NORTHWESTERN UNIVERSITY

H$ HP S7''*(/ ': H&5%!-1(''41(-&-&,5 +-(10*&,5 0* / +1(*%0, 1B -'& ?10C <P0@ 0' 1(D4&1(3 67 ASME B 1$1$

I$ #P S7''*(/ ': #+A!-1(''41(-&-&,5 +-(10*&,5 0* 1B -'& ?10C <P0@ +1 2('' 0' 1(D4&1(3 67 ASME B 1E

1$C ABBREVIATIONS

A$ HDPE: %&5%!3(, '&*7 -+27(*%72(, (

B$ RTRP: 1(&,.+1)(3 *%(1 / +'(**&,5 1('&, -20'*&)

C$ RTRF: 1(&,.+1)(3 *%(1 / +'(**&,5 1('&, .&**&,5'

1$B DE#IVERY8 STORAGE AND HAND#ING

1$ C+ / -27 A&*% -1+;&'&+,' &, K ASME B 1$E8 B4&23&,5 S(1;&)(' P&-&,5 / ASME B 1$18 P+A(1 P&-&,5 L $
2$ C(1*&.7 *%0* (0)% A(23(1 %0' -0'' (3 AWS D40&.&)0*&+,*('*' .+1 A(23&,5 -1+)('' (' &,;+2;(3 0,3 *%0*)(1*&.&)0*&+,&')411(,*$

E$ ASME C+ / -&0,)(: C+ / -27 A&*% [!S"# $%&'() $uilding Ser*ices +iping) / !S"# $%&'&) +ower +iping .+1 / 0*(1&O2'8 -1+34)*'8 0,3 &,'*0220*&+,$

F$ ASME C+ / -&0,)(: S0.(*7 ;02;(' 0,3 -1('' 41(;('' (2' '%022 6(01 0--1+-1&0*(ASME 206(2'$

1$8 SUBMITTA#S

A$ M0,4.0)*41(1'W #&*(10*41(0,3 D0*0 '%022 6('46 / &**(38 0' +,(-0)<05(8 .+1 -&-('8 .&**&,5' 0,3 0--41*(,0,)('8 &,)243&,5 I+&,*&,5 / 0*(1&O2'8 &,'420*&+,8 %0,501' 0,3 +*%(1 / &')(220,(+4' &*(/ '$

1$E APP#ICAB#E PUB#ICATIONS

A$ T%(-462&)0*&+,' 2&'*(3 6(2+A .+1 / 0 -01* +. *%&' '-()&.&)0*&+, *+ *%((:*(,* 1(.(1(,)(3$ T%(-462&)0*&+,' 01(1(.(11(3&, *%(*(:* 67 60'&) 3('&5,0*&+, +,27$

F(3(102 S-()&.&)0*&+,' ?F(3$ S-()$@:

A!A!6000B NOT 1	F10 / ('8 C+;(1'8 G10*&,58 S*(-'8 S4 / - 0,3 C0*)% B0'&,8 M0,%+2(
#!S!12B	S)1((,&,58 I,'()*8 N+, / (*022&)

M&2&*017 S-()&.&)0*&+,' ?M&2$ S-()$@:

MI#!S!E01	S%+)< T('*' HI ?H&5% I / -0)*@ S%&-6+013 M0)%&,(178 ED4&- / (,* 0,3 S7'*(/ '

A / (1&)0, S+)&(*7 .+1 T('*&,5 0,3 M0*(1&O2' ?ASTM@:

A 6/A 6M!08	C016+, S*14)*4102 S*((2
ACG/ACGM!EE?200E@	F(11&*&) M022(062(I1+, C0'*&,5'
AB /AB M!10	P&-(8 S*((28 B20)< 0,3 H+*!D&--(38 N&,)!C+0*(38 W(23(3 0,3 S(0 / 2(''
A10B/A10BM!100	C016+, S*((2 F+15&,5' .+1 P&-&,5 A--2&)0*&+,'
A106/A106M!10	S(0 / 2('' C016+, S*((2 P&-(.+1 H&5%!T(/ -(10*41(S(1;&)(
A126!0C?200E@	G107 I1+, C0'*&,5' .+1 V02;('8 F20,5('8 0,3 P&-(F&**&,5'
A1 E/A1 EM!0C?2010@	E2()*1&)!F4'&+, ?A1)@!W(23(3 S*((2 P&-(?NPS C 0,3 O;(1@
A16G!EE?200E@	S*0&,2('' 0,3 H(0*!R('&'*&,5 C%1+ / &4 / !N&)<(2 S*((2 P20*(8 S%((*8 0,3 S*1&-

A1E /A1E M!100	A22+7!S*((2 0,3 S*0&,2(' ' S*((2 B+2*&,5 .+1 H&5% T(/ -(10*41(+1 H&5% P1(''41(S(1;&)(0,3 O*%(1 S-()&02 P41-+'(A--2&)0*&+,'
A1EC/A1ECM!100	C016+, 0,3 A22+7 S*((2 N4*' .+1 B+2*' .+1 H&5% P1(''41(+1 H&5%

C1126!100 F0)(3 +1 U,.0)(3 R&5&3 C(2&2&01 P%(,+&) T%(1/0& I,'4&0*&+,

C11 6!10 F&(:&6&(8 #+A P(1/(0,)(V0-+1 R(*013(1' .+1 T%(1/0& I,'4&0*&+,

D2EE6!01?200G@ F&&0/(,*!W+4,3 F&6(15&0'' ?G&0''!F&6(1!R(&,.+1)(3 T%(1/+'(**&,5!R('&,@ P&-(

DC02C!0B M0)%&,(M03(F&6(15&0'' ?G&0''!F&6(1!R(&,.+1)(3 T%(1/+'(**&,5 R('&,@ F&0,5('

E8C!106 S41.0)(B41,&,5 C%010)*(1&'*&)'+. B4&&3&,5 M0*(1&0&'

A/(1&)0,S+)&(*7 +. M()%0,&)0& E,5&,((1' ?ASME@:

B1$20$1!2006 P&-(T%1(03'8 G(,(10& P41-+'(?I,)%@

B16$!2006 M0&&(06&(I1+,T%1(03(3 F&**&,5':C&0''(' 1B0 0,3 00

B16$C!2006 G107 I1+,T%1(03(3 F&**&,5':?C&0''(' 12B 0,3 2B0@

B16!B!200E P&-(F&0,5(' 0,3 F&0,5(3 F&**&,5': NPS 1/2 *%1+45% NPS 2C M(*1&)/I,)% S*0,3013

B16$E!200G F0)*+17!M03(W1+45%* B4**A(&3&,5 F&**&,5'

B16$11!200E F+15(3 F&**&,5'8 S+)<(*!W(&3&,5 0,3 T%1(03(3

B16$21!200B N+,/(*0&&) F&0* G0'<(*' .+1 P&-(F&0,5('

B18$2$1!2010 SD401(8 H(:8 H(0;7 H(:8 0,3 A'<(A H(03 B+&*' 0,3 H(:8 H(0;7 H(:8 H(: F&0,5(8 #+6(3 H(038 0,3 #05 S)1(A' ?I,)% S(1&('@

B 1$1!2010 P+A(1 P&-&,5

B 1$E!2008 B4&&3&,5 S(1;&)(' P&-&,5

BC0$1000!200E P1(''41(G045(' 0,3 G045(A**0)%/(,*'

A/(1&)0,W(&3&,5 S+)&(*7 ?AWS@:

B2$1!B2$1M!BMG!200E B0'(M(*0& G1+4-&,5 .+1 W(&3&,5 P1+)(341(' 0,3 P(1.+1/0,)(H40&&.&)0*&+,

D10$12/D10$12M!2000 G4&3(.+1 A(&3&,5 M&&3 S*((& P&-(

A/(1&)0,A''+)&0*&+,+. S*0*(H&5%A07 0,3 T10,'-+1*0*&+,O..&)&0&' ?AASHTO@:

M 00!0 I,+150,&)N&,)!R&)% P1&/(1

M0,4.0)*41(1M' S*0,3013&00*&+,S+)&(*7 ?MSS@:

H$ F20,5(B+2*' 0,3 N4*': ASME B18$2$18)016+, '*((28 4,2(' ' +*%(1A&'(&,3&)0*(3$

2$2 FIBERG#ASS PIPE AND FITTINGS

A$ RTRP: ASTM D2EE68 .&20 / (,*!A+4,3 -&-(A&*% *0-(1(3 6(22 0,3 '-&5+* (,3' .+1 03%('&;(I+&,*'$

B$ RTRF: C+ / -1('' &+, +1 '-107!4-/)+,*0)* /+23(3 +. '0 / (/ 0*(1&028 -1('' 41( )20'' 8 0,3 I+&,&,5 / (*%+3 0' -&-($

C$ F&6(1520'' P&-(A3%('&;(: F41,&'%(3 +1 0' 1()+ / / (,3(3 67 *%(-&-(/ 0,4.0)*41(1$

D$ F20,5(': ASTM DC02C8 .422!.0)(50'<(*' '4&*062(.+1 *%('(1;&)(8 / &,& / 4 / 1/8 &,)% ? $2 / / @ *%&)<8 60!G0 341+ / (*(1$ ASTM A 0G8 G103(B8 %(:!%(03 6+2*' A&*% A0'%(1'$

2$ CONDUIT PIPING SYSTEM

A$ C+,34&* P&-&,5 S7'*(/ : F0)*+17!.061&)0*(3 0,3 0'' (/ 62(38 0&1*&5%* 0,3 A0*(1*&5%*8 310&,062(8 -1('' 41(!*('*(3 -&-&,5 A&*%)+,34&*8 &,,(1 -&-('4--+1*'8 0,3 &,'420*(3)011&(1 -&-&,5$ F061&)0*('+ &,'420*&+,)0, 6(31&(3 &, -20) (67 .+1)&,5 317 0&1 *%1+45%)+,34&*$

B$ C011&(1 P&-(I,'420*&+,:

1$ M&,(102!W++2 P&-(I,'420*&+,: M&,(102 +1 520'' .&6(1' 6+,3(3 A&*% 0 *%(1 / +'(**&,5 1('&,$ C+ / -27 A&*% ASTM CBCG8 [Type 2) **3. /** deg **4** (**1. 1** deg **,**) / Type 22) **&- / /** deg **4** (**01(** deg **,**) 8 G103(A$

0$ B0,3' '%022 6(ASTM A6668 T7-(0C8 '*0&,2('' '*((28 /C &,)% ?1E / / @ A&3(8 0$020

2$C #OOSE!FI## INSU#ATION

A$ G10 , 4?018 ?++ ' (!.&22 & , ' 4?0*%+ , : I , +150 , &)8 , + , *+ : &)8 , + , .?0 / / 06?(8 '+3&4 / -+*0 ' '&4 / 0?4 / & , 4 /

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TAB#E 1 M&,&/4/ P&-(I,'420*&+, T%&)<,(''//?&,)%('@ F+1 S*(0/ 16 *+ C08 -'&?110 *+ 2800 <P0@ 505(			
N+/&,02 P&-(D&0/(*(1 I,)%('?//@	MPT!PC MPT!PF	D(?*0	T%(1/+!12 S4-(1 C02*(/-
1 ?2B@	2 ?B0@	2!1/2 ?6B@	C ?100@
1!1/2 ?C0@	2 ?B0@	2!1/2 ?6B@	C ?100@
2 ?B0@	2!1/2 ?6B@	!1/2 ?8B@	C!1/2 ?110@
2!1/2 ?6B@	2!1/2 ?6B@	!1/2 ?8B@@	C!1/2 ?110@
?80@	?GB@	C ?100@	B ?12B@
C ?100@	?GB@	C ?100@	B ?12B@
B ?12B@	?GB@	C ?100@	B ?12B@
6 ?1B0@	!1/2 ?8B@	C!1/2 ?110@	B!1/2 ?1 B@
8 ?200@	!1/2 ?8B@	C!1/2 ?110@	B!1/2 ?1 B@
10 ?2B0@	C ?100@	B ?12B@	6 ?1B0@
12 ? 00@	C ?100@	B ?12B@	6 ?1B0@
1C ? B0@	C ?100@	B ?12B@	6 ?1B0@
16 ?C00@	C ?100@	B ?12B@	6 ?1B0@
18 ?CB0@	C ?100@	B ?12B@	6 ?1B0@

N+*(':

E$ I, '4?0*&+, B0, 3&, 5 0, 3 J0)<(*: ASTM A16G8 '*O&, ?(' ' '*((? 60, 3' 0, 3)?&- '8 0* ?(0'* 0$B &,)%(' ?1 / / @ A&3(8 ? 0C '*O&, ?(' ' '*((?@8 / 0:& / 4 / '-0)&,

1$ T1(,)%)+; (1': P1( )0'* 1(&, .+1) (3)+,)1(*(' ()*&+, '8 ' (* *+ (:&'*&, 5 5103 (8 .20* 0 ,3 *14(0* 022 -+&, *' +.)+, *0)* +, *1(,)% A0220 *1(,)% 0 ,3)+; (1 *+ .+1 / 0 A0*(1*&5%* (, ; (2+- (A%(, 0' ' (/ 62(3$

2$ W0*(1-1++.&, 5: A- -27 *+ 022 6 (2+A 5103(-+1*&+, ' +. *%(*1(,)%$

$ G0'<(*' 0 ,3 ' (020, *': ASTM CE208 1/C &,)% ?6 / / @ *%&)< , (+-1(, (-03' A&*% 0 / &, & / 4 / A&3*% +. 2 &,)%(' ?B0 / / @ 6(*A((,)+; (1' 0 ,3 *+- ' +. A022'Q (20'*+ / (1&) ' (020, *' *%0* 01(0 ; 0&206 2(0' 0 +, (+1 *A+)+ / -+, (, * '7'*(/ $ A' -%02*&) ' (020, *' 01(, +* - (1 / &**(3$ S(020, *' / 4'* 1('&'* B0R *+*02 I+&, * / +; (/ (, *$ N+, !'055&, 5 ' (020, * / 4'* 6(4' (3 .+1 ; (1*&) 02 I+&, *'$ S(2.!2(; (2&, 5 ' (020, * / 4'* 6(4' (3 .+1 *1(,)% *+- 64** I+&, *'$

2$E STEAM CARRIER PIPING

A$ P&- (: K ASTM AB 8 '*((28 ' (0 / 2(' '8 G103(B / +1 / ASTM A1068 G103(B8 (2( )*1&) 1('&'*0,) (A(23(3 / +1 / ASTM AB 8 G103(B8 S)%(342(C0 L $ S*0, 3013 A(&5%* - (1 / &**(3 .+1 -&- ('&0(' 12 &,)%(' ? 00 / / @ 0, 3 06+; ($ G103(F8 .41, 0) (64**!A(23(3 -&- (8 &' , +* - (1 / &**(3$

B$ J+&, *':

1$ I, *1(,)%(' 0, 3 3&1( )*!641&(3 '7'*(/ ': B4**!A(23

1$ I, T1(,)%(' 0,3 3&1()*!641&(3 '7'*(/ ': B4** A(?3 I+&,*'$ S+)<(* A(?3 &' 1(D4&1(3 .+1 -&-(
'&O(' 2 &,)%(' ?B0 / /@ 0,3 6(?+A$ M0,4.0)*41(1\' '*0,3013 '2&3&,58 50'<(*(3 I+&,*' 01(
-(1/&**(3 6(*A((, .0)*+17!.061&)0*(3 '()*&+,' +. 3&1()* 641&(3 WS# '7'*(/$ N+ I+&,*' 01(
0?2+A(3 &, .0)*+17!.061&)0*(3 '*10&5%* '()*&+,' +. -1(!(,5&,((1(3 3&1()*!641&(3 '7'*(/'$

3(*0&2(3 +, *%( )+,*10)* 310A&,5'$ G4&3(2+)0*&+,' / 4'*)+,.+1 / *+ 1()+ / / (,30*&+,' +. (:-0,'&+, I+&,* / 0,4.0)*41(1$

2$1 BA## JOINTS

A$ F0)*+17 64&2* 3(;&)('8 &,'(1*(3 &, -&-(2&,(+..'(*' &, 51+4-' +. *A+ +1 *%1((0' '%+A, *+ 06'+16)7)2&)02 -&-(/ +;(/ (,* A%&)% 1('42*' .1+ / *%(1 / 02 (:-0,'&+, 0,3)+,*10)*&+,$

B$ M&,& / 4 / '(1;&)(1(D4&1(/ (,*' '%022 6(10*(3 2B0 -'& ?1G2B <P0@8 CB0 3(5 F ?2 2 3(5 C@8)+,*&,4+4' +, '*(0 / 0,3)+,3(,'0*($

C$ S46 / &* &,3(-(,3(,*)(1*&.&)0*&+, *%0* '& / &201 4,&*' %0;(-0''(3 *%(.+2+A&,5 *('*' A&*% ,+ 2(0<'$

1$ #+A P1('' 41(#(0<05(T('*: M&,& / 4 / 6 -'& ?C0 <P0@ '0*410*(3 '*(0 / .+1 60 307'$
2$ #&.(C7)2(F2(: T('*: M&,& / 4 / 8000 .2(:)7)2(' 0* 2B0 -'& ?1G2B <P0@ '0*410*(3 '*(0 / $
$ T%(1 / 02 C7)2&,5 T('*: M&,& / 4 / 100)7)2(' .1+ / 0* / +'-%(1&) -1('' 41(*+ +-(10*&,5 -1('' 41(0,3 60)< *+ 0* / +'-%(1&) -1('' 41(A&*% '0*410*(3 '*(0 / $
C$ E,;&1+, / (,*02 S%+)< T('*: MI# S E01$
B$ V&610*&+, T('*: T('* .+1 1G0 %+41' +, (0)% +. *%1((/ 4*4022 7 -(1-(,3&)4201 0:(' 0* 2B *+ 12B HN0 0$0B *+ 0$10 &,)% ?1 *+ 2 / / @ 3+462(0 / -2&*43(+, 0 '&,52(6022 I+&,* 0,3 +, 0 *%1((6022 I+&,* +..'(*$

D$ J+&,*': ASME B 1$1:

1$ C0'* +1 .+15(3)016+, '*((2 A&*% A(23(3 (,3'$
2$ S*0,3013 A(&5%* -&-(A022 *%&)<,('$
$ M&,& / 4 / 0,5420 1 / +;(/ (,*)0-06&2&*7: 1B 3(51((' 0,3 60 3(51((' 1+*0*&+,02 / +;(/ (,*$
C$ G0'<(*': N+, 0'6('*+'$
B$ P0)<&,5 &,I()*&+, 3(;&)('8 &. -1+;&3(3: A22+A &,I()*&+, 4,3(1 .422 2&,(-1('' 41($ P1+;&3(+,(7(01 '4--27 +. -0)<&,5$

2$1C VA#VES

A$ G0*(V02;(' ?ASTM A126@:

1$ T7-(101 '%022 %0;(:

0$ C0'* '*((2 6+378 10*(3 1B0 -'& ?102B <P0@ 0* B00 3(5 F ?260 3(5 C@8 11!1/2 *+ 1 -(1)(,*)%1+ / &4 / '*0&,2('' '*((2 .2(:&62(A(35(0,3 %013 .0)(3 ?'*(22&*(@ +1 ,&)<(2)+--(1 022+7 '(0*'8 1B0 -'& ?102B <P0@ .20,5(3 (,3'8 OSSY8 1&'&,5 '*(/ 8 6+2*(3 6+,,(*$
6$ F0)*+17 &,'*022(3 52+6(;02;(3 67-0'' +, 022 '*(0 / ;02;(' 2015(1 *%0, &,)%(' ?80 / / @$
)$ D1&22 0,3 *0- 6+''(' .+1)+,,()*&+, +. 310&,' A%(1('%+A,$

2$ T7-(102 &' ,+* 4'(3$
$ T7-(10 '%022 %0;(:

0$ C0'* &1+, 6+378 C20'' B8 10*(3 .+1 12B -'& ?8B0 <P0@ '0*410*(3 '*(0 / 8 200 -'& ?1 GB <P0@ WOG8 61+,0(+1 61+,0(.0)(3 A(35(0,3 '(0*'8 12B -'& ?8B0 <P0@ ASME .20,5(3 (,3'8 OSSY8 1&'&,5 '*(/ 8 6+2*(3 6+,,(*8 1(,(A062('(0* 1&,5'$

C$ T7-(10C '%022 %0;(:

0$ B1+,0(6+378 10*(3 .+1 200 -'& ?1 GB <P0@ '0*410*(3 '*(0/8 C00 -'& ?2GB0 <P0@ WOG8 61+,0(A(35(' 0,3 M+,(2 +1 '*0&,2(' ' '*((2 '(0*'8 *%1(03(3 (,3'8 1&'&,5 '*(/8 4,&+, 6+,,(*$

B$ T7-(10B &' ,+* 4'(3$

6$ T7-(106 '%022 %0;(:

0$ F+15(3 '*((2 6+378 10*(3 .+1 00 -'& ?20B0 <P0@ 0* C20 3(5 F ?216 3(5 C@ /&,&/4/ C20'' 600 -'& ?C1 0 <P0@ +1 C20'' 800 -'& ?BB00 <P0@8 %013(,(3 '*0&,2(' '*((2 +1 '0*(22&*(A(35(0,3 '(0*'8 *%1(03(3 (,3'8 OSSY8 1&'&,5 '*(/8 6+2*(3 6+,,(*$

B$ G2+6(V02;(' ?ASTM A126@:

1$ T7-(201 '%022 %0;(:

0$ C0'* '*((2 6+378 10*(3 1B0 -'& ?102B <P0@ 0* B00 3(5 F ?260 3(5 C@8 11!1/2 *+ 1 -(1)(,*)%1+/&4/ '*0&,2(' '*((2 +1 '*(22&*(3&') 0,3 '(0*8 1B0 -'& ?102B <P0@ ASME .20,5(3 (,3'8 OSSY8 1&'&,5 '*(/8 6+2*(3 6+,,(*8 1(,(A062('(0* 1&,5'$ D1&22 0,3 *0-6+''(' .+1)+,,()*&+, +. 310&,'$

2$ T7-(202 &' ,+* 4'(3$

$ T7-(20 :

0$ C0'* &1+, 6+378 10*(3 .+1 12B -'& ?8B0 <P0@ '0*410*(3 '*(0/8 200 -'& ?1 GB <P0@ WOG8 61+,0(+1 61+,0(!.0)(3 3&') ?T(.2+, +1)+/-+'&*&+, .0)&,5 -(1/&**(3@ 0,3 '(0*8 12B -'& ?8B0 <P0@ ASME .20,5(3 (,3'8 OSSY8 1&'&,5 '*(/8 6+2*(3 6+,,(*8 1(,(A062('(0* 1&,5'$

C$ T7-(20C:

0$ ASTM B618 61+,0(6+378 10*(3 .+1 200 -'& ?1 GB <P0@ '0*410*(3 '*(0/8 C00 -'& ?2GB0 <P0@ WOG8 %013(,(3 '*0&,2(' '*((2 3&') 0,3 '(0*8 *%1(03(3 (,3'8 1&'&,5 '*(/8 4,&+, 6+,,(*8 1(,(A062('(0* 1&,5'$

C$ C%()< ;02;(' ?ASTM A126@:

1$ T7-(C01 '%022 %0;(:

0$ C0'* '*((2 6+378 'A&,5!*7-(8 10*(3 .+1 1B0 -'& ?102B <P0@ 0* B00 3(5 F ?260 3(5 C@8 '*0&,2(' '*((2 +1 '*0&,2(' '*((2 ! .0)(3 3&') 0,3 '(0*8 1B0 -'& ?102B <P0@ ASME .20,5(3 (,3'8 6+2*(3)+;(18 1(,(A062(3&')$

2$ T7-(C02 &' ,+* 4'(3$

$ T7-(C0 '%022 %0;(:

0$ C0'* &1+, 6+378 C20'' B8 'A&,5!*7-(8 10*(3 .+1 12B -'& ?8B0 <P0@ '0*410*(3 '*(0/8 200 -'& ?1 GB <P0@ WOG8 61+,0(+1 61+,0(!.0)(3 3&') 0,3 '(0*8 12B -'& ?8B0 <P0@ ASME .20,5(3 (,3'8 6+2*(3)+;(18 1(,(A062(3&') 0,3 '(0*$

C$ T7-(C0C '%022 %0;(:

0$ B1+,0(6+378 'A&,5!*7-(8 10*(3 .+1 200 -'& ?1 GB <P0@ '0*410*(3 '*(0/8 C00 -'& ?2GB0 <P0@ WOG8 61+,0(3&')8 *%1(03(3 (,3'8 1(51&,3&,5 3&')$

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2$1G STRAINERS8 Y TYPE

A$ P1+;&3(0' '%+A, +, '*(0/ 0,3)+,3(,'0*(-&-&,5 '7'*(/ '$

B$ I,)243(+-(, (,3 1(/+;062()72&,31&)02 ')1((, 0,3 *%1(03(3 62+A +..)+,,()*&+,$

C$ F+1 '*(0/ '(1;&)(4- *+ 1B0 -'& ?102B <P0@ 0,3 0* 31&- *10-'8 '*10&,(1 '%022 6(10*(3 .+1 /&,&/4/ 1B0 -'& ?102B <P0@ '0*410*(3 '*(0/Q 10*(3 .+1 1B0 -'& ?102B <P0@8 .20,5(3 (,3'8)0'* '*((28 .+1 -&-('&O(' 06+;(2 &,)%(' ?B0 / /@$ U'()0'* &1+, +1 61+,0(8 10*(3 .+1 2B0 -'& ?1G2B <P0@ '0*410*(3 '*(0/8 *%1(03(3 (,3'8 .+1 -&-('&O(' 2 &,)%(' ?B0 / /@ 0,3 4,3(1$

D$ F+1)+,3(,'0*('(1;&)(8 '*10&,(1 '%022 6(10*(3 .+1 12B -'& ?8B0 <P0@ '0*410*(3 '*(0/8 1GB -'& ?1200 <P0@ WOG$ P1+;&3(12B -'& ?8B0 <P0@8 .20,5(3 (,3'8)0'* &1+, 8 .+1 -&-('&O(' 06+;(2 &,)%(' ?B0 / /@$ P1+;&3()0'* &1+, +1 61+,0(8 *%1(03(3 (,3'8 .+1 -&-('&O(' 2 &,)%(' ?B0 / /@ 0,3 4,3(1$

E$ S*10&,(1 ')1((, '%022 6('*0&,2('' '*((28 A&*% 0 .1((01(0 ,+* 2('' *%0, 2 1/2 *&/(' .2+A 01(0 +. -&-($ D&0/(*(1 +. +-(,&,5' '%022 6(0$0B &,)% ?1$ / /@ +1 2('' +, '*(0/ '(1;&)(0,3 0$06 &,)% ?1$B / /@ +1 2('' +, A0*(1 '(1;&)($

F$ I,)243(50*(*7-(;02;(0,3 D4&)<)+4-2(%+'()+,,()*&+, +, 022 62+A+..)+,,()*&+,'$

2$18 SAFETY VA#VES AND VENT CONNECTORS

A$ S0.(*7 ;02;('C+,.+1/ *+ *%(1(D4&1(/(,*' +. ASME B+&2(1 0,3 P1(''41(V(''(2 C+3(?S()*&+, VIII8 U,.&1(3 P1(''41(V(''(2'@ 0,3 6(0--1+;(3 67 *%(N0*&+,02 B+013 +. B+&2(1 0,3 P1(''41(V(''(2 I,'-()*+1'$

B$ R(2&(;&,5)0-0)&*7: N+* 2('' *%0, *%0* '%+A, +, *%(310A&,5' A&*% 0 -1(''41(1&'(06+;('(* -1(''41(,+* *+ (:)((3 10 -(1)(,* +. '(* -1(''41($

C$ P1+;&3(8 0* *%(3&')%015(+. (0)% '0.(*7 ;02;(8 0 '-()&02 .2(:&62()+,,()*+1 0**0)%(3 *+ *%(;(,* -&-(0,3 *%('0.(*7 ;02;($ M42*&!-27 '*0&,2('' '*((2 6(22+A'8 .422 &,*(1,02 -&-(2&,(18 -1+*()*&;((:*(1&+1 '%1+438 31&-)0*)%&,5)+,.&5410*&+, A&*% 310&,8 3('&5,(3 *+ -1(;(,* 62+A 60)< +. '*(0/ &,*+ '-0)(8 -1(''41(*('*(3 0*,+* 2('' *%0, 1B -'& ?100 <P0@$ D1&- -0, (22',+* 022+A(3 &, *4,,(2' +1)+,'*1&)*(3 '-0)(' 6()04'(+. =62+A!60)<> +. '*(0/ .1+/ *%(31&- -0, (22 +-(,&,5'$

2$1E PRESSURE GAGES

A$ P1+;&3(505(' &/ /(3&0*(27 3+A,'*1(0/ +. (0)% '*(0/ 2&,(&'+20*&+, ;02;(8 6(.+1(0,3 0.*(1 (0)%

F$E + 4&0.356603(%)0.71(2;S 1+ &,)??1

G$ P1+;&3(2&D4&3 .&22(3 505(' 0* +4*2(* +. 022 -4 / -'$

C$ A))410)7: G103(2A8 1/2 -(1)(,*8 +, 022 505('Q (:)(-* G103(A8 +,(-(1)(,* -(1/&**(3 +, 3&0-%105/ 0)*40*(3 505('8 2&D4&3 .&22(3 505('8 0,3)+/ -+4,3 505('$

D$ I,)243(:

1$ R(3 '(* %0,3' +, 505(' 2+)0*(3 0* 04*+ / 0*&) -1(''41(1(5420*+1 ;02;(+4*2(*'$
2$ N((32(;02;(+1 505( )+)< 10*(3 .+1 *%('(1;&)($
$ S7-%+, +, 022 '*(0/ 505('$
C$ O;(12+03 '*+- +, 022 -1(''41(505('$

E$ E:)(-* A%(1(+*%(1A&'('%+A, +, *%(310A&,5'8 -1(''41(10,5(' '%022 6(0' .+22+A':

SERVICE	RANGE
S*(0/ *+ 1B -'& ?100 <P0@	0 *+ 0 -'& ?0 *+ 200 <P0@
S*(0/ *+ BE -'& ?C0G <P0@	0 *+ 100 -'& ?0 *+ G00 <P0@
S*(0/ 06+;(BE -'& ?C0G <P0@	0 *+ 200 -'& ?0 *+ 1B00 <P0@
C+,3(,'0*(P4 / - D&')%015(	0 *+ 100 -'& ?0 *+ G00 <P0@
V0)44/ R(*41,	0 &,)%(' HG 0 ! *+ 1B -'& ?100 <P0 ;0)44/ *+ 100 <P0@

2$20 THERMOMETERS8 PIPE OR TAN9 MOUNTED

A$ T%(1/+/ (*(1 2+)0*&+,' 01('%+A, +, *%(310A&,5'$

B$ T%(1/+/ (*(1':

1$ I,34'*1&02*7-(8 '(-0106 2(A(22 0,3 '+)<(*8 4,&+,)+,,()*(3$
2$ R(3 1(03&,5 / (1)417)+/ 6&,0*&+, F0%1(,%(&*/C(2'&4' ')02(8 E &,)%(' ?220 / /@ 2+,5$
$ C+11+'&+, 1('&'*0,*)0'(A&*% 520'' +1 -20'*&) .1+,*$
C$ S*10&5%* +1 60)< .+1/ (:)(-* *%+'(2+)0*(3 / +1(*%0, G .((* ?2100 / /@ 06+;(.2++1 '%022 6(03I4'*062(0,52($
B$ W(22' '&O(3 *+ '4&* -&-(3&0/ (*(1 A&*%+4* 1('*1&)*&,5 .2+A8 +1 -1+;&3(+;(1'&O(3 -&-(0* A(22 2+)0*&+,$ S,45 '2&3&,5 .&* 6(*A((, '+)<(* 0,3 A(22$
6$ A))410)7 '%022 6(+,(-(1)(,* +. ')02(10,5($
G$ 0 *+ 00 3(5 F ?0 *+ 1B0 3(5 C@$

2$21 PIPE HANGERS AND SUPPORTS

A$ R(D4&1(/ (,*': MSS SP B8 0,3 ASME B 1$1$

B$ A--2&(' *+ 022 -&-&,5 ,+* &, .0)*+17!.061&)0*(3 3&1()*!641&(3 '7'*(/$ A22 '7'*(/ ' '%022 6( )+/ -2(*(27 '4--+1*(3$ A110,5('4--+1*' '+ *%0* 022 2+03' 34(*+ A(&5%*8 *%(1/02(:-0,'&+,8 '(&'/&) '%+)< ?&.0--2&)062(@8 0,3 -1(''41(01(*10,'.(11(3 .1+/ *%('4--+1* '7'*(/ *+ *%('*14)*41($ T%(3('&5, 0,3 2+)0*&+, +. '4--+1*' '%022 0* 022 *&/ (' -1(;(,* (:)(''&;(.+1)('8 /+/ (,*'8 0,3 '*1(''(.1+/ 6(&,5 &/ -+'(3 +, *%((D4&-/ (,*8 '*14)*41(8 '4--+1*(3 '7'*(/ 8 0,3 '4--+1*'$ H(0*(3 '7'*(/ '

D$ D10A&,5':

1$ T7-('8 '&O('8 2+)0*&+,'8 0,3 '-0)&,5 +. 022 %0,5(1' 0,3 '4--+1*'$
2$ R+22(1 +1 '2&3(1 '4--+1*' .+1 022 %+1&O+,*02 '*(0/ 0,3)+,3(,'0*(-&-&,5$
$ S-()&02 '4--+1*' &,)243&,5 0,)%+1'8 54&3(' 0,3 610)('$
C$ I. (D4&-/(,* 0,3 -&-&,5 0110,5(/(,* 3&..(1' .1+/ *%0* '%+A, +, *%(310A&,5'8 '4--+1* 2+)0*&+,' 0,3 *7-(' '%022 6(1(;&'(3 0* ,+)+'* *+

M$ P&-( )+;(1&,5 -1+*()*&+, '033?(': MSS SP B88 T7-(E$ P1+;&3(0* 022 '4--+1* -+&,*' +, &,'420*(3 -&-((:)(-* A%(1(T7-(-&-( )?0 / -&' -1+;&3(3$

N$ S?&3&,5 '4--+1*': MSS SP B88 T7-(B$ W(?3(3 '*((? 0**0)%/(,*' *+ -&-(0,3 '*14)*41(A&*% T(.?+, +1 510-%&*('?&3&,5 '41.0)(' 6+,3(3 *+ *%(0**0)%/(,*'$ P1+;&3('*((? 54&3('8 (:)(-* 0* (:-0,'&+, 6(,3'8 *+ -1(;(,*?0*(10? /+;(/(,*+. *%(-&-($

O$ P&-(10)<' 0,3 /&')(220,(+4' '4--+1*': ASTM A 68 '*14)*410? '*((? '%0-('$ M0,4.0)*41(3 '*14* '7'*(/' 01(0))(-*06?(&. *%(7 %0;(*%(1(D4&1(3?+03)0117&,5 06&2&*7$

P$ S4--+1*'8&,)?43&,5 022 '*14)*410? '*((28&, *1(,)%(' 0,3 /0,%+?('': H+*!3&- 502;0,&0(3$

H$ S(&'/&) R('*10&,*':

1$ P1+;&3(610)&,5 0' 1(D4&1(3$ R(.(1*+ 3(*0?' +, 310A&,5'$
2$ S%+)<A6'+16(1': MSS SP B88 T7-(B0$ M()%0,&)0? +1 %73104?&) *7-(10*(3 .+1 '%+)<?+03'$ P&-(0**0)%/(,*' '%022 6(MSS SP B88 T7-($
$ I,'420*&+, M0*(1&0?' ?I, M0,%+?('8 T4,,(?'8 C+,)1(*(T1(,)%('8 O-(,A1(0'@

R$ C0?)&4/ S&2&)0*(I,'420*&+,:

1$ P1(.+1/(3 -&-&,5&,'420*&+,: ASTM CB 8 T7-(I$
2$ B?+)<': ASTM CB 8 T7-(I$
$ F&**&,5 I,'420*&+,: ASTM CB 8 A&*% -+?7;&,7?)%?+1&3(8 T7-(II G103(GU8 0,3 T7-(III8 -1(/+?3(3 .&**(3)+;(1&,5 0$020&,)%(' ?0$B / /@ *%&)<$

S$ F&6(15?0'' I,'420*&+,:

1$ P1(.+1/(3 -&-&,5&,'420*&+,: ASTM CBCG8 CB0 3(5 F ?2 0 3(5 C@$
2$ F&**&,5&,'420*&+,: ASTM CBCG8 CB0 3(5 F ?2 0 3(5 C@8 A&*% -+?7;&,7?)%?+1&3(8 T7-(II G103(GU8 0,3 T7-(III8 -1(/+?3(3 .&**(3)+;(1&,5 0$020&,)%(' ?0$B / /@ *%&)<$

T$ R&5&3)?+'(3)(22 -%(,+&) .+0/: ASTM C11268 T7-(III8 G103(18 2B0 3(5 F ?121 3(5 C@$

U$ C(224?01 5?0'' &,'420*&+,: ASTM CBB2$

V$ I,'420*&+,5 0,3 .&,&'%&,5)(/(,*': ASTM CCCE8 0' 1()+/ /(,3(3 67 *%(/0,4.0)*41(1 .+1 *%(*7-(+. &,'420*&+, '7'*(/ 0,3 '(1;&)( )+,3&*&+,'$

W$ I,'420*&+, 60,3': ASTM A16G8 /&,&/4/ +. 1/2&,)% ?12 / /@ A&3(67 0$01B&,)% ?0$C / /@ *%&)<'*0&,?('' '*((?$

J$ A?4/&,4/ I0)<(*': M&,&/4/ +. 0$016&,)% ?0$C / /@ *%&)< 0?4/&,4/8 00 0??+78 H!1C *(/-(18 A&*% ?+)<&,5 ?+,5&*43&,0? I+&,*'$ J0)<(*' .+1 (?6+A'8 *((' 0,3 +*%(1 .&**&,5' '%0?? 6(.0)*+17 .061&)0*(3 *+ /0*)% /0*(1&0? 0,3)+,'*14)*&+, +. *%('*10&5%* 14, I0)<(*'$ F0)*+17 .061&)0*(3 '*0&,?('' '*((? 60,3' '%0?? 6(.41,&'%(3 0,3&,'*0??(3 +, 0??)&1)4/.(1(,*&0? I+&,*'$ B0,3' '%0?? 6(0$GB&,)% ?20 / /@ A&3(+, 18&,)% ?CB0 / /@)(,*(1'$ B0,3' '%0?? 6(0--2&(3 A&*% /0,4.0)*41(1' 1()+/ /(,3(3 '(020,*$ E,*&1('7'*(/ '%0?? 6(A0*(1*&5%*$

Y$ S(1;&)(I0)<(*': ASTM C11 68 A%&*(<10.* 6+,3(3 *+ 0$001&,)% ?0$02B / /@ *%&)< 0?4/&,4/ .+&28 .&6(15?0'' 1(&,.+1)(38 -1('' 1&('(,'&*&;(03%('&;( )?+'41(8 6(0)% -4,)*41(*('*(3 *+ B0 4,&*'8 '4&*06?(.+1 -0&,*&,5 A&*%+4* '&0&,5$ J0)<(*' '%0?? %0;(0 /&,&/4/ 1!1/2&,)% ?C0 / /@ ?0- +,?+,5&*43&,0? I+&,*' 0,3 ,+*?('' *%0, C&,)% ?100 / /@ 64** '*1&-' +, (,3 I+&,*'$ B4** '*1&- /0*(1&0?

'%02 6('0 / (0' *%(I0)<(*$ #0- 0,3 64** '*1&-' / 0

C$ S(02 022 +-(,&,5'&, /0,%+2(+1 64&23&,5 A022'0.*(1 1(/+;02 +.-&-&,5$

D$ U,2('' '*0*(3 +*%(1A&'(67 F0)&22*&(' O-(10*&+,' M0,05(/(,* 022 /0*(1&02 0,3 (D4&-/(,* 1(/+;(3 '%022 6()+/(*%(-1+-(1*7 +.*%(C+,*10)*+1 0,3 '%022 6(1(/+;(3 .1+/ N+1*%A('*(1, U,&;(1'&*7 -1+-(1*7 0,3 '%022 ,+* 6('*+1(3&, +-(10*&,5 01(0'$

E$ A22 .20/()4**&,5 '%022 6(-(1.+1/(3 A&*% 03(D40*(.&1(-1+*()*+,.0)&22*&(' 0;0&2062(0' 1(D4&1(3

NORTHWESTERN UNIVERSITY
PROJECT NAME _____ FOR: _____
JOB # _____

9$ S()41(0,)%+1' A&*%)+,)1(*(*%14'* 62+)<'$

#$ C+,,()** '*(0/ 0,3)+,3(,'0*(-&-&,5 A%(1(&* -0''(' *%1+45% *%(64&23&,5 A022$

M$ #++'(!F&22 I,'420*&+, I,'*0220*&+,:

1$ F+1/ &,'420*&+, *1(,)% 67 (:)0;0*&+, +1 67 &,'*022&,5 317A022 '&3(.+1/' *+ ('*062&'% *%(1(D4&1(3 %(&5%* 0,3 A&3*% +. *%(&,'420*&+,$

2$ S4--+1* -&-&,5 A&*% -1+-(1 -&*)%8 '(-010*&+,8 0,3)2(010,)(*+ 60)<.&22 +1 '&3(.+1/' 4'&,5 *(/ -+1017 '4--+1*&,5 3(;&)(' *%0*)0, 6(1(/+;(3 0.*(1 60)< .&22&,5 A&*% &,'420*&+,$

$ P20)(&,'420*&+, 0,3 60)<.&22 0.*(1 .&(23 D402&*7!)+,*1+2 *('*&,5 %0' 6((,)+/ -2(*(3 0,3 1('42*' 0--1+;(3$

C$ A--27 6&*4/0'*&))+0*&,5 *+)016+,!'*((2 0,)%+1' 0,3 54&3('$ P+41)+,)1(*(*%14'* 62+)<' 0,3 0,)%+1'$

B$ W10- -&-&,5 0* (:-0,'&+, 2++-' 0,3 +..'(*' A&*% /&,(102!A++2 &,'420*&+, +. *%&)<,('' 0--1+-1&0*(.+1)02)420*(3(:-0,'&+, 0/+4,*$

6$ P+41 2++'(!.&22 &,'420*&+, *+ 1(D4&1(3 3&/(,'&+, 05&*0*&,5 &,'420*&+, *+ (2&/&,0*(;+&3' 01+4,3 -&-&,5$

G$ R(/+;(*(/-+1017 %0,5(1' 0,3 '4--+1*'$

8$ C+;(1 2++'(!.&22 &,'420*&+, A&*% -+27(*%72(,('%((* 0 /&,&/4/ +. C /&2' ?0$10 / /@ *%&)<8 0,3(/-*7 2++'(!.&22 &,'420*&+, 605' +, *+-$

E$ M0,4027 60)<.&22 A&*% 6 &,)% ?1B0 / /@ 2&.*' +.)2(0, 60)<.&22$ I. /()%0,&)02)+/-0)*&+, &' 1(D4&1(38 /0,4027 60)<.&22 A&*% 12 &,)% ? 00 / /@ 2&.*'$

N$ I,'*022 T10)(1 W&1(-(1 22 0000 =C+/ /+, W+1< R('42*' .+1 P24/6&,5>$

$B DRAIN VA#VES AND VENT VA#VES

A$ P1+;&3(1!1/2 &,)% ?C0 / /@ /&,&/4/ -&-('&O(310&, ;02;(' +,)+,3(,'0*(1(*41,)011&(1 -&-(' 0* 022 2+A -+&,*' &, /0,%+2('$ P1+;&3(1&,)% ?2B / /@ /&,&/4/ 0&1 ;(,* ;02;(' &, /0,%+2(' 0* 022 %&5% -+&,*' &,)+,3(,'0*(1(*41,)011&(1 -&-&,5$

$6 PIPE SUPPORT INSTA##ATION ?IN TRENCHES8 TUNNE#S8 MANHO#ES@

A$ C++13&,0*('4--+1* 2+)0*&+,' -1&+1 *+ (1()*&+, +. -&-&,5$ H0,5(1 -01*' /4'* 6(/01<(3 0* *%(.0)*+17 A&*% 0 ,4/6(1&,5 '7'*(/ <(7(3 *+ %0,5(1 207+4* 310A&,5'$ #07+4* 310A&,5' /4'* 6(0;0&2062(0* *%('&*(341&,5)+,'*14)*&+,$

D$ S-()&02 S4--+1*':

1$ S()41(%+1&0+,*02 -&-(' A%(1(,()(''017 *+ -1(;(,* ;&610*&+, +1 (:)('' 'A07$
2$ W%(1(%0,5(1')0,,+* 6(03(D40*(27 '()41(3 0' '-()&.&(38 /0<('-()&02 -1+;&'&+,' .+1 %0,5&,5 0,3 '4--+1*&,5 -&-(0' 0--1+;(3 67 *%(C+,*10)*&,5 O..&)(1W' R(-1('(,*0*&;(5&;('A1&**(,-(1/&''&+,$
$ D+ ,+* 0**0)% -&-('4--+1*'8 %0,5(1'8)20/-' +1 0,)%+1' *+ (D4&-/(,*4,2('' '-()&.&(3.+1 *%0* (D4&-/(,*+14,2('' *%(C+,*10)*&,5 O..&)(1W' R(-1('(,*0*&;(5&;('A1&**(,-(1/&''&+,$

E$ #+)0*('-1&,5 %0,501 4,&*' A&*%&, 1.++*?00 / /@ +. *%(-&-(0**0)%/(,*8 (:)(-* &, 2+)0*&+,' A%(1('-1&,5 0''(/62&('&,*(1.(1(A&*% -&-(&,'420*&+,$

F$ S(&'/&)B10)('0,3R('*10&,*': D+ ,+*&,'420*(-&-&,5 A&*%&, 1.++*?00 / /@+.3(;&)(4,*&23(;&)(%0'6((,&,'-()*(3 67 C+,*10)*&,5 O..&)(1W' R(-1('(,*0*&;($//

G$ M&,&/4/ C2(010,)('&, T4,,(2'0,3 T1(,)%(':

1$ F2++1 *+ 6+**+/ +. -&-('4--+1*6(0/:2&,)%(' ?B0 / /@
2$ F2++1 *+ 6+**+/ +. -&-(&,'420*&+, I0)<(*: 6&,)%(' ?1B0 / /@
$ W022 *+ '&3(+. -&-(&,'420*&+, I0)<(*: &,)%(' ?GB / /@
C$ C(&2&,5 *+ *+- +. -&-(&,'420*&+, I0)<(*: 1&,)% ?2B / /@

$G PAINTING EJPOSED STEE# SURFACES IN MANHO#ES8 TUNNE#S AND CONCRETE SHA##OW TRENCHES

A$ F+1 /0,%+2(' 0,3 A02<!*%1+45% *4,,(2'8 -1+;&3('41.0)()2(0,&,5 0,3 -1(-010*&+, 0,3 0--27 -1&/()+0*+.14'*1('&'*0,* /(*02 -1&/(1$

B$ F+1)+,)1(*('%022+A*1(,)%('8 -1+;&3('41.0)()2(0,&,5 0,3 -1(-010*&+,8 0--27 -1&/(1 0,3 .&,&'%)+0*+. 0&,)!1&)% -0&,*$

$8 DIRECT!BURIED SYSTEM INSTA##ATION

A$ T%(C+,*10)*+1 '%022+;(1'((*%(3(2&;(18 '*+1(8&,'*022 0,3*('**%('7'*(/ 0' -(1 /0,4.0)*41(1W' 1()+/ /(,30*&+,'$ A22 A+1< '%022 6(&, '*1&)* 0))+130,)(A&*% *%(1(D4&1(/(,*' '-()&.&(3 67 *%(/0,4.0)*41(1$ P1&,*(3&,'*14)*&+,' /4'* 6(0;0&2062(+, '&*(-1&+1 *+ 3(2&;(17 +. '7'*(/)+/-+,(,*'$ A,7)%0,5(' 1(D4&1(3*+ *%(3('&5,0,3 207+4* +. *%('7'*(/34(*+ '&*()+,3&*&+,' /4'* 6(0--1+;(3&, A1&*&,5 67 *%(C+,*10)*&,5 O..&)(1W' R(-1('(,*0*&;($ A22 610,)% -&-&,5)+,,()*&+,'8 ;02;('0,3 31&-*10-' /4'* 6(2+)0*(3 A&*%&, /0,%+2('$

B$ E:)0;0*&+,8 T1(,)%&,58 0,3 B0)<.&22&,5: P(1.+1/ 022 (:)0;0*&+,8 *1(,)%&,58 0,3 60)<.&22&,5 0'1(D4&1(3 67 *%('7'*(/ /0,4.0)*41(1W' 3('&5,$ B(0)% '0,3+1 0,7 '0,3 A&*% 2015(0/+4,*' +.)%2+1&3(' &' ,+* -(1/&**(3$ P20)('7'*(/ +, 0 6&,)% ?1B0 / /@ *%&)<'0,3 6(3 0,3 60)<.&22 +, 022 '&3(' A&*% 6&,)% ?1B0 / /@ *%&)<'0,3 0' /(0'41(3 .1+/ +4*'&3(*%( )011&(1 -&-(/&,'420*&+,$ F+4,30*&+, .+1 '7'*(/ /4'* 6(.&1/0,3 '*062($ F+4,30*&+, 0,3 60)<.&22 /4'* 6(.1((.1+/ 1+)<'$ C+,)1(*(0,)%+1 0,3 *%14'* 62+)<' /4'* 6(&,'*022(3&, 4,3&'*416(3 (01*%$ B0)<.&22&,5 /4'* ,+*)+/ /(,)(4,*&2(2(;0*&+,' %0;((6((,'41;(7(3 0,3 0))(-*(3 0,3 '7'*(/ %0' 6((,'0*&'.0)*+1&27 -1(''41(*('*(3&,)243&,5 %731+'*0*&)*('*&,5 +.)011&(1 -&-('0,3 0&1*('*&,5 +.)0'&,5'$

C$ M0&,*0&,)+,'*0,*'2+-(+.)011&(1 -&-('0' '%+A,+1 '-()&.&(3$ P1&+1 *+ 60)<.&22&,5 +;(1*%(*+- +. *%( )0'&,58 64* 0.*(1 1(/+;02 +. *(/-+1017 '4--+1*'8 C+,*10)*+1 '%022 /(0'41(0,3 1()+13 (2(;0*&+,' +. *+- +.)0'&,5&, *%(*1(,)%$ E2(;0*&+,' '%022 6(*0<(,0* (;(17 .&(23 I+&,*8 1/ -+&,*' 02+,5 (0)% -&-('()*&+,8 0,3 0* *+-' +. (26+A'$ T%('(/(0'41(/(,*' '%022 6()%()<(3 050&,'*)+,*10)* 310A&,5' 0,3 '%022)+,.&1/ *%0* *%()+,34&* '7'*(/ %0' 6((,&,'*022(3 *+ *%((2(;0*&+,'

'%+A, +, *%( )+,*10)* 310A&,5' 4,2('' 0--1+;(3 67 *%(C+,*10)*&,5 O..&)(1&' R(-1('(,*0*&;($ S2+-('%022 6(4,&.+1/ A&*%&, 0$1 -(1)(,*$ M(0'41(/(,*' '%022 6(1()+13(3 67 *%(C+,*10)*+18 &,)243(3 &, *%(3&1()* 641&(3 '7'*(/ /0,4.0)*41(1 1(-1('(,*0*&;(&' 30&27 1(-+1*8 0,3 5&;(, *+ *%(C+,*10)*&,5 O..&)(1&' R(-1('(,*0*&;(-1&+1 *+)+;(1&,5 *%(*+- +. *%( )0'&,5 A&*% 60)<.&22$

D$ P1+;&3( )0*%+3&) -1+*()*&+, .+1 022 '*((2)0'&,5 '7'*(/' 0,3 022 641&(3 (:-+'(3 / (*02$ P1+;&3(3&(2()*1&) -&-(.20,5(' 0,3 4,&+,' 0,3 &'+20*&+, 3(;&)(' 0* 022 -+&,*' ,()(''017$ P1+;&3(*('* '*0*&+,' 0* 5103(+, (0)%'()*&+, +.*%(-&-&,5 '7'*(/$ I'+20*&+, .20,5(' 0,3 4,&+,' '%022 6(10*(3 .+1 *%( )011&(1 -&-('(1;&)(*(/-(10*41(0,3 -1('' 41($

E$ R(/+;(022 3&1*8 ')02(8 0,3 +*%(1 .+1(&5, /0**(1 .1+/ &,'&3(*%(-&-&,5 67 4'(+. 0 -&-('A06 +1 -&-(=-&5> 6(.+1( )+,,()*&,5 -&-('()*&+,'8 ;02;('8 +1 .&**&,5'$

F$ S()*&+,' +. '7'*(/ *%0* %0;(6((, .4227 +1 -01*&0227 '46/(15(3 &, A0*(1 / 4'* 6(1(-20)(3$ M+&'*41( )+,*(,* +. &,'420*&+, 341&,5 &,'*0220*&+, '%022 ,+* (:)((3 .&;(-(1)(,* 67 A(&5%*$

G$ A* (0)%)0'&,5 *(1/&,0*&+, ?(,3 -20*(@&, 64&23&,5' 0,3 /0,%+2('8 -245 *%( )0'&,5 310&, +-(,&,5' A&*% 610'' -245' 0,3 (:*(,3 1&,)% -&-('&O(502;0,&O(3 ;(,* -&-(' ?ASTM AB @.1+/ *%( )0'&,5 ;(,*' *%1+45% *%(*+-' +. *%(/0,%+2(' +1 1 .++* ? 00 / /@ 06+;(*%( )+,34&* &, 64&23&,5'$ T(1/&,0*(*%(+4*'&3(;(,*' &, 180!3(51((6(,3'$

H$ P1+;&3(1(-+1*' *+ *%(C+,*10)*&,5 O..&)(1&' R(-1('(,*0*&;(*%0* &,)243(:

1$ D0&27 A1&**(,1(-+1*: P1(-01(3 30&27 0,3 '&5,(3 67 *%(C+,*10)*+1$ S46/&* *%(+1&5&,02 1(-+1* *+ *%(C+,*10)*&,5 O..&)(1&' R(-1('(,*0*&;(+, *%('0/(307 &* &' -1(-01(3$ P1+;&3(+,(' (*+. .&(23 -&)*41(' +. A+1< 30&27$

2$ R(-+1* C+,*(,*': S*0*(A%(*%(1 +1 ,+* *%( )+,3&*&+, 0,3 D402&*7 +. *%(/0*(1&02' 4'(3 0,3 *%(3(2&;(178 '*+105(8 &,'*0220*&+, 0,3 *('*&,5 +. *%('7'*(/ 01(&, 0))+130,)(A&*% *%(/0,4.0)*41(1&' 1()+/ /(,30*&+,'8)%0,5(' *+ 310A&,5' 0,3 '-()&.&)0*&+,'8 0,7)+11()*&;(0)*&+, *%0* A0' *0<(, +. *%('7'*(/8 &3(,*&.7 0,7)+,3&*&+,' *%0*)+423 1('42* &, 0, 4,'0*&'.0)*+17 &,'*0220*&+,$

$ R(-+1* C(1*&.&)0*&+,: D0&27 1(-+1*' 01(*+ 6(1(;&(A(38 '&5,(3 0,3 '(02(3 67 *%(P1+.('' &+,02 E,5&,((1 1('-+,'&62(.+1 *%('7'*(/ &,'*0220*&+,$

C$ R(-+1* S46/&**02' 0,3 S*+- O13(1: D0&27 1(-+1*' '%022 6('46/&**(3 A&*% *%(-07/(,* 1(D4('*'$ A22 A+1< /4'* '*+-&. 30&27 1(-+1*' 01(,+* .41,&'%(3 0,3 1(D4('*' .+1 -07/(,*' '%022 6(3(,&(302,1.7152(&)4.71394(,)0.71320(8,301(

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$10 INSTA##ATION ! SAFETY VA#VES

A$ V02;(' /4'*6(4-1&5%*0,3+1&(,*(3'+*%0*2&.*&,52(;(1'01(0))('' &62(.1+/ ,(01('*A02<A07$

B$ P1+;&3('-()&02.2(:&62()+,,()*+1+, (0)%'0.(*7 ;02;(*%0*&' 3('&5,(3*+0;+&3 62+A!60)<+.
'*(0/ &,*+*%(*4,,(2+1 /0,%+2($S2&-I+&,**+6(0110,5(3*+-1(;(,*;(,*2&,(.1+/ &/-+'&,50,7
'*10&, +, '0.(*7 ;02;(0,3*+-1(;(,* /+&'*41(0))4/420*&+, &, '0.(*7 ;02;($S4--+1* ;(,*2&,(

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&$ F2(:&62( )+, ,()*+1'
I$ B022 I+&,*' (:)(-* -&-&,5 6(*A((, I+&,*'

6$ I,'*0220*&+, +.&,'420*&+,:

0$ P1('' 41(T('*': C+/ -2(*(022 -1('' 41(*('*' 6(.+1(&,'*022&,5$
6$ I,'420*&+, /0*(1&02: N(A8)2(0,8 317 0,3 '*+1(3

B$ W(23(1 H402&.&)0*&+,': A22 A(23(1' '%022 6(D402&.&(3 0' -(1 ASME B 1$1 0,3 AWS B2$1!B2$1M! BMG$

C$ F&(23 6(;(2' 0,3 '%+- 6(;(2': D+,(67 /()%0,&)02 /(0,' +1 67 .20/( )4**&,5$ W%(1(6(;(2&,5 &' 3+,(67 .20/( )4**&,58 '41.0)(' '%022 6(*%+1+45%27

$18 IDENTIFICATION SIGNS

A$ V02;('P1+;&3(20/&,0*(3-20'*&)'&5,'8A&*%(,510;(3 2(**(1&,5,+*2('' *%0, /16&,)%?B//@ %&5%8+, 022&'+20*&,5;02;(' +,'*(0/ 0,3)+,3(,'0*(1(*41,'7'*(/8&3(,*&.7&,5 64&23&,5 +1 01(0 '(1;(3$ A**0)%*+*%(;02;(' A&*%)+11+'&+,!1('&'*0,*)%0&,'$

B$ P&-('#06(2'(1;&)(+.022-&-(' &, /0,%+2(' 0,3 A02<!*%14 *4,,(2'$

$1E FIE#D HUA#ITY CONTRO#

A$ D(/+,'*10*(2(0<!*&5%*,('' +.022-&-&,5 '7'*(/' 67-(1.+1/&,5 %731+'*0*&)0,3 +-(10*&+,02*('*'$ A22206+18 /0*(1&02 0,3 *('*&,'*14/(,*' /4'*6(.41,&'%(3 67 *%(C+,*10)*+1$ A22&,'*14/(,*' /4'*

C$ E0)%)0'&,5 .&(23 I+&,* '%022 6(*('*(3 .+12(0<' 67 / (0,' +. '+0- '+24*&+, +1 (D4&;02(,*$

G$ NACE!0))1(3&*(3)+11+'&+, '-()&02&'* '%022 *('*)0*%+3&) -1+*()*&+, '7'*(/ ' 0,3 3(/ +,'*10*(-1+-(1 +-(10*&+, 0,3 -1+*()*&+, &, 0))+130,)(A&*% *%(1()+ / / (,30*&+,' 0,3)1&*(1&0 &, NACE SP016E$

H$ D(.&)&(,)&(' 3&')+;(1(3 '%022 6( )+11()*(3 0* *%(C+,*10)*+1F' (:-(,'(8 *+ '0*&'.0)*&+, +. C+,*10)*&,5 O..&)(1M' R(-1('(,*0*&;($ M0I+1 3(.&)&(,)&(' +1 .0&241(*+)+11()* 3(.&)&(,)&('8 *+ *%('0*&'.0)*&+, +. *%(C+,*10)*&,5 O..&)(1M' R(-1('(,*0*&;(8 / 07 6( )+,'&3(1(3)04'(.+1 1(I()*&,5 *%((,*&1(&,'*022O*&+,$

SITE CONDITION	GENERA# CONDITIONS OF GROUND WATER DURING THE WETTEST PERIOD OF THE YEAR	SURFACE WATER ACCUMU#ATION RAINFA##/ IRRIGATION	TRENCH CONSTRUCTION
A$ F&, (510&, (3 & / - (1;&+4' +1 '(/ &- (1;&+4' 0,3)+01' (510&, (3 & / - (1;&+4'	W0*(1 *062(5(, (1022 7 1 .++* ? 00 / / @ 6(2+A 2+A('* -+&,* +. A0*(1 (,*17 ?S((N+*(B@ A&*% ,+* / +1(*%0, 2BR +. *%(2(,5*% +. *%(-1+-+' (3)+,)1(*(*1(,)% '7'*(/ '%+A&,5 A0*(1 A&*%&, 1 .++* ? 00 / / @ +. *%(2+A('* -+&,* +. A0*(1 (,*17$	B 7(01 ! G 307 10&,.022 (D402 *+ +1 2(' ' *%0, 10 &,)%(' ?2B0 / / @$?S((N+*(2@	C+,*&,4+4' A022 0,3 6+**+ / $
B$ C+01' (510&, (3 '(/ &- (1;&+4' 0,3 - (1;&+4' ?S((N+*(2@	S0 / (0' .+1 A$ 06+;($	B 7(01 ! G 307 10&,.022 (D402 *+ +1 2(' ' *%0, 10 &,)%(' ?2B0 / / @$	S0 / (0' .+1 A$ 06+;(
	W0*(1 *062(5(, (1022 7 2 .((* ?600 / / @ +1 / +1(6(2+A -+&,* +. A0*(1 (,*17 A&*% ,+* / +1(*%0, 10R +. *%(2(,5*% +. *1(,)% '7'*(/ '%+A&,5 A0*(1 A&*%&, 2 .((* ?600 / / @ 64* ,+*)2+'(1 *%0, 1 .++* ? 00 / / @ *+ 2+A('* -+&,* +. A0*(1 (,*17$	B 7(01 ! G 307 10&,.022 (D402 *+ +1 2(' ' *%0, 8 &,)%(' ?200 / / @$?S((N+*(2@	C+,*&,4+4' A022Q +-(,&,5' / 07 6(-1+;&3(3 &, *1(,)% 6+**+ / *+ -1+;&3(310&,05($
C$ SA(22&,5 '+&2' ?S((N+*(@	S0 / (0' .+1 A$ 06+;($	S0 / (0' .+1 A$ 06+;($	S0 / (0' .+1 A$ 06+;(-24' 3('&5, +. I+&,* '-0)&,5 0,3 I+&,* 3(*0&2' *+ 0))+ / / +30*(/ +;(/ (,*$

NOTES:

1$ S%022+A)+,)1(*(*1(,)% '7'*(/ '%022 ,+* 6(4'(3 &. 0,7)+,3&*&+,' 3(.&,(3 67 *%('( )1&*(1&0 01((:)((3(3$

2$ A' '%+A, &, U$ S$ W(0*%(1 B41(04 ?USWB@ T()%,&)02 P0-(1 C0 0,3)+,.&1 / (3 A&*% 2+)02 30*0 0,3 2+)02 A(0*%(1 -0**(1,'

$ SA(22&,5 '+&2' 01(/ 0*(1&02' A&*% %&5% 'A(22 -+*(,*&02 A%(, '46I()*(3 *+ 0, &,)1(0'(&, / +&'*41( )+,*(,*$

C$ P1()&-&*0*&+, 10*(' .+1 0 '-()&.&) '&*('%+423 6(4'(3 *+ 3('&5, 310&,05('7'*(/ ' 0,3 '(2()* '4 / - -4 / -'$

B$ #+A('* -+&,* +. A0*(1 (,*17 &' 3(.&,(3 0' *%(I+

B ! B03	1$ T%(A0*(1 *062(&' (: - ()*(3 *+ 6(+))0'&+, 027 06+; (*%(6+**+ / +. *%('7'*(/ 0, 3 '41.0) (A0*(1 &' (: - ()*(3 *+ 0))4 / 420*(0, 3 1(/ 0&, .+1 '%+1* - (1&+3' ?+1 , +* 0* 022@ &, *%('+&2 '411+4, 3&, 5 *%('7'*(/ 8 +1
	2$ T%(A0*(1 *062(&' (: - ()*(3 , (; (1 *+ 6(06+; (*%(6+**+ / +. *%('7'*(/ 64* '41.0) (A0*(1 &' (: - ()*(3 *+ 0))4 / 420*(0, 3 1(/ 0&, .+1 2+, 5 - (1&+3' &, *%('+&2 '411+4, 3&, 5 *%('7'*(/ $
C ! M+3(10*(	T%(A0*(1 *062(&' (: - ()*(3 , (; (1 *+ 6(06+; (*%(6+**+ / +. *%('7'*(/ 64* '41.0) (A0*(1 &' (: - ()*(3 *+ 0))4 / 420*(0, 3 1(/ 0&, .+1 '%+1* - (1&+3' &, *%('+&2 '411+4, 3&, 5 *%('7'*(/ $
D ! M&23	T%(A0*(1 *062(&' (: - ()*(3 , (; (1 *+ 6(06+; (*%(6+**+ / +. *%('7'*(/ 0, 3 '41.0) (A0*(1 &' , +* (: - ()*(3 *+ 0))4 / 420*(+1 1(/ 0&, &, *%('+&2 '411+4, 3&, 5 *%('7'*(/ $