	1.500	61.53	3.90		224.57	392.88
14" SST 316-L, pipe assembly, shop fabricated	55.00	LF	$8,753	41.02	83	$3,384	$214		$12,351	**$21,608**
152101901170A		Unit Costs---->	198.29	PIPE04S	1.700	69.74	4.42		284.34	497.45
18" SST 316-L, pipe assembly, shop fabricated	140.00	LF	$29,426	41.02	238	$9,763	$619		$39,808	**$69,643**
		Unit Costs---->	0.01						0.01	
Line 13 - Fittings & Work Req'd, Ref Dwg. -1543 & -1544	1.00									
152101041110		Unit Costs---->	290.00	PIPE04S	6.557	268.98	17.05		593.42	1038.18
8" Stainless Steel, Slip-On Flange	30.00	EA	$9,222	41.02	197	$8,069	$511		$17,803	**$31,145**
152101042320A		Unit Costs---->	735.00	PIPE04S	1.713	70.27	4.45		853.82	1493.74
8" Grooved Coupling	10.00	EA	$7,791	41.02	17	$703	$45		$8,538	**$14,937**
152101201110A		Unit Costs---->	356.00	PIPE04S	6.600	270.74	17.16		665.26	
10" Stainless Steel, Fab'd 90 Elbow	1.00	EA	$377	41.02	7	$271	$17		$665	**$1,164**
152101201130A		Unit Costs---->	328.00	PIPE04S	8.800	360.99	22.88		731.54	1279.82
10" Stainless Steel Tee	5.00	EA	$1,738	41.02	44	$1,805	$114		$3,658	**$6,399**
152101243110A		Unit Costs---->	444.00	PIPE04S	4.400	180.49	11.44		662.57	1159.16
10" Stainless Steel, Weld on Saddle	6.00	EA	$2,824	41.02	26	$1,083	$69		$3,975	**$6,955**
152101242320A		Unit Costs---->	875.00	PIPE04S	2.058	84.42	5.35		1017.27	1779.70
10" Grooved Coupling	12.00	EA	$11,130	41.02	25	$1,013	$64		$12,207	**$21,356**
152101241110A		Unit Costs---->	444.00	PIPE04S	8.197	336.25	21.31		828.20	1448.92
10" Stainless Steel, Slip-On Flange	6.00	EA	$2,824	41.02	49	$2,018	$128		$4,969	**$8,694**
152101201140A		Unit Costs---->	115.00	PIPE04S	6.600	270.74	17.16		409.80	716.93
10" x 8" Stainless Steel Reducer	10.00	EA	$1,219	41.02	66	$2,707	$172		$4,098	**$7,169**
152101401120A		Unit Costs---->	394.00	PIPE04S	7.200	295.35	18.72		731.71	
12" Stainless Steel, Fab'd 90 Elbow	1.00	EA	$418	41.02	7	$295	$19		$732	**$1,280**
152101401120A		Unit Costs---->	371.00	PIPE04S	7.200	295.36	18.72		707.34	1237.46
12" Stainless Steel, Fab'd 45 Elbow	2.00	EA	$787	41.02	14	$591	$37		$1,415	**$2,475**

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

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CLIENT PROJ NO.:

ENR CCI: November 2007 ENR for Los Angeles at 8871.09
ESTIMATOR: Robert Lawson/RDD
REVIEWED BY: Robert Lawson/RDD
EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
B 1st St. Reject/2nd St. Feed Hydranautics MECHANICAL									
152101401130A	Unit Costs---->	470.00	PIPE04S	9.600	393.80	24.96		916.96	1604.21
12" Stainless Steel Tee	5.00 EA	$2,491	41.02	48	$1,969	$125		$4,585	**$8,021**
152101443140A	Unit Costs---->	659.00	PIPE04S	4.800	196.90	12.48		907.92	1588.39
12" Stainless Steel, Weld on Saddle	2.00 EA	$1,397	41.02	10	$394	$25		$1,816	**$3,177**
152101401210A	Unit Costs---->	659.00	PIPE04S	9.836	403.49	25.57		1127.60	1972.70
12" Stainless Steel, Slip-On Flange	2.00 EA	$1,397	41.02	20	$807	$51		$2,255	**$3,945**
152101442320A	Unit Costs---->	1225.00	PIPE04S	2.250	92.30	5.85		1396.65	2443.40
12" Grooved Coupling	4.00 EA	$5,194	41.02	9	$369	$23		$5,587	**$9,774**
15120030010012	Unit Costs---->	134.03	PIPE05	3.750	189.35	9.38		340.80	596.22
Pipe Specialties, Flexible Couplings - Dresser #138, 12" Dia	3.00 EA	$426	50.49	11	$568	$28		$1,022	**$1,789**
152101401140A	Unit Costs---->	151.00	PIPE04S	7.200	295.35	18.72		474.13	829.48
12" x 10" Stainless Steel Reducer	6.00 EA	$960	41.02	43	$1,772	$112		$2,845	**$4,977**
152101601140	Unit Costs---->	368.00	PIPE04S	9.600	393.80	24.96		808.84	
14" x 10" Stainless Steel Reducer	1.00 EA	$390	41.02	10	$394	$25		$809	**$1,415**
15120030010014	Unit Costs---->	241.43	PIPE05	4.000	201.98	10.00		467.89	818.57
Pipe Specialties, Flexible Couplings - Dresser #38, 14" Dia	3.00 EA	$768	50.49	12	$606	$30		$1,404	**$2,456**
152102001140B	Unit Costs---->	519.00	PIPE04S	14.700	603.01	38.22		1191.37	
18" x 12" Stainless Steel Reducer	1.00 EA	$550	41.02	15	$603	$38		$1,191	**$2,084**
152102001140A	Unit Costs---->	519.00	PIPE04S	14.700	603.01	38.22		1191.37	
18" x 14" Stainless Steel Reducer	1.00 EA	$550	41.02	15	$603	$38		$1,191	**$2,084**
15120030010018	Unit Costs---->	278.15	PIPE06	6.600	331.06	35.42		661.32	1156.97
Pipe Specialties, Flexible Couplings - Dresser #38, 18" Dia	5.00 EA	$1,474	50.16	33	$1,655	$177		$3,307	**$5,785**

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

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ENR CCI: November 2007 ENR for Los Angeles at 8871.09
ESTIMATOR: Robert Lawson/RDD
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EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
B 1st St. Reject/2nd St. Feed Hydranautics MECHANICAL									
	Unit Costs---->	10000.00	PIPE04S	100.000	4102.12	259.98		14962.10	
Allowance for Re-Use of Exist Supports & Brackets, Plus Additional	1.00 L.S.	$10,600	41.02	100	$4,102	$260		$14,962	**$26,176**
Subtotal		$134,981			$63,405	$4,074		$202,460	
Markups using CH-MK		$101,165			$47,521	$3,054			$151,740
TOTAL 15000 MECHANICAL		**$236,146**		**1,533**	**$110,926**	**$7,128**		**$202,460**	**$354,200**
1.00 LS									
1.00 LS									***$354,200.00***

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DESCRIPTION	QTY	UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
A Interstage to ER Fluid Systems MECHANICAL										
		Unit Costs---->	0.01						0.01	
Fluid Systems	1.00									
		Unit Costs---->	0.01						0.01	
Line 14 - DSB Collection Trench	1.00									
152102301170A		Unit Costs---->	334.83	PIPE04S	1.800	73.84	4.68		433.44	758.29
24" SST 316-L, pipe assembly, shop fabricated	22.00	LF	$7,808	41.02	40	$1,624	$103		$9,536	**$16,682**
152102501170A		Unit Costs---->	646.21	PIPE04S	2.400	98.45	6.24		789.67	1381.52
30" SST 316-L, pipe assembly, shop fabricated	308.00	LF	$210,975	41.02	739	$30,323	$1,922		$243,219	**$425,507**
		Unit Costs---->	0.01						0.01	
Line 14 - Fittings & Work Req'd, Ref Dwg. -4505	1.00									
152102401120A		Unit Costs---->	3925.00	PIPE04S	19.800	812.22	51.48		5024.19	8789.72
24" Stainless Steel Elbow, 90 degree (4 Miter Elbow)	4.00	EA	$16,642	41.02	79	$3,249	$206		$20,097	**$35,159**
152102401130A		Unit Costs---->	2444.00	PIPE04S	26.400	1082.96	68.63		3742.23	
24" Stainless Steel Tee	1.00	EA	$2,591	41.02	26	$1,083	$69		$3,742	**$6,547**
152102601140A		Unit Costs---->	1994.00	PIPE04S	21.000	861.45	54.60		3029.69	
30" x 24" Stainless Steel Reducer	1.00	EA	$2,114	41.02	21	$861	$55		$3,030	**$5,300**
152102601130B		Unit Costs---->	4484.00	PIPE04S	28.000	1148.59	72.79		5974.42	
30" x 20" Stainless Steel Reducer Tee	1.00	EA	$4,753	41.02	28	$1,149	$73		$5,974	**$10,452**
152102601130C		Unit Costs---->	4484.00	PIPE04S	28.000	1148.59	72.79		5974.42	
30" x 24" Stainless Steel Reducer Tee	1.00	EA	$4,753	41.02	28	$1,149	$73		$5,974	**$10,452**
152102601120A		Unit Costs---->	4118.00	PIPE04S	21.000	861.45	54.59		5281.12	9239.21
30" Stainless Steel Elbow, 45 degree (3 Miter Elbow)	2.00	EA	$8,730	41.02	42	$1,723	$109		$10,562	**$18,478**
152102641110		Unit Costs---->	8261.00	PIPE04S	24.590	1008.71	63.93		9829.30	17196.15
30" Stainless Steel, Slip-On Flange	2.00	EA	$17,513	41.02	49	$2,017	$128		$19,659	**$34,392**
		Unit Costs---->	0.01						0.01	
Line 15 - Outside DSB to Sleeve Valve & Turbines	1.00									
152101901170A		Unit Costs---->	198.29	PIPE04S	1.700	69.74	4.42		284.34	497.45
18" SST 316-L, pipe assembly, shop fabricated	118.00	LF	$24,802	41.02	201	$8,229	$522		$33,552	**$58,699**
152102501170A		Unit Costs---->	646.21	PIPE04S	2.400	98.45	6.24		789.67	1381.52
30" SST 316-L, pipe assembly, shop fabricated	430.00	LF	$294,543	41.02	1,032	$42,334	$2,683		$339,559	**$594,052**
		Unit Costs---->	0.01						0.01	
Line 15 - Fittings & Work Req'd, Ref Dwg. -4209, -4498, -4501, & 4579	1.00									
152102001120A		Unit Costs---->	1050.00	PIPE04S	14.700	603.01	38.22		1754.22	3068.98
18" Stainless Steel Elbow, 15 degree (1 Miter Elbow)	2.00	EA	$2,226	41.02	29	$1,206	$76		$3,508	**$6,138**

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

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FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
A Interstage to ER Fluid Systems MECHANICAL									
152102001120A	Unit Costs---->	1027.00	PIPE04S	14.700	603.01	38.22		1729.85	3026.33
18" Stainless Steel Elbow, 45 degree (3 Miter Elbow)	2.00 EA	$2,177	41.02	29	$1,206	$76		$3,460	**$6,053**
152102001120A	Unit Costs---->	1468.00	PIPE04S	14.700	603.01	38.22		2197.31	
18" Stainless Steel Elbow, 90 degree (4 Miter Elbow)	1.00 EA	$1,556	41.02	15	$603	$38		$2,197	**$3,844**
152102601130C	Unit Costs---->	4484.00	PIPE04S	28.000	1148.59	72.79		5974.42	
30" x 18" Stainless Steel Reducer Tee	1.00 EA	$4,753	41.02	28	$1,149	$73		$5,974	**$10,452**
152102601120A	Unit Costs---->	1342.00	PIPE04S	21.000	861.45	54.60		2338.57	
30" Stainless Steel Elbow, 15 degree (1 Miter Elbow)	1.00 EA	$1,423	41.02	21	$861	$55		$2,339	**$4,091**
152102601120A	Unit Costs---->	4118.00	PIPE04S	21.000	861.45	54.59		5281.12	9239.21
30" Stainless Steel Elbow, 45 degree (3 Miter Elbow)	2.00 EA	$8,730	41.02	42	$1,723	$109		$10,562	**$18,478**
152102601120A	Unit Costs---->	5882.00	PIPE04S	21.000	861.45	54.59		7150.96	12510.45
30" Stainless Steel Elbow, 90 degree (4 Miter Elbow)	2.00 EA	$12,470	41.02	42	$1,723	$109		$14,302	**$25,021**
	Unit Costs---->	15000.00	PIPE04S	120.000	4922.55	311.98		21134.53	
Allowance for Re-Use of Exist Supports & Brackets, Plus Additional	1.00 L.S.	$15,900	41.02	120	$4,923	$312		$21,135	**$36,974**
Subtotal		$644,458			$107,134	$6,790		$758,382	
Markups using CH-MK		$483,008			$80,295	$5,089			$568,391
TOTAL 15000 MECHANICAL		**$1,127,466**		**2,612**	**$187,429**	**$11,879**		**$758,382**	**$1,326,774**
1.00 LS									
1.00 LS									***$1,326,773.80***
B Interstage to ER Hydranautics MECHANICAL									
	Unit Costs---->	0.01						0.01	
Hydranautics	1.00								
	Unit Costs---->	0.01						0.01	
Line 16 - DSB Collection Trench	1.00								

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

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ESTIMATOR: Robert Lawson/RDD
REVIEWED BY: Robert Lawson/RDD
EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
B Interstage to ER Hydranautics MECHANICAL									
152101701170A	Unit Costs---->	172.55	PIPE04S	1.600	65.63	4.16		252.70	442.09
16" SST 316-L, pipe assembly, shop fabricated	82.00 LF	$14,998	41.02	131	$5,382	$341		$20,721	**$36,251**
	Unit Costs---->	0.01						0.01	
Line 16 - Fittings & Work Req'd, Ref Dwg. -4505	1.00								
152101801130A	Unit Costs---->	1037.00	PIPE04S	16.400	672.75	42.64		1814.61	
16" Stainless Steel Tee	1.00 EA	$1,099	41.02	16	$673	$43		$1,815	**$3,175**
152101801120A	Unit Costs---->	975.00	PIPE04S	12.300	504.56	31.98		1570.04	2746.75
16" Stainless Steel Elbow, 45 degree (3 Miter Elbow)	2.00 EA	$2,067	41.02	25	$1,009	$64		$3,140	**$5,494**
152101801120A	Unit Costs---->	1041.00	PIPE04S	12.300	504.56	31.98		1640.00	2869.14
16" Stainless Steel Elbow, 90 degree (4 Miter Elbow)	2.00 EA	$2,207	41.02	25	$1,009	$64		$3,280	**$5,738**
	Unit Costs---->	0.01						0.01	
Line 17 - Outside DSB to Sleeve Valve & Turbines	1.00								
152101101110A	Unit Costs---->	97.62	PIPE04S	1.300	53.33	3.38		160.18	280.24
10" SST 316-L, pipe assembly, shop fabricated	102.00 LF	$10,555	41.02	133	$5,439	$345		$16,339	**$28,584**
152101701170A	Unit Costs---->	172.55	PIPE04S	1.600	65.63	4.16		252.70	442.09
16" SST 316-L, pipe assembly, shop fabricated	492.00 LF	$89,988	41.02	787	$32,292	$2,047		$124,327	**$217,507**
	Unit Costs---->	0.01						0.01	
Line 17 - Fittings & Work Req'd, Ref Dwg. -4259, -4498, -4501, & -4579	1.00								
152101201110A	Unit Costs---->	356.00	PIPE04S	6.600	270.74	17.16		665.26	
10" Stainless Steel, Fab'd 90 Elbow	1.00 EA	$377	41.02	7	$271	$17		$665	**$1,164**
152101201111A	Unit Costs---->	320.00	PIPE04S	6.600	270.74	17.16		627.10	1097.10
10" Stainless Steel, Fab'd 45 Elbow	2.00 EA	$678	41.02	13	$541	$34		$1,254	**$2,194**
152101801130B	Unit Costs---->	1037.00	PIPE04S	16.400	672.75	42.64		1814.61	
16" x 10" Stainless Steel Reducer Tee	1.00 EA	$1,099	41.02	16	$673	$43		$1,815	**$3,175**
152101801120A	Unit Costs---->	760.00	PIPE04S	12.300	504.56	31.98		1342.14	
16" Stainless Steel Elbow, 15 degree (1 Miter Elbow)	1.00 EA	$806	41.02	12	$505	$32		$1,342	**$2,348**
152101801120A	Unit Costs---->	975.00	PIPE04S	12.300	504.56	31.98		1570.04	2746.75
16" Stainless Steel Elbow, 45 degree (3 Miter Elbow)	2.00 EA	$2,067	41.02	25	$1,009	$64		$3,140	**$5,494**
152101801120A	Unit Costs---->	1041.00	PIPE04S	12.300	504.56	31.98		1640.00	2869.14
16" Stainless Steel Elbow, 90 degree (4 Miter Elbow)	2.00 EA	$2,207	41.02	25	$1,009	$64		$3,280	**$5,738**

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

PROJECT: Piping Rehabilitation for YDP
CLIENT: United States Bereau of Reclamation
DESIGN STAGE: Preliminary Design, Class 3 Estimate
PROJ MGR: Bruce Johnson/LAS
CLIENT PROJ NO.:

ENR CCI: November 2007 ENR for Los Angeles at 8871.09
ESTIMATOR: Robert Lawson/RDD
REVIEWED BY: Robert Lawson/RDD
EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
B Interstage to ER Hydranautics MECHANICAL									
	Unit Costs---->	10000.00	PIPE04S	100.000	4102.12	259.98		14962.10	
Allowance for Re-Use of Exist Supports & Brackets, Plus Additional	1.00 L.S.	$10,600	41.02	100	$4,102	$260		$14,962	**$26,176**
Subtotal		$138,749			$53,914	$3,417		$196,080	
Markups using CH-MK		$103,989			$40,408	$2,561			$146,958
TOTAL 15000 MECHANICAL		**$242,738**		**1,314**	**$94,322**	**$5,978**		**$196,080**	**$343,037**
1.00 LS									
1.00 LS									***$343,037.40***

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

PROJECT: Piping Rehabilitation for YDP
CLIENT: United States Bereau of Reclamation
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PROJ MGR: Bruce Johnson/LAS
CLIENT PROJ NO.:

ENR CCI: November 2007 ENR for Los Angeles at 8871.09
ESTIMATOR: Robert Lawson/RDD
REVIEWED BY: Robert Lawson/RDD
EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY	UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
A Low Pressure Reject Fluid Systems MECHANICAL										
		Unit Costs---->	0.01						0.01	
Fluid Systems	1.00									
		Unit Costs---->	0.01						0.01	
Line 18 - DSB Control Block Trench No. 1 (East)	1.00									
152100701110A		Unit Costs---->	22.74	PIPE04S	0.750	30.77	1.95		56.82	99.41
3" SST 316-L, pipe assembly, shop fabricated	420.00	LF	$10,124	41.02	315	$12,922	$819		$23,864	**$41,750**
152101701170A		Unit Costs---->	172.55	PIPE04S	1.600	65.63	4.16		252.70	442.09
16" Sch 10 SST 316-L, pipe assembly, shop fabricated	352.00	LF	$64,382	41.02	563	$23,103	$1,464		$88,949	**$155,615**
		Unit Costs---->	0.01						0.01	
Line 18 - Fittings & Work Req'd, Ref Dwg. -4542, -4510, & -4511	1.00									
152101841110A		Unit Costs---->	1716.00	PIPE04S	13.115	537.99	34.10		2391.05	
16" Stainless Steel, Slip-On Flange	1.00	EA	$1,819	41.02	13	$538	$34		$2,391	**$4,183**
151079603100A		Unit Costs---->	49.00	Q15	4.938	219.96	20.86		292.76	512.19
Tee, stainless, straight, butt weld, 3", schedule 10, type 316, includes t	17.00	Ea.	$883	44.55	84	$3,739	$355		$4,977	**$8,707**
151079607844A		Unit Costs---->	44.00	Q1	0.571	25.43			72.08	126.09
Cap, stainless steel, welded, 3", type 316	2.00	Ea.	$93	44.54	1	$51			$144	**$252**
		Unit Costs---->	50.00	PIPE04S	2.000	82.04	5.20		140.24	245.35
3" Stainless Steel Nozzle, Pe x Pe, Weld to Main Line	18.00	EA	$954	41.02	36	$1,477	$94		$2,524	**$4,416**
151076905010		Unit Costs---->	22.50	Q1	0.239	10.65			34.50	60.35
Grooved End Coupling, stainless steel, flexible, 3" diameter	34.00	Ea.	$811	44.54	8	$362			$1,173	**$2,052**
152100401210		Unit Costs---->	70.00	PIPE04S	2.492	102.22	6.48		182.90	319.99
3" Stainless Steel, Slip-On Flange	51.00	EA	$3,784	41.02	127	$5,213	$330		$9,328	**$16,319**
		Unit Costs---->	0.01						0.01	
Line 19 - DSB Control Block Trench No. 2 (West)	1.00									
152100701110A		Unit Costs---->	22.74	PIPE04S	0.750	30.77	1.95		56.82	99.41
3" SST 316-L, pipe assembly, shop fabricated	263.00	LF	$6,339	41.02	197	$8,091	$513		$14,944	**$26,144**
152101701170A		Unit Costs---->	172.55	PIPE04S	1.600	65.63	4.16		252.70	442.09
16" Sch 10 SST 316-L, pipe assembly, shop fabricated	352.00	LF	$64,382	41.02	563	$23,103	$1,464		$88,949	**$155,615**

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

PROJECT: Piping Rehabilitation for YDP
CLIENT: United States Bereau of Reclamation
DESIGN STAGE: Preliminary Design, Class 3 Estimate
PROJ MGR: Bruce Johnson/LAS
CLIENT PROJ NO.:

ENR CCI: November 2007 ENR for Los Angeles at 8871.09
ESTIMATOR: Robert Lawson/RDD
REVIEWED BY: Robert Lawson/RDD
EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY	UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
A Low Pressure Reject Fluid Systems MECHANICAL										
		Unit Costs---->	0.01						0.01	
Line 19 - Fittings & Work Req'd, Ref Dwg. -4542, -4510, & -4511	1.00									
152101841110A		Unit Costs---->	1716.00	PIPE04S	13.115	537.99	34.10		2391.05	
16" Stainless Steel, Slip-On Flange	1.00	EA	$1,819	41.02	13	$538	$34		$2,391	**$4,183**
152101801120A		Unit Costs---->	975.00	PIPE04S	12.300	504.56	31.98		1570.04	2746.75
16" Stainless Steel Elbow, 45 degree (3 Miter Elbow)	2.00	EA	$2,067	41.02	25	$1,009	$64		$3,140	**$5,494**
151079602110A		Unit Costs---->	30.00	Q15	3.292	146.64	13.91		192.35	336.51
Elbow, 90 Deg., stainless steel, long, butt weld, 3", schedule 10, type 316, inc	12.00	Ea.	$382	44.55	40	$1,760	$167		$2,308	**$4,038**
151079603100A		Unit Costs---->	49.00	Q15	4.938	219.96	20.86		292.77	512.19
Tee, stainless, straight, butt weld, 3", schedule 10, type 316, includes t	5.00	Ea.	$260	44.55	25	$1,100	$104		$1,464	**$2,561**
151079607844A		Unit Costs---->	44.00	Q1	0.571	25.44			72.08	126.09
Cap, stainless steel, welded, 3", type 316	5.00	Ea.	$233	44.55	3	$127			$360	**$630**
		Unit Costs---->	50.00	PIPE04S	2.000	82.04	5.20		140.24	245.35
3" Stainless Steel Nozzle, Pe x Pe, Weld to Main Line	17.00	EA	$901	41.02	34	$1,395	$88		$2,384	**$4,171**
151076905010		Unit Costs---->	22.50	Q1	0.239	10.65			34.50	60.35
Grooved End Coupling, stainless steel, flexible, 3" diameter	22.00	Ea.	$525	44.55	5	$234			$759	**$1,328**
152100401210		Unit Costs---->	70.00	PIPE04S	2.492	102.22	6.48		182.90	319.99
3" Stainless Steel, Slip-On Flange	39.00	EA	$2,894	41.02	97	$3,987	$253		$7,133	**$12,479**

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

PROJECT: Piping Rehabilitation for YDP
CLIENT: United States Bereau of Reclamation
DESIGN STAGE: Preliminary Design, Class 3 Estimate
PROJ MGR: Bruce Johnson/LAS
CLIENT PROJ NO.:

ENR CCI: November 2007 ENR for Los Angeles at 8871.09
ESTIMATOR: Robert Lawson/RDD
REVIEWED BY: Robert Lawson/RDD
EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
A Low Pressure Reject									
Fluid Systems									
MECHANICAL									
	Unit Costs---->	12000.00	PIPE04S	100.000	4102.12	259.98		17082.10	
Allowance for Re-Use of Exist Supports & Brackets, Plus Additional	1.00 L.S.	$12,720	41.02	100	$4,102	$260		$17,082	**$29,885**
Subtotal		$175,371			$92,852	$6,043		$274,266	
Markups using CH-MK		$131,437			$69,590	$4,529			$205,557
TOTAL 15000 MECHANICAL		**$306,808**		**2,249**	**$162,442**	**$10,572**		**$274,266**	**$479,823**
1.00 LS									
1.00 LS									***$479,822.60***
B Low Pressure Reject									
Hydranautics									
MECHANICAL									
	Unit Costs---->	0.01						0.01	
Hydranautics	1.00								
	Unit Costs---->	0.01						0.01	
Line 20 - DSB Control Block Trench	1.00								
152100701110A	Unit Costs---->	22.74	PIPE04S	0.750	30.77	1.95		56.82	99.41
3" SST 316-L, pipe assembly, shop fabricated	192.00 LF	$4,628	41.02	144	$5,907	$374		$10,909	**$19,086**
152101701170A	Unit Costs---->	172.55	PIPE04S	1.600	65.63	4.16		252.70	442.09
16" Sch 10 SST 316-L, pipe assembly, shop fabricated	352.00 LF	$64,382	41.02	563	$23,103	$1,464		$88,949	**$155,615**
	Unit Costs---->	0.01						0.01	
Line 20 - Fittings & Work Req'd, Ref Dwg. -1549	1.00								
152101841110A	Unit Costs---->	1716.00	PIPE04S	13.115	537.99	34.10		2391.05	
16" Stainless Steel, Slip-On Flange	1.00 EA	$1,819	41.02	13	$538	$34		$2,391	**$4,183**
151079602110A	Unit Costs---->	30.00	Q15	3.292	146.64	13.91		192.35	
Elbow, 90 Deg., stainless steel, long, butt weld, 3", schedule 10, type 316, inc	1.00 Ea.	$32	44.54	3	$147	$14		$192	**$337**

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

PROJECT: Piping Rehabilitation for YDP
CLIENT: United States Bereau of Reclamation
DESIGN STAGE: Preliminary Design, Class 3 Estimate
PROJ MGR: Bruce Johnson/LAS
CLIENT PROJ NO.:

ENR CCI: November 2007 ENR for Los Angeles at 8871.09
ESTIMATOR: Robert Lawson/RDD
REVIEWED BY: Robert Lawson/RDD
EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
B Low Pressure Reject									
Hydranautics									
MECHANICAL									
151079603100A	Unit Costs---->	49.00	Q15	4.938	219.96	20.86		292.76	512.19
Tee, stainless, straight, butt weld, 3", schedule 10, type 316, includes t	8.00 Ea.	$416	44.55	40	$1,760	$167		$2,342	**$4,097**
151079607844A	Unit Costs---->	44.00	Q1	0.571	25.44			72.08	126.10
Cap, stainless steel, welded, 3", type 316	3.00 Ea.	$140	44.55	2	$76			$216	**$378**
	Unit Costs---->	50.00	PIPE04S	2.000	82.04	5.20		140.24	245.35
3" Stainless Steel Nozzle, Pe x Pe, Weld to Main Line	11.00 EA	$583	41.02	22	$902	$57		$1,543	**$2,699**
151076905010	Unit Costs---->	22.50	Q1	0.239	10.65			34.50	60.35
Grooved End Coupling, stainless steel, flexible, 3" diameter	17.00 Ea.	$405	44.55	4	$181			$586	**$1,026**
152100401210	Unit Costs---->	70.00	PIPE04S	2.492	102.22	6.48		182.90	319.99
3" Stainless Steel, Slip-On Flange	26.00 EA	$1,929	41.02	65	$2,658	$168		$4,756	**$8,320**
	Unit Costs---->	6000.00	PIPE04S	60.000	2461.27	155.99		8977.26	
Allowance for Re-Use of Exist Supports & Brackets, Plus Additional	1.00 L.S.	$6,360	41.02	60	$2,461	$156		$8,977	**$15,706**
Subtotal		$80,694			$37,733	$2,435		$120,862	
Markups using CH-MK		$60,478			$28,280	$1,825			$90,584
TOTAL 15000 MECHANICAL		**$141,172**		**916**	**$66,014**	**$4,260**		**$120,862**	**$211,446**
1.00 LS									
1.00 LS									***$211,446.00***
C Low Pressure Reject									
Combined									
MECHANICAL									
	Unit Costs---->	0.01						0.01	
Combined	1.00								
	Unit Costs---->	0.01						0.01	
Line 21 - DSB Collection Trench	1.00								

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

PROJECT: Piping Rehabilitation for YDP
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CLIENT PROJ NO.:

ENR CCI: November 2007 ENR for Los Angeles at 8871.09
ESTIMATOR: Robert Lawson/RDD
REVIEWED BY: Robert Lawson/RDD
EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
C Low Pressure Reject Combined MECHANICAL									
152101701170A	Unit Costs---->	172.55	PIPE04S	1.600	65.63	4.16		252.70	442.09
16" Sch 10 SST 316-L, pipe assembly, shop fabricated	330.00 LF	$60,358	41.02	528	$21,659	$1,373		$83,390	**$145,889**
	Unit Costs---->	0.01						0.01	
Line 21 - Fittings & Work Req'd, Ref Dwg. -4505	1.00								
152101801130A	Unit Costs---->	1037.00	PIPE04S	16.400	672.75	42.63		1814.61	3174.61
16" Stainless Steel Tee	2.00 EA	$2,198	41.02	33	$1,346	$85		$3,629	**$6,349**
152101801120A	Unit Costs---->	1041.00	PIPE04S	12.300	504.56	31.98		1640.00	2869.14
16" Stainless Steel Elbow, 90 degree (4 Miter Elbow)	4.00 EA	$4,414	41.02	49	$2,018	$128		$6,560	**$11,477**
152101841110A	Unit Costs---->	1716.00	PIPE04S	13.115	537.99	34.10		2391.05	4183.09
16" Stainless Steel, Slip-On Flange	5.00 EA	$9,095	41.02	66	$2,690	$170		$11,955	**$20,915**
	Unit Costs---->	5000.00	PIPE04S	50.000	2051.06	129.99		7481.05	
Allowance for Re-Use of Exist Supports & Brackets, Plus Additional	1.00 L.S.	$5,300	41.02	50	$2,051	$130		$7,481	**$13,088**
Subtotal		$81,365			$29,764	$1,886		$113,015	
Markups using CH-MK		$60,981			$22,307	$1,414			$84,703
TOTAL 15000 MECHANICAL		**$142,346**		**726**	**$52,071**	**$3,300**		**$113,015**	**$197,718**
1.00 LS									
1.00 LS									***$197,718.10***

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EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY	UNIT	MATERIALS	CREW	RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
A Product											
Fluid Systems											
MECHANICAL											
		Unit Costs---->	0.01							0.01	
Fluid Systems	1.00										
		Unit Costs---->	0.01							0.01	
Line 23 - DSB Control Block Trench No. 1 (East)	1.00										
152100701110A		Unit Costs---->	47.75	PIPE04S		1.000	41.02	2.60		94.24	164.86
6" SST 316-L Sch 40, pipe assembly, shop fabricated	57.00	LF	$2,885	41.02		57	$2,338	$148		$5,371	**$9,397**
152100901110A		Unit Costs---->	73.47	PIPE04S		1.125	46.15	2.92		126.95	222.10
8" SST 316-L Sch 20, pipe assembly, shop fabricated	29.00	LF	$2,258	41.02		33	$1,338	$85		$3,682	**$6,441**
152101101110A		Unit Costs---->	102.50	PIPE04S		1.250	51.28	3.25		163.18	285.47
10" SST 316-L Sch 20, pipe assembly, shop fabricated	88.00	LF	$9,561	41.02		110	$4,512	$286		$14,360	**$25,122**
152101501170A		Unit Costs---->	157.64	PIPE04S		1.438	58.99	3.74		229.83	402.07
14" SST 316-L Sch 10, pipe assembly, shop fabricated	56.00	LF	$9,358	41.02		81	$3,303	$209		$12,870	**$22,516**
152101901170A		Unit Costs---->	208.20	PIPE04S		1.594	65.39	4.14		290.22	507.74
18" SST 316-L Sch 10, pipe assembly, shop fabricated	37.00	LF	$8,166	41.02		59	$2,419	$153		$10,738	**$18,786**
152102301170A		Unit Costs---->	351.57	PIPE04S		1.750	71.79	4.55		449.00	785.52
24" SST 316-L Sch 10, pipe assembly, shop fabricated	56.00	LF	$20,869	41.02		98	$4,020	$255		$25,144	**$43,989**
152102501170A		Unit Costs---->	678.52	PIPE04S		2.375	97.42	6.17		822.83	1439.53
30" SST 316-L Sch 10, pipe assembly, shop fabricated	114.00	LF	$81,992	41.02		271	$11,106	$704		$93,803	**$164,106**
152102701170A		Unit Costs---->	810.69	PIPE04S		2.594	106.41	6.74		972.48	1701.34
36" SST 316-L Sch 10, pipe assembly, shop fabricated	66.00	LF	$56,716	41.02		171	$7,023	$445		$64,184	**$112,288**
		Unit Costs---->	0.01							0.01	
Line 23 - Fittings & Work Req'd, Ref Dwg. -1539	1.00										
152101001110A		Unit Costs---->	250.00	PIPE04S		3.000	123.06	7.80		395.86	692.55
6" Stainless Steel, Fab'd 90 Elbow	33.00	EA	$8,745	41.02		99	$4,061	$257		$13,063	**$22,854**
152101001140A		Unit Costs---->	78.00	PIPE04S		3.600	147.68	9.36		239.72	419.38
8" x 6" Stainless Steel Reducer	34.00	EA	$2,811	41.02		122	$5,021	$318		$8,150	**$14,259**
152101042320A		Unit Costs---->	735.00	PIPE04S		1.713	70.27	4.45		853.82	1493.74
8" Grooved Coupling	34.00	EA	$26,489	41.02		58	$2,389	$151		$29,030	**$50,787**
152101103030A		Unit Costs---->	125.00	PIPE04S		3.600	147.68	9.36		289.54	506.54
10" Stainless Steel Nozzle, Pe x Pe, Weld to Main Line	18.00	EA	$2,385	41.02		65	$2,658	$168		$5,212	**$9,118**
152101201130A		Unit Costs---->	328.00	PIPE04S		8.800	360.99	22.88		731.54	1279.82
10" Stainless Steel Tee	17.00	EA	$5,911	41.02		150	$6,137	$389		$12,436	**$21,757**
152101242320A		Unit Costs---->	875.00	PIPE04S		2.058	84.42	5.35		1017.27	1779.70
10" Grooved Coupling	33.00	EA	$30,608	41.02		68	$2,786	$177		$33,570	**$58,730**

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

PROJECT: Piping Rehabilitation for YDP
CLIENT: United States Bereau of Reclamation
DESIGN STAGE: Preliminary Design, Class 3 Estimate
PROJ MGR: Bruce Johnson/LAS
CLIENT PROJ NO.:

ENR CCI: November 2007 ENR for Los Angeles at 8871.09
ESTIMATOR: Robert Lawson/RDD
REVIEWED BY: Robert Lawson/RDD
EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
A Product Fluid Systems MECHANICAL									
152101242320A	Unit Costs---->	110.00	PIPE04S	2.200	90.25	5.72		212.57	
10" Stainless Steel Cap	1.00 EA	$117	41.02	2	$90	$6		$213	**$372**
152101201140A	Unit Costs---->	115.00	PIPE04S	6.600	270.74	17.16		409.80	716.93
10" x 8" Stainless Steel Reducer	17.00 EA	$2,072	41.02	112	$4,603	$292		$6,967	**$12,188**
152101601140	Unit Costs---->	368.00	PIPE04S	9.600	393.80	24.96		808.84	
14" x 10" Stainless Steel Reducer	1.00 EA	$390	41.02	10	$394	$25		$809	**$1,415**
152102001140A	Unit Costs---->	519.00	PIPE04S	14.700	603.01	38.22		1191.37	
18" x 14" Stainless Steel Reducer	1.00 EA	$550	41.02	15	$603	$38		$1,191	**$2,084**
152102401140A	Unit Costs---->	997.00	PIPE04S	19.800	812.22	51.48		1920.52	
24" x 18" Stainless Steel Reducer	1.00 EA	$1,057	41.02	20	$812	$51		$1,921	**$3,360**
152102601140A	Unit Costs---->	1994.00	PIPE04S	21.000	861.45	54.60		3029.69	
30" x 24" Stainless Steel Reducer	1.00 EA	$2,114	41.02	21	$861	$55		$3,030	**$5,300**
152102801140A	Unit Costs---->	2643.00	PIPE04S	23.400	959.90	60.84		3822.32	
36" x 30" Stainless Steel Reducer	1.00 EA	$2,802	41.02	23	$960	$61		$3,822	**$6,687**
	Unit Costs---->	0.01						0.01	
Line 24 - DSB Control Block Trench No. 2 (West)	1.00								
152100701110A	Unit Costs---->	47.75	PIPE04S	1.000	41.02	2.60		94.24	164.86
6" SST 316-L Sch 40, pipe assembly, shop fabricated	40.00 LF	$2,025	41.02	40	$1,641	$104		$3,769	**$6,595**
152100901110A	Unit Costs---->	73.47	PIPE04S	1.125	46.15	2.92		126.95	222.10
8" SST 316-L Sch 20, pipe assembly, shop fabricated	21.00 LF	$1,635	41.02	24	$969	$61		$2,666	**$4,664**
152101101110A	Unit Costs---->	102.50	PIPE04S	1.250	51.28	3.25		163.18	285.47
10" SST 316-L Sch 20, pipe assembly, shop fabricated	62.00 LF	$6,736	41.02	78	$3,179	$201		$10,117	**$17,699**
152101501170A	Unit Costs---->	157.64	PIPE04S	1.438	58.99	3.74		229.83	402.07
14" SST 316-L Sch 10, pipe assembly, shop fabricated	56.00 LF	$9,358	41.02	81	$3,303	$209		$12,870	**$22,516**
152101901170A	Unit Costs---->	208.20	PIPE04S	1.594	65.39	4.14		290.22	507.74
18" SST 316-L Sch 10, pipe assembly, shop fabricated	37.00 LF	$8,166	41.02	59	$2,419	$153		$10,738	**$18,786**
152102301170A	Unit Costs---->	351.57	PIPE04S	1.750	71.79	4.55		449.00	785.52
24" SST 316-L Sch 10, pipe assembly, shop fabricated	56.00 LF	$20,869	41.02	98	$4,020	$255		$25,144	**$43,989**
152102501170A	Unit Costs---->	678.52	PIPE04S	2.375	97.42	6.17		822.83	1439.53
30" SST 316-L Sch 10, pipe assembly, shop fabricated	114.00 LF	$81,992	41.02	271	$11,106	$704		$93,803	**$164,106**
152102701170A	Unit Costs---->	810.69	PIPE04S	2.594	106.41	6.74		972.48	1701.34
36" SST 316-L Sch 10, pipe assembly, shop fabricated	66.00 LF	$56,716	41.02	171	$7,023	$445		$64,184	**$112,288**
	Unit Costs---->	0.01						0.01	
Line 24 - Fittings & Work Req'd, Ref Dwg. -1539	1.00								

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

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CLIENT PROJ NO.:

ENR CCI: November 2007 ENR for Los Angeles at 8871.09
ESTIMATOR: Robert Lawson/RDD
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EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY	UNIT	MATERIALS	CREW	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
A Product										
Fluid Systems										
MECHANICAL										
152101001110A		Unit Costs---->	250.00	PIPE04S	3.000	123.06	7.80		395.86	
6" Stainless Steel, Fab'd 90 Elbow	1.00	EA	$265	41.02	3	$123	$8		$396	**$693**
152101001140A		Unit Costs---->	78.00	PIPE04S	3.600	147.68	9.36		239.72	
8" x 6" Stainless Steel Reducer	1.00	EA	$83	41.02	4	$148	$9		$240	**$419**
152101103030A		Unit Costs---->	125.00	PIPE04S	3.600	147.68	9.36		289.54	506.54
10" Stainless Steel Nozzle, Pe x Pe, Weld to Main Line	17.00	EA	$2,253	41.02	61	$2,511	$159		$4,922	**$8,611**
152101242320A		Unit Costs---->	110.00	PIPE04S	2.200	90.25	5.72		212.57	371.88
10" Stainless Steel Cap	2.00	EA	$233	41.02	4	$180	$11		$425	**$744**
152101201140A		Unit Costs---->	115.00	PIPE04S	6.600	270.74	17.16		409.80	
10" x 8" Stainless Steel Reducer	1.00	EA	$122	41.02	7	$271	$17		$410	**$717**
152101241110A		Unit Costs---->	444.00	PIPE04S	8.197	336.25	21.31		828.20	
10" Stainless Steel, Slip-On Flange	1.00	EA	$471	41.02	8	$336	$21		$828	**$1,449**
152101601140		Unit Costs---->	368.00	PIPE04S	9.600	393.80	24.96		808.84	
14" x 10" Stainless Steel Reducer	1.00	EA	$390	41.02	10	$394	$25		$809	**$1,415**
152101601120A		Unit Costs---->	460.00	PIPE04S	8.000	328.17	20.80		836.57	
14" Stainless Steel, Fab'd 90 Elbow	1.00	EA	$488	41.02	8	$328	$21		$837	**$1,464**
152101642120A		Unit Costs---->	175.00	PIPE04S	2.800	114.86	7.28		307.64	
14" Stainless Steel Cap	1.00	EA	$186	41.02	3	$115	$7		$308	**$538**
152102001140A		Unit Costs---->	519.00	PIPE04S	14.700	603.01	38.22		1191.37	
18" x 14" Stainless Steel Reducer	1.00	EA	$550	41.02	15	$603	$38		$1,191	**$2,084**
152102401140A		Unit Costs---->	997.00	PIPE04S	19.800	812.22	51.48		1920.52	
24" x 18" Stainless Steel Reducer	1.00	EA	$1,057	41.02	20	$812	$51		$1,921	**$3,360**
152102601140A		Unit Costs---->	1994.00	PIPE04S	21.000	861.45	54.60		3029.69	
30" x 24" Stainless Steel Reducer	1.00	EA	$2,114	41.02	21	$861	$55		$3,030	**$5,300**
152102801140A		Unit Costs---->	2643.00	PIPE04S	23.400	959.90	60.84		3822.32	
36" x 30" Stainless Steel Reducer	1.00	EA	$2,802	41.02	23	$960	$61		$3,822	**$6,687**

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

PROJECT: Piping Rehabilitation for YDP
CLIENT: United States Bereau of Reclamation
DESIGN STAGE: Preliminary Design, Class 3 Estimate
PROJ MGR: Bruce Johnson/LAS
CLIENT PROJ NO.:

ENR CCI: November 2007 ENR for Los Angeles at 8871.09
ESTIMATOR: Robert Lawson/RDD
REVIEWED BY: Robert Lawson/RDD
EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
A Product									
Fluid Systems									
MECHANICAL									
	Unit Costs---->	15000.00	PIPE04S	120.000	4922.55	311.98		21134.53	
Allowance for Re-Use of Exist Supports & Brackets, Plus Additional	1.00 L.S.	$15,900	41.02	120	$4,923	$312		$21,135	**$36,974**
Subtotal		$492,263			$113,663	$7,204		$613,129	
Markups using CH-MK		$368,941			$85,188	$5,399			$459,527
TOTAL 15000 MECHANICAL		**$861,204**		**2,771**	**$198,850**	**$12,603**		**$613,129**	**$1,072,657**
1.00 LS									
1.00 LS									***$1,072,656.60***
B Product									
Hydranautics									
MECHANICAL									
	Unit Costs---->	0.01						0.01	
Hydranautics	1.00								
	Unit Costs---->	0.01						0.01	
Line 25 - DSB Control Block Trench	1.00								
152100901110A	Unit Costs---->	73.47	PIPE04S	1.125	46.15	2.92		126.95	222.10
8" SST 316-L Sch 20, pipe assembly, shop fabricated	211.00 LF	$16,432	41.02	237	$9,737	$617		$26,787	**$46,863**
152101101110A	Unit Costs---->	102.50	PIPE04S	1.250	51.28	3.25		163.18	285.47
10" SST 316-L Sch 20, pipe assembly, shop fabricated	19.00 LF	$2,064	41.02	24	$974	$62		$3,100	**$5,424**
152101501170A	Unit Costs---->	157.64	PIPE04S	1.438	58.99	3.74		229.82	402.07
14" SST 316-L Sch 10, pipe assembly, shop fabricated	78.00 LF	$13,034	41.02	112	$4,601	$292		$17,926	**$31,362**
152102101170A	Unit Costs---->	263.76	PIPE04S	1.625	66.66	4.22		350.47	613.14
20" SST 316-L Sch 10, pipe assembly, shop fabricated	78.00 LF	$21,808	41.02	127	$5,199	$330		$27,337	**$47,825**
152102501170A	Unit Costs---->	678.52	PIPE04S	2.375	97.42	6.17		822.83	1439.53
30" SST 316-L Sch 10, pipe assembly, shop fabricated	209.00 LF	$150,319	41.02	496	$20,362	$1,290		$171,972	**$300,861**
	Unit Costs---->	0.01						0.01	
Line 25 - Fittings & Work Req'd, Ref Dwg. -1547	1.00								

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

PROJECT: Piping Rehabilitation for YDP
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PROJ MGR: Bruce Johnson/LAS
CLIENT PROJ NO.:

ENR CCI: November 2007 ENR for Los Angeles at 8871.09
ESTIMATOR: Robert Lawson/RDD
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EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
B Product Hydranautics MECHANICAL									
152101103030A	Unit Costs---->	125.00	PIPE04S	3.600	147.68	9.36		289.54	506.54
10" Stainless Steel Nozzle, Pe x Pe, Weld to Main Line	10.00 EA	$1,325	41.02	36	$1,477	$94		$2,895	**$5,065**
152101201130A	Unit Costs---->	328.00	PIPE04S	8.800	360.99	22.88		731.54	1279.82
10" Stainless Steel Tee	8.00 EA	$2,781	41.02	70	$2,888	$183		$5,852	**$10,239**
152101201110A	Unit Costs---->	356.00	PIPE04S	6.600	270.74	17.16		665.26	
10" Stainless Steel, Fab'd 90 Elbow	1.00 EA	$377	41.02	7	$271	$17		$665	**$1,164**
152101242320A	Unit Costs---->	875.00	PIPE04S	2.058	84.42	5.35		1017.27	1779.70
10" Grooved Coupling	16.00 EA	$14,840	41.02	33	$1,351	$86		$16,276	**$28,475**
152101242320A	Unit Costs---->	110.00	PIPE04S	2.200	90.25	5.72		212.57	
10" Stainless Steel Cap	1.00 EA	$117	41.02	2	$90	$6		$213	**$372**
152101201140A	Unit Costs---->	115.00	PIPE04S	6.600	270.74	17.16		409.80	
10" x 8" Stainless Steel Reducer	1.00 EA	$122	41.02	7	$271	$17		$410	**$717**
152101601140	Unit Costs---->	368.00	PIPE04S	9.600	393.80	24.96		808.84	
14" x 10" Stainless Steel Reducer	1.00 EA	$390	41.02	10	$394	$25		$809	**$1,415**
152102201140A	Unit Costs---->	791.00	PIPE04S	18.600	762.99	48.36		1649.81	
20" x 14" Stainless Steel Reducer	1.00 EA	$838	41.02	19	$763	$48		$1,650	**$2,886**
152102601140A	Unit Costs---->	1994.00	PIPE04S	23.000	943.49	59.80		3116.93	
30" x 20" Stainless Steel Reducer	1.00 EA	$2,114	41.02	23	$943	$60		$3,117	**$5,453**
	Unit Costs---->	12000.00	PIPE04S	80.000	3281.70	207.98		16209.68	
Allowance for Re-Use of Exist Supports & Brackets, Plus Additional	1.00 L.S.	$12,720	41.02	80	$3,282	$208		$16,210	**$28,358**
Subtotal		$239,282			$52,603	$3,334		$295,219	
Markups using CH-MK		$179,337			$39,425	$2,499			$221,260
TOTAL 15000 MECHANICAL		**$418,618**		**1,282**	**$92,028**	**$5,832**		**$295,219**	**$516,479**
1.00 LS									
1.00 LS									***$516,479.10***

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

PROJECT: Piping Rehabilitation for YDP
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ENR CCI: November 2007 ENR for Los Angeles at 8871.09
ESTIMATOR: Robert Lawson/RDD
REVIEWED BY: Robert Lawson/RDD
EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
C Product Combined MECHANICAL									
	Unit Costs---->	0.01						0.01	
Line 26 - DSB Collection Trench	1.00								
152102501170A	Unit Costs---->	678.52	PIPE04S	2.375	97.42	6.17		822.83	1439.53
30" SST 316-L Sch 10, pipe assembly, shop fabricated	103.00 LF	$74,081	41.02	245	$10,035	$636		$84,752	**$148,271**
152102901170A	Unit Costs---->	962.00	PIPE04S	2.813	115.39	7.31		1142.43	1998.65
42" SST 316-L Sch 10, pipe assembly, shop fabricated	145.00 LF	$147,859	41.02	408	$16,732	$1,060		$165,652	**$289,804**
152103301170A	Unit Costs---->	1289.12	PIPE04S	3.750	153.83	9.75		1530.05	2676.78
54" SST 316-L Sch 10, pipe assembly, shop fabricated	77.00 LF	$105,218	41.02	289	$11,845	$751		$117,814	**$206,112**
	Unit Costs---->	0.01						0.01	
Line 26 - Fittings & Work Req'd, Ref Dwg. -4503	1.00								
152102601120A	Unit Costs---->	5882.00	PIPE04S	21.000	861.45	54.60		7150.97	
30" Stainless Steel Elbow, LR 90 degree (4 Miter Elbow)	1.00 EA	$6,235	41.02	21	$861	$55		$7,151	**$12,510**
152103001130A	Unit Costs---->	9000.00	PIPE04S	27.900	1144.49	72.53		10757.02	
42" x 36" Stainless Steel Tee	1.00 EA	$9,540	41.02	28	$1,144	$73		$10,757	**$18,819**
152103001140A	Unit Costs---->	2830.00	PIPE04S	18.600	762.99	48.36		3811.15	
42" x 30" Stainless Steel Reducer	1.00 EA	$3,000	41.02	19	$763	$48		$3,811	**$6,668**
152103401130A	Unit Costs---->	12670.00	PIPE04S	36.000	1476.76	93.59		15000.55	
54" x 36" Stainless Steel Tee	1.00 EA	$13,430	41.02	36	$1,477	$94		$15,001	**$26,243**
152103401140A	Unit Costs---->	3600.00	PIPE04S	24.000	984.51	62.40		4862.91	
54" x 42" Stainless Steel Reducer	1.00 EA	$3,816	41.02	24	$985	$62		$4,863	**$8,508**
	Unit Costs---->	10000.00	PIPE04S	60.000	2461.27	155.99		13217.26	
Allowance for Re-Use of Exist Supports & Brackets, Plus Additional	1.00 L.S.	$10,600	41.02	60	$2,461	$156		$13,217	**$23,123**
Subtotal		$373,779			$46,303	$2,935		$423,017	
Markups using CH-MK		$280,139			$34,703	$2,199			$317,042
TOTAL 15000 MECHANICAL		**$653,919**		**1,129**	**$81,006**	**$5,134**		**$423,017**	**$740,059**
1.00 LS									
1.00 LS									***$740,058.80***

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

PROJECT: Piping Rehabilitation for YDP
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FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
D2 Other									
Exterior, Plant Service									
MECHANICAL									
	Unit Costs---->	0.01						0.01	
Line 37 - Plant Service Water Pump Manifolds	1.00								
151079202860A	Unit Costs---->	9.65	PIPE04S	0.500	22.27	2.11		34.61	60.56
2" SST 316-L Sch 40, pipe assembly, shop fabricated	15.00 L.F.	$153	44.55	8	$334	$32		$519	**$908**
151079202890A	Unit Costs---->	28.52	PIPE04S	0.656	26.91	1.71		58.85	102.95
4" SST 316-L Sch 40, pipe assembly, shop fabricated	30.00 L.F.	$907	41.02	20	$807	$51		$1,765	**$3,089**
152100701110A	Unit Costs---->	47.75	PIPE04S	1.000	41.02	2.60		94.24	164.86
6" SST 316-L Sch 40, pipe assembly, shop fabricated	69.00 L.F.	$3,492	41.02	69	$2,830	$179		$6,502	**$11,376**
152100901110A	Unit Costs---->	73.47	PIPE04S	1.125	46.15	2.92		126.95	222.10
8" SST 316-L Sch 20, pipe assembly, shop fabricated	42.00 L.F.	$3,271	41.02	47	$1,938	$123		$5,332	**$9,328**
152101301140A	Unit Costs---->	126.54	PIPE04S	1.384	56.77	3.60		194.50	340.28
12" SST 316-L Sch 20, pipe assembly, shop fabricated	120.00 L.F.	$16,096	41.02	166	$6,813	$432		$23,340	**$40,834**
	Unit Costs---->	0.01						0.01	
Line 37 - Fittings & Work Req'd, Ref Dwg. -4527 & -4528	1.00								
	Unit Costs---->	22600.00	PIPE04S	310.000	12716.58	805.94		37478.52	
Allowance for Fittings Req'd	1.00 L.S.	$23,956	41.02	310	$12,717	$806		$37,479	**$65,568**
Notes: *Assumed since this is piping at the Service Water Pump Station, it will require lots of fittings - no dwg furnished detailing this so allowed cost for these at same as cost of LF of pipe.*									
	Unit Costs---->	5000.00	PIPE04S	40.000	1640.85	103.99		7044.84	
Allowance for Re-Use of Exist Supports & Brackets, Plus Additional	1.00 L.S.	$5,300	41.02	40	$1,641	$104		$7,045	**$12,325**
Subtotal		$53,176			$27,080	$1,727		$81,983	
Markups using CH-MK		$39,854			$20,296	$1,294			$61,444
TOTAL 15000 MECHANICAL		**$93,030**		**660**	**$47,376**	**$3,021**		**$81,983**	**$143,427**
1.00 LS									
1.00 LS									***$143,427.00***

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

PROJECT: Piping Rehabilitation for YDP
CLIENT: United States Bereau of Reclamation
DESIGN STAGE: Preliminary Design, Class 3 Estimate
PROJ MGR: Bruce Johnson/LAS
CLIENT PROJ NO.:

ENR CCI: November 2007 ENR for Los Angeles at 8871.09
ESTIMATOR: Robert Lawson/RDD
REVIEWED BY: Robert Lawson/RDD
EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY	UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
A Cleaning Product Return Fluid Systems MECHANICAL										
		Unit Costs---->	0.01						0.01	
Fluid Systems	1.00									
		Unit Costs---->	0.01						0.01	
Line 38 - DSB Control Block Trench No. 1 (East)	1.00									
151079202880		Unit Costs---->	20.04	Q15	0.348	15.50	1.47		38.21	66.86
Pipe, stainless steel, butt weld, 3" diameter, schedule 10, type 316, includes w	457.00	L.F.	$9,708	44.55	159	$7,084	$672		$17,464	**$30,553**
		Unit Costs---->	0.01						0.01	
Line 38 - Fittings & Work Req'd, Ref Dwg. -5090	1.00									
151079603100A		Unit Costs---->	49.00	Q15	4.938	219.96	20.86		292.76	512.19
Tee, stainless, straight, butt weld, 3", schedule 10, type 316, includes t	17.00	Ea.	$883	44.55	84	$3,739	$355		$4,977	**$8,707**
152100401210		Unit Costs---->	70.00	PIPE04S	2.492	102.22	6.48		182.90	319.99
3" Stainless Steel, Slip-On Flange	51.00	EA	$3,784	41.02	127	$5,213	$330		$9,328	**$16,319**
151076905010		Unit Costs---->	22.50	Q1	0.239	10.65			34.50	60.35
Grooved End Coupling, stainless steel, flexible, 3" diameter	34.00	Ea.	$811	44.54	8	$362			$1,173	**$2,052**
		Unit Costs---->	0.01						0.01	
Line 39 - DSB Control Block Trench No. 2 (West)	1.00									
151079202880		Unit Costs---->	20.04	Q15	0.348	15.50	1.47		38.21	66.86
Pipe, stainless steel, butt weld, 3" diameter, schedule 10, type 316, includes w	307.00	L.F.	$6,521	44.55	107	$4,759	$451		$11,732	**$20,524**
		Unit Costs---->	0.01						0.01	
Line 39 - Fittings & Work Req'd, Ref Dwg. -5090	1.00									
151079602110A		Unit Costs---->	30.00	Q15	3.292	146.64	13.91		192.35	336.51
Elbow, 90 Deg., stainless steel, long, butt weld, 3", schedule 10, type 316, inc	12.00	Ea.	$382	44.55	40	$1,760	$167		$2,308	**$4,038**
152100401210		Unit Costs---->	70.00	PIPE04S	2.492	102.22	6.48		182.90	319.99
3" Stainless Steel, Slip-On Flange	24.00	EA	$1,781	41.02	60	$2,453	$155		$4,390	**$7,680**
151076905010		Unit Costs---->	22.50	Q1	0.239	10.65			34.50	60.35
Grooved End Coupling, stainless steel, flexible, 3" diameter	12.00	Ea.	$286	44.55	3	$128			$414	**$724**

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

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CLIENT PROJ NO.:

ENR CCI: November 2007 ENR for Los Angeles at 8871.09
ESTIMATOR: Robert Lawson/RDD
REVIEWED BY: Robert Lawson/RDD
EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
A Cleaning Product Return Fluid Systems MECHANICAL									
	Unit Costs---->	1000.00	PIPE04S	20.000	820.42	52.00		1932.42	
Allowance for Re-Use of Exist Supports & Brackets, Plus Additional	1.00 L.S.	$1,060	41.02	20	$820	$52		$1,932	**$3,381**
Subtotal		$25,216			$26,319	$2,183		$53,718	
Markups using CH-MK		$18,899			$19,726	$1,636			$40,260
TOTAL 15000 MECHANICAL		**$44,115**		**607**	**$46,045**	**$3,819**		**$53,718**	**$93,978**
1.00 LS									
1.00 LS									***$93,978.40***
B Cleaning Product Return Hydranautics MECHANICAL									
	Unit Costs---->	0.01						0.01	
Hydranautics	1.00								
	Unit Costs---->	0.01						0.01	
Line 40 - DSB Control Block Trench	1.00								
151079202880	Unit Costs---->	20.04	Q15	0.348	15.50	1.47		38.21	66.86
Pipe, stainless steel, butt weld, 3" diameter, schedule 10, type 316, includes w	187.00 L.F.	$3,972	44.54	65	$2,899	$275		$7,146	**$12,502**
	Unit Costs---->	0.01						0.01	
Line 40 - Fittings & Work Req'd, Ref Dwg. -5090	1.00								
151079603100A	Unit Costs---->	49.00	Q15	4.938	219.96	20.86		292.76	512.19
Tee, stainless, straight, butt weld, 3", schedule 10, type 316, includes t	8.00 Ea.	$416	44.55	40	$1,760	$167		$2,342	**$4,097**
152100401210	Unit Costs---->	70.00	PIPE04S	2.492	102.22	6.48		182.90	319.99
3" Stainless Steel, Slip-On Flange	24.00 EA	$1,781	41.02	60	$2,453	$155		$4,390	**$7,680**
151076905010	Unit Costs---->	22.50	Q1	0.239	10.65			34.50	60.35
Grooved End Coupling, stainless steel, flexible, 3" diameter	16.00 Ea.	$382	44.54	4	$170			$552	**$966**

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

PROJECT: Piping Rehabilitation for YDP
CLIENT: United States Bereau of Reclamation
DESIGN STAGE: Preliminary Design, Class 3 Estimate
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CLIENT PROJ NO.:

ENR CCI: November 2007 ENR for Los Angeles at 8871.09
ESTIMATOR: Robert Lawson/RDD
REVIEWED BY: Robert Lawson/RDD
EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
B Cleaning Product Return Hydranautics MECHANICAL									
	Unit Costs---->	250.00	PIPE04S	6.000	246.13	15.60		526.73	
Allowance for Re-Use of Exist Supports & Brackets, Plus Additional	1.00 L.S.	$265	41.02	6	$246	$16		$527	**$922**
Subtotal		$6,815			$7,528	$613		$14,957	
Markups using CH-MK		$5,108			$5,642	$459			$11,210
TOTAL 15000 MECHANICAL		**$11,923**		**174**	**$13,171**	**$1,072**		**$14,957**	**$26,166**
1.00 LS									
1.00 LS									***$26,166.20***

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

PROJECT: Piping Rehabilitation for YDP
CLIENT: United States Bereau of Reclamation
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PROJ MGR: Bruce Johnson/LAS
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FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY	UNIT	MATERIALS	CREW	RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
D Special											
Filters											
MECHANICAL											
		Unit Costs---->	0.01							0.01	
Line 41 - Filter Effluent Pipes (28 ea at 10')	1.00										
152103101170A		Unit Costs---->	962.00	PIPE04S	3.100	127.17	8.06			1154.94	2020.55
42" SST 316-L, pipe assembly, shop fabricated	350.00	L.F.	$356,902	41.02	1,085	$44,508	$2,821			$404,231	**$707,193**
		Unit Costs---->	0.01							0.01	
Line 41 - Fittings & Work Req'd, Ref Dwg. Figure 4-14	1.00										
152103041110		Unit Costs---->	14300.00	PIPE04S	24.000	984.51	62.40			16204.90	28350.13
42" Stainless Steel, Slip-On Flange	56.00	Ea.	$848,848	41.02	1,344	$55,133	$3,494			$907,475	**$1,587,607**
151076605655A		Unit Costs---->	127.00	Q15	7.273	323.98	30.73			489.32	856.06
Nozzle, stainless steel, weld-on, 12" pipe, includes 1 weld per joint and weld	28.00	Ea.	$3,769	44.55	204	$9,071	$860			$13,701	**$23,970**
152101401120A		Unit Costs---->	394.00	PIPE04S	8.000	328.17	20.80			766.61	1341.16
12" Stainless Steel, Fab'd 90 Elbow	28.00	EA	$11,694	41.02	224	$9,189	$582			$21,465	**$37,553**
		Unit Costs---->		PIPE07	30.000	1499.84	297.00			1796.84	3143.52
Remove & Reinstall Aluminum Grating After Pipe Upgrade, Over Piping	28.00	Ea.		49.99	840	$41,995	$8,316			$50,311	**$88,019**
050909200100		Unit Costs---->		E25	0.025	1.03	0.28			1.31	2.30
Cutting, steel, to 1/2" thick, by hand, incl prep, torch cutting & grinding, exc	616.00	L.F.		41.26	15	$635	$173			$809	**$1,415**
		Unit Costs---->		PIPE07	4.000	199.98	39.60			239.58	419.14
Remove 42" & 12" Piping to be replaced & Dispose of	28.00	L.S.		49.99	112	$5,599	$1,109			$6,708	**$11,736**
		Unit Costs---->		PIPE07	24.500	1224.87	242.55			1467.42	2567.21
Remove & Reinstall, Flexible Couplings, 42" Dia	28.00	Ea.		49.99	686	$34,296	$6,791			$41,088	**$71,882**
		Unit Costs---->		PIPE07	30.000	1499.84	297.00			1796.84	3143.52
Remove & Reinstall Flgd Butterfly Valve, 42" Dia	28.00	Ea.		49.99	840	$41,995	$8,316			$50,311	**$88,019**

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FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
D Special									
Filters									
MECHANICAL									
	Unit Costs---->	2800.00	PIPE04S	200.000	8204.24	519.96		11692.20	
Allowance for Re-Use of Exist Supports & Brackets, Plus Additional	1.00 L.S.	$2,968	41.02	200	$8,204	$520		$11,692	**$20,455**
Subtotal		$1,224,181			$250,627	$32,983		$1,507,791	
Markups using CH-MK		$917,498			$187,839	$24,720			$1,130,057
TOTAL 15000 MECHANICAL		**$2,141,679**		**5,550**	**$438,466**	**$57,703**		**$1,507,791**	**$2,637,848**
1.00 LS									
1.00 LS									***$2,637,848.00***

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

PROJECT: Piping Rehabilitation for YDP
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EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY	UNIT	MATERIALS	CREW	RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
01 Rehabilitation, Col. D											
Mobilization											
GENERAL CONDITIONS											
		Unit Costs---->							45000.00	45000.00	
Mobilization & Demobilization (Approx. 7.5% Total)	1.00	LS							$45,000	$45,000	**$45,000**
TOTAL 01000 GENERAL CONDITIONS									**$45,000**	**$45,000**	**$45,000**
	1.00	**LS**									
	1.00	***LS***									***$45,000.00***

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PROJECT: Piping Rehabilitation for YDP
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EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY	UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
D Pretreatment										
Exterior										
MECHANICAL										
		Unit Costs---->	0.01						0.01	
Line 28 - Intake PS Disch Manifold & Pipeline	1.00									
152101101110A		Unit Costs---->	97.62	PIPE04S	1.300	53.33	3.38		160.18	280.24
10" SST 316-L, pipe assembly, shop fabricated	62.00	LF	$6,416	41.02	81	$3,306	$210		$9,931	**$17,375**
152101701170A		Unit Costs---->	172.55	PIPE04S	1.600	65.63	4.16		252.70	442.09
16" SST 316-L, pipe assembly, shop fabricated	62.00	LF	$11,340	41.02	99	$4,069	$258		$15,667	**$27,409**
152102501170A		Unit Costs---->	646.21	PIPE04S	2.400	98.45	6.24		789.67	1381.52
30" SST 316-L, pipe assembly, shop fabricated	98.00	LF	$67,128	41.02	235	$9,648	$611		$77,388	**$135,389**
152103101170A		Unit Costs---->	1597.05	PIPE04S	3.100	127.17	8.06		1828.10	3198.22
72" SST 316-L, pipe assembly, shop fabricated	89.00	LF	$150,666	41.02	276	$11,318	$717		$162,701	**$284,641**
		Unit Costs---->	0.01						0.01	
Line 28 - Fittings & Work Req'd, Ref Dwg. Figure 4-7	1.00									
152101201110A		Unit Costs---->	356.00	PIPE04S	6.600	270.74	17.16		665.26	
10" Stainless Steel, Fab'd 90 Elbow	1.00	EA	$377	41.02	7	$271	$17		$665	**$1,164**
152101201111A		Unit Costs---->	320.00	PIPE04S	6.600	270.74	17.16		627.10	
10" Stainless Steel, Fab'd 45 Elbow	1.00	EA	$339	41.02	7	$271	$17		$627	**$1,097**
152101103030A		Unit Costs---->	125.00	PIPE04S	3.600	147.68	9.36		289.54	
10" Stainless Steel Nozzle, Pe x Pe, Weld to Main Line	1.00	EA	$133	41.02	4	$148	$9		$290	**$507**
152101241110A		Unit Costs---->	444.00	PIPE04S	8.197	336.25	21.31		828.20	1448.92
10" Stainless Steel, Slip-On Flange	2.00	EA	$941	41.02	16	$673	$43		$1,656	**$2,898**
152101801120A		Unit Costs---->	1041.00	PIPE04S	12.300	504.56	31.98		1640.00	
16" Stainless Steel Elbow, 90 degree (4 Miter Elbow)	1.00	EA	$1,103	41.02	12	$505	$32		$1,640	**$2,869**
152101841110A		Unit Costs---->	1716.00	PIPE04S	13.115	538.00	34.09		2391.05	4183.09
16" Stainless Steel, Slip-On Flange	2.00	EA	$3,638	41.02	26	$1,076	$68		$4,782	**$8,366**
152101801120A		Unit Costs---->	975.00	PIPE04S	12.300	504.56	31.98		1570.04	
16" Stainless Steel Elbow, 45 degree (3 Miter Elbow)	1.00	EA	$1,034	41.02	12	$505	$32		$1,570	**$2,747**
152101801150A		Unit Costs---->	350.00	PIPE04S	8.200	336.37	21.32		728.69	
16" Stainless Steel Nozzle, Pe x Pe, Weld to Main Line	1.00	EA	$371	41.02	8	$336	$21		$729	**$1,275**
152102501170A		Unit Costs---->	646.21	PIPE04S	2.400	98.45	6.24		789.67	1381.52
30" SST 316-L, pipe assembly, shop fabricated for Manway	2.00	LF	$1,370	41.02	5	$197	$12		$1,579	**$2,763**
152102645160A		Unit Costs---->	8260.00	PIPE04S	14.000	574.30	36.40		9366.30	
30" Stainless Steel, Weld on Saddle	1.00	EA	$8,756	41.02	14	$574	$36		$9,366	**$16,386**

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

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ESTIMATOR: Robert Lawson/RDD
REVIEWED BY: Robert Lawson/RDD
EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY	UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
D Pretreatment										
Exterior										
MECHANICAL										
152102601140A		Unit Costs---->	1994.00	PIPE04S	21.000	861.45	54.60		3029.69	
30" x 20" Stainless Steel Reducer	1.00	EA	$2,114	41.02	21	$861	$55		$3,030	**$5,300**
152102601120A		Unit Costs---->	1342.00	PIPE04S	21.000	861.45	54.60		2338.56	4091.26
30" Stainless Steel Elbow, 15 degree (1 Miter Elbow)	15.00	EA	$21,338	41.02	315	$12,922	$819		$35,078	**$61,369**
152102641110		Unit Costs---->	8261.00	PIPE04S	24.590	1008.71	63.93		9829.30	17196.15
30" Stainless Steel, Slip-On Flange	10.00	EA	$87,567	41.02	246	$10,087	$639		$98,293	**$171,962**
152104001120A		Unit Costs---->	6500.00	PIPE04S	48.000	1969.02	124.79		8983.81	
72" Stainless Steel Elbow, 30 degree (2 Miter Elbow)	1.00	EA	$6,890	41.02	48	$1,969	$125		$8,984	**$15,717**
152104001126A		Unit Costs---->	6500.00	PIPE04S	32.000	1312.68	83.19		8285.87	
72" Stainless Steel End Cap	1.00	EA	$6,890	41.02	32	$1,313	$83		$8,286	**$14,496**
		Unit Costs---->	0.01						0.01	
Line 33 - Backwash Manifold	1.00									
152102301170A		Unit Costs---->	334.83	PIPE04S	1.800	73.84	4.68		433.44	758.29
24" SST 316-L, pipe assembly, shop fabricated	100.00	LF	$35,492	41.02	180	$7,384	$468		$43,344	**$75,829**
		Unit Costs---->	0.01						0.01	
Line 33 - Fittings & Work Req'd, Ref Dwg. Figure 4-11	1.00									
15060012000009A		Unit Costs---->	75.00	PIPE04S	2.000	82.04	5.20		166.74	
6" Stainless Steel Nozzle, Pe x Pe, Weld to Main Line	1.00	EA	$80	41.02	2	$82	$5		$167	**$292**
152101801150A		Unit Costs---->	350.00	PIPE04S	8.200	336.38	21.32		728.70	1274.83
16" Stainless Steel Nozzle, Pe x Pe, Weld to Main Line	2.00	EA	$742	41.02	16	$673	$43		$1,457	**$2,550**
152101841110A		Unit Costs---->	1716.00	PIPE04S	13.115	537.99	34.10		2391.05	4183.09
16" Stainless Steel, Slip-On Flange	3.00	EA	$5,457	41.02	39	$1,614	$102		$7,173	**$12,549**
152101801120A		Unit Costs---->	1041.00	PIPE04S	12.300	504.56	31.98		1640.00	
16" Stainless Steel Elbow, 90 degree (4 Miter Elbow)	1.00	EA	$1,103	41.02	12	$505	$32		$1,640	**$2,869**
152101701170A		Unit Costs---->	172.55	PIPE04S	1.600	65.63	4.16		252.70	442.09
16" SST 316-L, pipe assembly, shop fabricated	34.00	LF	$6,219	41.02	54	$2,232	$141		$8,592	**$15,031**
152102401140A		Unit Costs---->	997.00	PIPE04S	19.800	812.22	51.48		1920.52	
24" x 16" Stainless Steel Reducer	1.00	EA	$1,057	41.02	20	$812	$51		$1,921	**$3,360**
152102401130A		Unit Costs---->	2444.00	PIPE04S	26.400	1082.96	68.63		3742.23	
24" Stainless Steel Tee	1.00	EA	$2,591	41.02	26	$1,083	$69		$3,742	**$6,547**
152102401120A		Unit Costs---->	3925.00	PIPE04S	19.800	812.22	51.48		5024.20	
24" Stainless Steel Elbow, 90 degree (4 Miter Elbow)	1.00	EA	$4,161	41.02	20	$812	$51		$5,024	**$8,790**

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

PROJECT: Piping Rehabilitation for YDP
CLIENT: United States Bereau of Reclamation
DESIGN STAGE: Preliminary Design, Class 3 Estimate
PROJ MGR: Bruce Johnson/LAS
CLIENT PROJ NO.:

ENR CCI: November 2007 ENR for Los Angeles at 8871.09
ESTIMATOR: Robert Lawson/RDD
REVIEWED BY: Robert Lawson/RDD
EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
D Pretreatment									
Exterior									
MECHANICAL									
152102441110	Unit Costs---->	3583.00	PIPE04S	19.762	810.66	51.38		4660.02	
24" Stainless Steel, Slip-On Flange	1.00 EA	$3,798	41.02	20	$811	$51		$4,660	**$8,153**
	Unit Costs---->	7500.00	PIPE04S	100.000	4102.12	259.98		12312.10	
Allowance for Re-Use of Exist Supports & Brackets, Plus Additional	1.00 L.S.	$7,950	41.02	100	$4,102	$260		$12,312	**$21,540**
Subtotal		$447,058			$80,157	$5,080		$532,295	
Markups using CH-MK		$335,060			$60,076	$3,807			$398,943
TOTAL 15000 MECHANICAL		**$782,118**		**1,954**	**$140,232**	**$8,888**		**$532,295**	**$931,238**
1.00 LS									
1.00 LS									***$931,238.20***

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

PROJECT: Piping Rehabilitation for YDP
CLIENT: United States Bereau of Reclamation
DESIGN STAGE: Preliminary Design, Class 3 Estimate
PROJ MGR: Bruce Johnson/LAS
CLIENT PROJ NO.:

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EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY	UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
D1 Other										
Exterior, WQIC										
MECHANICAL										
		Unit Costs---->	0.01						0.01	
Line 35 - WQIC Intake/Supply Pipe	1.00									
152100901110A		Unit Costs---->	69.97	PIPE04S	1.300	53.33	3.38		130.88	228.96
8" SST 316-L, pipe assembly, shop fabricated	19.00	LF	$1,409	41.02	25	$1,013	$64		$2,487	**$4,350**
152101101110A		Unit Costs---->	97.62	PIPE04S	1.300	53.33	3.38		160.19	280.24
10" SST 316-L, pipe assembly, shop fabricated	330.00	LF	$34,147	41.02	429	$17,598	$1,115		$52,861	**$92,479**
		Unit Costs---->	0.01						0.01	
Line 35 - Fittings & Work Req'd, Ref Dwg. Figure 4-13	1.00									
152101201140A		Unit Costs---->	115.00	PIPE04S	6.600	270.74	17.16		409.80	
10" x 8" Stainless Steel Reducer	1.00	EA	$122	41.02	7	$271	$17		$410	**$717**
152101201110A		Unit Costs---->	356.00	PIPE04S	6.600	270.74	17.16		665.26	
10" Stainless Steel, Fab'd 90 Elbow	1.00	EA	$377	41.02	7	$271	$17		$665	**$1,164**
152101241110A		Unit Costs---->	444.00	PIPE04S	8.197	336.25	21.31		828.20	1448.92
10" Stainless Steel, Slip-On Flange	4.00	EA	$1,883	41.02	33	$1,345	$85		$3,313	**$5,796**
152101201111A		Unit Costs---->	320.00	PIPE04S	6.600	270.74	17.16		627.10	
10" Stainless Steel, Fab'd 45 Elbow	1.00	EA	$339	41.02	7	$271	$17		$627	**$1,097**
		Unit Costs---->	0.01						0.01	
Line 36 - WQIC Supply Pipe	1.00									
152100901110A		Unit Costs---->	69.97	PIPE04S	1.300	53.33	3.38		130.88	228.96
8" SST 316-L, pipe assembly, shop fabricated	8.00	LF	$593	41.02	10	$427	$27		$1,047	**$1,832**
		Unit Costs---->	0.01						0.01	
Line 36 - Fittings & Work Req'd, Ref Dwg. Figure 4-13	1.00									
152101001110A		Unit Costs---->	300.00	PIPE04S	3.600	147.68	9.36		475.04	831.06
8" Stainless Steel, Fab'd 90 Elbow	2.00	EA	$636	41.02	7	$295	$19		$950	**$1,662**
152101041110		Unit Costs---->	290.00	PIPE04S	6.557	268.98	17.05		593.42	1038.18
8" Stainless Steel, Slip-On Flange	2.00	EA	$615	41.02	13	$538	$34		$1,187	**$2,076**

CH2MHILL ESTIMATE DETAIL REPORT No.1 Ver 3.9

PROJECT: Piping Rehabilitation for YDP
CLIENT: United States Bereau of Reclamation
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CLIENT PROJ NO.:

ENR CCI: November 2007 ENR for Los Angeles at 8871.09
ESTIMATOR: Robert Lawson/RDD
REVIEWED BY: Robert Lawson/RDD
EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

DESCRIPTION	QTY UNIT	MATERIALS	CREW RATE	MH	LABOR	EQUIPMENT	INSTL S/C	TOTAL DIRECT	TOTAL W/MRKUPS
D1 Other									
Exterior, WQIC									
MECHANICAL									
	Unit Costs---->	2500.00	PIPE04S	50.000	2051.06	129.99		4831.05	
Allowance for Re-Use of Exist Supports & Brackets, Plus Additional	1.00 L.S.	$2,650	41.02	50	$2,051	$130		$4,831	**$8,452**
Subtotal		$42,772			$24,080	$1,526		$68,378	
Markups using CH-MK		$32,057			$18,047	$1,144			$51,247
TOTAL 15000 MECHANICAL		**$74,828**		**587**	**$42,127**	**$2,670**		**$68,378**	**$119,625**
1.00 LS									
1.00 LS									***$119,625.00***

CH2M HILL - CONTRACTOR MARKUP REPORT - Ver 3.9

PROJECT: Piping Rehabilitation for YDP
CLIENT: United States Bereau of Reclamation
DESIGN STAGE: Preliminary Design, Class 3 Estimate
PROJ MGR: Bruce Johnson/LAS
CLIENT PROJ NO.:

ENR CCI: November 2007 ENR for Los Angeles at 8871.09
ESTIMATOR: Robert Lawson/RDD
REVIEWED BY: Robert Lawson/RDD
EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

Reported From: Replacement of Piping

	Code	Contractor/Markup Description	Markup	Add-On Amount	Applied to Labor	Equip	Material	Other1	Other2	Other3
	CH-MK	**CH2M HILL Standard Markup Set - Prime Contractor**								
		1. Field Detail Allowance	2.000%		Yes	Yes	Yes	Yes	Yes	Yes
		2. Bond/Permits/Insurance	5.000%		Yes	Yes	Yes	Yes	Yes	Yes
		3. Contractors Overheads	10.000%		Yes	Yes	Yes	Yes	Yes	Yes
		4. Contractors Profit	8.000%		Yes	Yes	Yes	Yes	Yes	Yes
		5. Project Contingency	25.000%		Yes	Yes	Yes	Yes	Yes	Yes
		6. Market Adjustment Factor	10.000%		Yes	Yes	Yes	Yes	Yes	Yes
*	**CH-MK**	**CH2M HILL Standard Markup Set - Prime Contractor**		**Percentages-->**	74.95%	74.95%	74.95%	74.95%	74.95%	74.95%

**** Indicates Contractor is used in estimate.***

	SUB-EL	**Sub-Contractor Electrical/I & C**								
	SUB-EL	**Sub-Contractor Electrical/I & C**		**Percentages-->**	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

**** Indicates Contractor is used in estimate.***

	SUB-PA	**Sub-Contractor Painting**								
	SUB-PA	**Sub-Contractor Painting**		**Percentages-->**	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

**** Indicates Contractor is used in estimate.***

	SUB-SC	**Sub-Contractor Site/Civil & Earthworks**								
	SUB-SC	**Sub-Contractor Site/Civil & Earthworks**		**Percentages-->**	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

**** Indicates Contractor is used in estimate.***

SUB-SS **Sub-Contractor**

CH2M HILL - CONTRACTOR MARKUP REPORT - Ver 3.9

PROJECT: Piping Rehabilitation for YDP
CLIENT: United States Bereau of Reclamation
DESIGN STAGE: Preliminary Design, Class 3 Estimate
PROJ MGR: Bruce Johnson/LAS
CLIENT PROJ NO.:

ENR CCI: November 2007 ENR for Los Angeles at 8871.09
ESTIMATOR: Robert Lawson/RDD
REVIEWED BY: Robert Lawson/RDD
EST NO. / REV NO.: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
PROJECT NO.: 345334.AA.T5

Reported From: Replacement of Piping

Code	Contractor/Markup Description	Markup	Add-On Amount	Applied to Labor	Equip	Material	Other1	Other2	Other3
	Steel & Metals								
SUB-SS	Sub-Contractor Steel & Metals	Percentages-->		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

**** Indicates Contractor is used in estimate.***

Yuma Desalting Plant
Aluminum Bronze Piping Rehabilitation

PROJECT: Piping Rehabilitation for YDP
CLIENT: United States Bereau of Reclamation
DESIGN STAGE: Preliminary Design, Class 3 Estimate
PROJ MGR: Bruce Johnson/LAS
CLIENT PROJ NO:

ESTIMATOR: Robert Lawson/RDD
REVIEWED BY: Robert Lawson/RDD
EST NO / REVISION NO: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
CH2M Hill PROJ NO: 345334.AA.T5

	QUANTITY	UNIT of MEAS	UNIT PRICE	TOTAL
- Replacement of Piping	1	LS	$16,091,750	$16,091,750
- A Rehabilitation, Col. B	1	LS	$14,995,887	$14,995,887
+ 01 Mobilization	1	LS	$625,000	$625,000
- 02 1st St. Feed/2nd St. Reject	1	LS	$5,163,646	$5,163,646
+ A Fluid Systems	1	LS	$3,470,088	$3,470,088
+ B Hydranautics	1	LS	$1,693,558	$1,693,558
- 03 1st St. Reject/2nd St. Feed	1	LS	$1,417,829	$1,417,829
+ A Fluid Systems	1	LS	$1,063,629	$1,063,629
+ B Hydranautics	1	LS	$354,200	$354,200
- 04 Interstage to ER	1	LS	$1,669,811	$1,669,811
+ A Fluid Systems	1	LS	$1,326,774	$1,326,774
+ B Hydranautics	1	LS	$343,037	$343,037
- 05 Low Pressure Reject	1	LS	$888,987	$888,987
+ A Fluid Systems	1	LS	$479,823	$479,823
+ B Hydranautics	1	LS	$211,446	$211,446
+ C Combined	1	LS	$197,718	$197,718
- 06 Product	1	LS	$2,329,195	$2,329,195
+ A Fluid Systems	1	LS	$1,072,657	$1,072,657
+ B Hydranautics	1	LS	$516,479	$516,479

Yuma Desalting Plant
Aluminum Bronze Piping Rehabilitation

PROJECT: Piping Rehabilitation for YDP
CLIENT: United States Bereau of Reclamation
DESIGN STAGE: Preliminary Design, Class 3 Estimate
PROJ MGR: Bruce Johnson/LAS
CLIENT PROJ NO:

ESTIMATOR: Robert Lawson/RDD
REVIEWED BY: Robert Lawson/RDD
EST NO / REVISION NO: 2007-REL-L072 // 0
FILE NAME: YDP_AB to SST Piping 2007.PWS
CH2M Hill PROJ NO: 345334.AA.T5

	QUANTITY	UNIT of MEAS	UNIT PRICE	TOTAL
+ C Combined	1	LS	$740,059	$740,059
- 08 Other	1	LS	$143,427	$143,427
+ D2 Exterior, Plant Service	1	LS	$143,427	$143,427
- 09 Cleaning Product Return	1	LS	$120,145	$120,145
+ A Fluid Systems	1	LS	$93,978	$93,978
+ B Hydranautics	1	LS	$26,166	$26,166
- 10 Special	1	LS	$2,637,848	$2,637,848
+ D Filters	1	LS	$2,637,848	$2,637,848
- B Rehabilitation, Col. D	1	LS	$1,095,863	$1,095,863
+ 01 Mobilization	1	LS	$45,000	$45,000
- 07 Pretreatment	1	LS	$931,238	$931,238
+ D Exterior	1	LS	$931,238	$931,238
- 08 Other	1	LS	$119,625	$119,625
+ D1 Exterior, WQIC	1	LS	$119,625	$119,625