SECTION 22 1000 ! PLUMBING EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. S"#$%&' I'#()*"+:

1. S"(, P-% .%' / S"01/" 1'* S) . 2 P) . 2+ W%$3 F&)- S

#1+%'/ 1##"++ #&4"-+B +& 31 1((21-$+ &, $3" 2) . 2 +)#$%&' #1+"B %'#()*%'/ $3" %. 2"((" -2&-$B +31((8" 1##"++%8(" ,&- #("1'%'/ 1'*%'+2"#$%&'.

5. T3" 2) . 2 #1+%'/ +31((8" *"+%/'"* +& 31 +),,%#%"'$ (%C)%* %+ -"$1%'"* %' $3" #1+%'/ $& -" 2-%. " $3" 2) . 2. T3" 2) . 2 +31((%'#()*" 1' %'$"/-1(-" . &418(" +)#$%&' ,(12 41(4"B 1'* +31((8" #1218(" &, -" 2-%. "B "4"' %, +&(%*+ 8"#&. " (&*/"*)'*"- +)#$%&' ,(12 41(4"B #1)+%'/ (%C)%* $& *-1%' 81#D $& $3" 0"$ 0"((03"' $3" 2) . 2 %+ %*(".

:. T3" 2) . 2 +31((8" 2-&4%"* 0%$3 1 41#)) . -1$"* /-&&4"* #&)2(%'/B 1$$1#3"* $& $3" +)#$%&' "(8&0B ,&- #&''"#$%&' $& $3" /-&&4"* "'* +)#$%&' 2%2".

F. C(&+" #&)2("* . &$&-.

1. E1#3 2) . 2 +31((8" *-%4"' 86 1 NEMA P-". %) . E,,%#%"'#6 . &$&- $& D""2 21#" 0%$3 EISA 2-&$&#&(+. T3" . &$&-+ +31((314" 1 $&$1((6 "'#(&+"* ,1' #&&("* 7TEFC9 "'#(&+)-" 0%$3 1 1.1< +"-4%#" ,1#$&-. E1#3 2) . 2 .)+$ &2"-1$" 0%$3%' $3" '1. "2(1$" 3&-+"2&0"- &, $3" . &$&- 1$ 1((2&%'$+ 1(&'/ $3" "'$%-" 2) . 2 #121#%$6 3"1* #)-4" 8"6&'* $3" *)$6 2&%'$ #&'*%$%&'B -"+"-4%'/ $3" 141%(18(" +"-4%#" ,1#$&- &, $3" . &$&- 1+ 1 +1,"$6 ,1#$&-.
2. P"-,&-. 1'#" #)-4"+ 03%#3 ";$"'* %'$& $3" +"-4%#" 7+1,"$69 ,1#$&-B 8"6&'* $3" '1. "2(1$" 3&-+"2&0"- (%'" 1$ 1'6 2&%'$B 1-" '&$ 1##"2$18(".

G. C&'$-&(21'"(.

1. P-&4%*" 1 +%'/(" "'#(&+)-" 2&0"- 1'* #&'$-&(21'"(7NEMA 19. T3" "'#(&+)-" +31((8" +$""(B 1'*,%'%+3"* 0%$3 1' &4"' 81D"* "'1. "(. T3" 21'"(+31((%'#()*" 1 *&&- %'$"-(&#D"* $3-&)/3 $3" *&&- +1,"$6 *%+#&''"#$ +0%$#3. T3" #&'$-&(21'"(+31((314" $3" UL (%+$%'/. 1-D ,&- %'*)+$-%1(#&'$-&(21'"(+B 1'* +31((%'#()*" 1 . %#-&2-&#"++&- 81+"* 2-&#"++ #&'$-&(("-. R"(16 81+"* #&'$-&(+6+$" .+B 03%#3 *& '&$ 1((&0 $3" ,(";%8%(%$6 &, 8"%'/ -" 2-&/-1. . "* %' $3" ,%"(*B 1-" '&$ 1##"2$18(".

1. T3" %'$"-'1(2&-$%&' &, $3" #&'$-&(21'"(+31((%'#()*" &'" 719 5 231+" 2&0"-*%+$-%8)$%&' 8(&#DB $0& 729 5 231+" $3"-. 1(. 1/'"$%# #%-#)%$ 8-"1D"-+B $0& 729 1#-&++ $3" (%'" +$1-$"-+B 1'* $0& 729 1*E)+$18(" #(1++ 10 &4"-(&1* 8(&#D+. T3" "'#(&+)-" +31((1(+& 3&)+" 1((&$3"- '"#"++1-6 #&'$-&(#& . 2&'"'$+B %'#()*%'/ 8)$ '&$ (%. %$"* $& &'" 719 #&'$-&(#%-#)%$ $-1'+,&-. "- 0%$3 +"21-1$"(6 ,)+"* 2-%. 1-6B 1'* +"#&'*1-6B . %#-&2-&#"++&- 81+"* 2-&#"++ #&'$-&(("-B 1+ +2"#%,%#1((6 -","-"'#"* 8"(&0.
8. T3" 2-&#"++ #&'$-&(("- +31((%'#()*" 1' &' 8&1-* 2:41# #&'$-&(#%-#)%$ $-1'+,&-. "-B $& 2-&4%*" (&0 4&($1/" 2&0"- $& $3" ("4"(+0%$#3"+.
#. T3" 2-&#"++ #&'$-&(("- +31((8" *"+%/'"* 0%$3 $3" ,&((&0%'/ ,1%(+1," &2"-1$%&'1(,"1$)-"+ 1'* %'*%#1$&-+:

19 I, &'"B $0&B &- 1+ . 1'6 1+ $3-"" &, $3" ,&)- 0"$ 0"((("4"(+0%$#3"+ 8"#&. " %'&2"-18("B $3" ,1%(+1," +"(, *%1/'&+$%# (&/%# #&'$-&(("- +31((8" *"+%/'"* $& #&'$%')")'%'$"--)2$"* 1)$&. 1$%# &2"-1$%&' &, &'" &- 8&$3 2). 2+B 1'* 1((1(1- . + H ,1)($+.

. T3" 2-&#"++ #&'$-&(("- +31((%'#()" $3" ,&((&0%'/ %'*%#1$&-+:

19 O'" 719 2&0"- &' (%/3$
29 T0& 729 2) . 2 -)' (%/3$+
59 T0& 729 2) . 2 ,1%((%/3$+
:9 T0& 729 #&'$1#$&- ,""*81#D +1)+ (%/3$+
<9 T0& 729 +"1(,1%((%/3$+ 703"' 122(%#18("9
=9 F&)- 7:9 ("4"(+0%$#3 +$1$)+ (%/3$+
>9 O'" 719 1(1- . #&*" (%/3$ $& *%+2(16 +"4"' 7>9 ,(1+3%'/ ,1)($ #&*"+

+)+#"2%8(" $& ,1%()-"B 1-" '&$ 1##"2$18(". C&-* /-%2+ ,1+$"'"* $& $3" 81+%' #&4"- +31((8")+"* $& +)22&-$ $3" ("4"(+0%$#3 #&-*+. T3" +0%$#3"+ +31((8" ,1+$"'"* $& 1 +$1%'("++ +$""(#31%' 0%$3 1'#3&-B%' +)#3 1 016 31 1((&0+ ("4"(1*E)+$. "'$ &, $3" +0%$#3"+ ,-& . 18&4" $3" 81+%' #&4"-. T3"+" ("4"(+0%$#3"+ +31((8")+"* $& #&'$-&(H . &'%$&- (%C)%* ("4"(%' $3" 0"$ 0"((.

2. T3" +0%$#3 %'+$1(("* %' $3" (&0"+$ 2&+%$%&' +31((+3)$ &,, 1((2) . 2+. T3" '";$ +0%$#3 ,-& . $3" 8&$$& . 0%((+$1-$ &'" 2) . 2 1'* +31(($-%//"- 1($"-'1$%&' &, $3" 2) . 2+ &' "1#3 +)##"++%4" #6#(" &, &2"-1$%&'. T3" $3%-* +0%$#3 ,-& . $3" 8&$$& . +31((+$1-$ 8&$3 2) . 2+ &- +$1-$ $3" +"#&'* 2) . 2 %, $3" ,%-+$ 2) . 2 ,1%(+ ,&- 1'6 -"1+&'.

5. T3" ,&)-$3 +0%$#3 +31((8" (&#1$"* 1$ $3" 3%/3"+$ 2&%'$B 1$ $3" %'4"-$ &, $3" 81+%' %'("$B 1'* +31((+%/'1(1 3%/3 0"$ 0"((("4"(1(1- . . A((("4"(+0%$#3"+ +31((8" -" . &418(" $3-&)/3 $3" 81+%' #&4"-.

I. F%"(* %'+$1((1$%&' -"C)%-" . "'$+.

1. A +)#$%&' 2%2" +31((8" 2-&4%*"* 86 $3" #&'$-1#$

NORTHWESTERN UNIVERSITY
PROJECT NAME _____
JOB # _____

FOR: _____

G. C&'$-&(P1'"(

1. P-&4%*" 1 +%'/(" "'#(&+)-" 2&0"- 1'* #&'$-&(21'"(7NEMA 19. T3" "'#(&+)-" +31((8" +$""(B 1'* ,%'%+3"* 0%$3 1' &4"' 81D"* "'1."(. T3" 21'"(+31((%'#()*" 1 *&&- %'$"-(&#D"* $3-&)/3 $3" *&&- +1,"$6 *%+#&''"#$ +0%$#3. T3" #&'$-&(21'"(+31((314" $3" UL (%+$%'/ .1-D ,&- %'*)+$-%1(#&'$-&(21'"(+B 1'* +31((%'#()*" 1 .%#-&2-&#"++&- 81+"* 2-&#"++ #&'$-&(("-. R"(16 81+"* #&'$-&(+6+$".+B 03%#3 *& '&$ 1((&0 $3" ,(";%8%(%$6 &, 8"%'/-" 2-&/-1.."* %' $3" ,%"(*B 1-" '&$ 1##"2$18(".

1. T3" %'$"-'1(2&-$%&' &, $3" #&'$-&(21'"(+31((%'#()*" &'" 719 5 231+" 2&0"- *%+$-%8)$%&' 8(&#DB $0& 729 5 231+" $3"-.1(.1/'"$%# #%-#)%$ 8-"1D"-+B $0& 729 1#-&++ $3" (%'" +$1-$"-+B 1'* $0& 729 1*E)+$18(" #(1++ 10 &4"-(&1* 8(&#D+. T3"
". "'#(&+)-" +31((1(+& 3&.84822()) 0.713207(+)-(") 03(# 6#-713207(.) 0.356603"(S-(#"713207(.) 0.023

3 -23.52 TdU [(1) 0.704(P) 8'/*
1.3583(*) 0.404(P) 8'.3583(%) 4.71394(+)-7(3) 0.713207(") 11.3583(*) 0.404(P) 8'3) 0.713207(")-17.073.08.713207(2) 011.3583

?9 I'#()*" +"21-1$" ,)+"+ ,&- "1#3 #&'$1#$&- #%-#)%$B 1+ 0"((1+ "1#3 1(1- . #%-#)%$.

I9 M&'%&- " . 8"**"* 2) . 2 . &$&- $3"- . 1(+"'+&-+B 03"' 0%-"*.

2. T3" #&'$-&(+6+$" . +31((8" 2-&4%*"* 0%$3 1 M"$-&2&(%$1' @M"$-& M1%(AB . "++1/%'/ +6+$" . B *"+%/'"* $& . &'%$&- 1'* -"2&-$ $3" +$1$)+ &, $3" "C)%2 . "'$ $& D"6 2"-+&''"(B *)-%'/ -"/)(1- 1'*J&- " . "-/"'#6 +%$)1$%&'+. T3")'%$ +31((8" #1218(" &, +"'*%'/ " . 1%(. "++1/"+ &- $";$. "++1/"+ $3-&)/3 1' %'$"-'"$ #&''"#$%&'. T3" "C)%2 . "'$ #&'$-&(+6+$" . +31((%'#()*" +%'/)(1- &- .)($%2(" -" . &$" 1(1- . #&'$1#$+ 1+ *"+%/'1$"* 0%$3%' $3" "C)%2 . "'$ #&'$-&(+6+$" . +2"#%,%#1$%&'+. T3"+" +31((8" ,1#$&-6 2-" 0%-"* $& $3" M"$-& M1%(. "++1/%'/ +6+$" . B "1#3 2&0"-"* 86 1 10 $& 50 4&($ 1# &- *# 2&0"- +)22(6. T3" . "++1/%'/ +6+$" . +31((%'#()*" "%/3$ 7?9 "("#$-%#1((6 +"21-1$"*B &2$%#1((6 %+&(1$"* *%/%$1(%'2)$+. E1#3 21%- &, %'2)$ $"- . %'1(+ +31((%'#()*" 1 -"* ("* %'*%#1$&- (%/3$B 03%#3 +31((%(() . %'1$" 03"' $3" #%-#)%$ %+ "'"-/%G"*. T3" . "++1/%'/ +6+$" . +31((1(+& %'#()*" 1 +%'/(" ("* %'*%#1$&- +$1$)+ (%/3$. T3%+ (%/3$ +31((/(&0 /-""' $& %'*%#1$" 31 $3")'%$ %+ 2&0"-"* 1'* %+ 2-&2"-(6 #&',%/)-"*K 1'* +31((,(1+3 $& %'*%#1$" 31 1' " . 1%(%+ 8"%'/ $-1'+ . %$$"*. T3" ("* %'*%#1$&- +31((/(&0 1 . 8"- $& %'*%#1$" 31 $3")'%$ %+ 8&&$%'/B &- $& %'*%#1$" 31 1' %2 ') . 8"- 31+ '&$ 8"" ' 1++%/'"*. A' "$3"-'"$ 2&-$ +31((8" 2-&4%*"*B $& 1((&0 #&''"#$%&' &, $3")'%$ $& 1' %'$"-'"$ #&''"#$%&'B)+%'/ 1 +$1'*1-* &- #-&++&4"- "$3"-'"$ #18(". T3" M"$-& M1%(+31((%'#()*" 1' &' 8&1-* 0"8 +"-4"-B 1((&0%'/ $3")+"- $& #&',%/)-" . "++1/"+K " . 1%(1**-"++"+K 1'* &$3"- +"$%'/+B 4%1 1 +$1'*1-* 0"8 8-&0+"-. T3" M"$-& M1%(+31((8" 2&0"-"* $3-&)/3 $3" . 1%' "C)%2 . "'$ #&'$-&(+6+$" . B 4%1 1 10 $& 50 41#J*# 2&0"- +)22(6.

5. C&'$-&(+6+$" . + 0%$3&)$ 1((&, $3" "++"'$%1(,1%(+1," &2"-1$%&'1(,"1$)-"+B (%/3$+B ,1)($ #&*"+B %'*%#1$&-+B 1'* -" . &$" . &'%$&-%'/ *"4%#"+ (%+$"* 18&4" 1-" %'+),,%#%"'$,&- $3" %'$"'*"* +"-4%#"B 1'* 1-" '&$ 1##"2$18(".

:. P-&4%*" BAS &2$%&'+ &' 21'"(&- ";$-1 #&''"#$%&' 2&%'$+ ,&- ,)$)-" BAS #&''"#$%&'. C&',%- . -"C)%-" . "'$+ 0%$3 NU.

H. L%C)%* ("4"(+"'+&-+.

1. P-&4%*" &'" 719 2"*"+$1(. &)'$"* . "#31'%#1(,(&1$ 1($"-'1$&- 1++" . 8(6 0%$3 +$1%'("++$""(,(&1$ 81((B ,(&1$ -&*B 1'* -&* +$&2+B 1+ 0"((1+ &'" 719 +)+2"'*"* . "#31'%#1(1(1- . ("4"(+0%$#3B 03%#3 +31((8")+"* $& #&'$-&(H . &'%$&- (%C)%* ("4"(%' $3" 0"$ 0"((. T3" ("4"(+0%$#3"+ +31((8" %'+$1(("* %' +)#3 1 016 31 $3"6 1((&0 ("4"(1*E)+$. "'$ &, $3" +0%$#3"+ ,-& . 18&4" $3" 81+%' #&4"-.

2. T3" . "#31'%#1(1($"-'1$&- +0%$#3 %'*";"* %' $3" (&0"+$ 2&+%$%&' +31((+3)$ &,, 1((2) . 2+. T3" '";$ 3%/3"+$ %'*";"* 2&+%$%&' +31((+$1-$ &'" 2) . 2B 1'* +31(($-%//"- 1($"-'1$%&' &, $3" 2) . 2+ &' "1#3 +)##"++%4" #6#(" &, &2"-1$%&'. T3" $3%-* 1'* 3%/3"+$ %'*";"* 2&+%$%&' +31((+$1-$ 8&$3 2) . 2+ &- +$1-$ $3" +"#&'* 2) . 2 %, $3" ,%-+$ 2) . 2 ,1%(+ ,&- 1'6 -"1+&'.

5. T3" +)+2"'*"* . "#31'%#1(1(1- . ("4"(+0%$#3 +31((8" (&#1$"* 1$ $3" 3%/3"+$ "("41$%&' &, 1((0"$ 0"((%'("$ "("41$%&'+B 1'* +31((+%/'1(1 3%/3 0"$ 0"((("4"(1(1- . . A((("4"(+0%$#3"+ +31((8" -" . &418(" $3-&)/3 $3" 81+%' #&4"-.

I. F%"(* %'+$1((1$%&' -"C)%-" . "'$+.

1. A +)#$%&' 2%2" +31((8" 2-&4%*"* 86 $3" #&'$-1#$&- 1'* %'+$1(("* &' "1#3 2) . 2. T3" +)#$%&' 2%2" .)+$ 8" &, 1 2%"#" #&'+$-)#$%&'B 1'* +31((8" +#3"*)(" ?0 PVCB /1(41'%G"* +$""(B &- %-&' 2%2". T3" +%G" &, $3" 2%2" +31((8" $3" +1 . " +%G" 1+ $3" 2) . 2 +)#$%&' #&''"#$%&'. T3" +)#$%&' 2%2"+ +31((8" %'+$1(("* 1%- $%/3$. T3" 8&$$& . "'* &, $3" 2%2" +31((8" %'+$1(("* $& 1 2&%'$. "1+)-%'/ =L $& ?A ,-& . $3" 0"$ 0"((,(&&-.

2. A' 122-&2-%1$" +"01/" $62" #3"#D 41(4" +31((8" 2-&4%*"* 86 $3" #&'$-1#$&- 1'* +31((8" %'+$1(("* %' $3" *%+#31-/" (%'" &, "1#3 2) . 2. A' 122-&2-%1$" /1$" 41(4" &- 2()/ 41(4" +31((8" 2-&4%*"* 86 $3" #&'$-1#$&- 1'* +31((8" %'+$1(("* *&0'+$-"1 . &, $3" #3"#D 41(4".

5. D)" $& $3" 2&$"'$%1((6 3%/3 &)$("$ 2-"++)-" &, $3"+" +1,"$6 *"4%#"+B "1#3 *"4%#" +31(("1#3 8" 2%2"* $& 1 #& . . &' ,1#$&-6 2-" ,18-%#1$"* 2A *%1 . "$"- *-1%'1/" 3"1*"- -)''%'/ $3" ("'/$3 &, $3" +$-)#$)-"B *"+%/'"* $& *%++%21$" $3" 2-"++)-" "'"-/6 2-%&- $& /-14%$6 *-1%'1/". P%2%'/ ,-& . $3" *-1%'1/" 3"1*"- $& 1 01+$" &2"'%'/ +31((8" %'+$1((" * 86 $3" #&'$-1#$&- %' $3" ,%"(*.

C. M&$&-+:

1. E1#3 2) . 2 +31((8" *-%4"' 86 1 5 P31+"B =0 H"-$GB &2"' *-%2 2-&&, 7ODP9 . &$&-. T3" . &$&- +31((314" 1 +6'#3-&'&)+ +2""* &, 5<00 RPMB 8)$ +31((&2"-1$" 1$ 41-6%'/ -1$"+ &, +2""* *)-%'/ +6+$" . &2"-1$%&'. E1#3 2) . 2 +31((8" *-%4"' 86 1 NEMA P-" . %) . E,,%#%"'#6 . &$&- $& D""2 21#" 0%$3 EISA 2-&$&#&(+. E1#3 2) . 2 .)+$ &2"-1$" 0%$3%' $3" '1 . "2(1$" 3&-+"2&0"- &, $3" . &$&- 1$ 1((2&%'$+ 1(&'/ $3" "'$%-" 2) . 2 #121#%$6 3"1* #)-4" 8"6&'* $3" *)$6 2&%'$ #&'*%$%&'B -"+"-4%'/ $3" 141%(18(" +"-4%#" ,1#$&- &, $3" . &$&- 1+ 1 +1,"$6 ,1#$&-.
2. P) . 2+ 0%$3 2"-,&- . 1'#" #)-4"+ 03%#3 &2"-1$" %'$& $3" +"-4%#" 7+1,"$69 ,1#$&-B 8"6&'* $3" '1 . "2(1$" 3&-+"2&0"- 1$ 1'6 2&%'$B 1-" '&$ 1##"2$18(".

D. H6*-& P'") . 1$%# T1'D:

1. T3" ,&((&0%'/ +31((122(6 $& 1((36*-& 2'") . 1$%# $1'D+ -"C)%-"* 86 $3" 2) . 2 +#3"*)(". F)-'%+3 1'* %'+$1((1+ +3&0' &' 2(1'+ 1 2-" #31-/"* 36*-& 2'") . 1$%# $1'D &- $1'D+. T3" $1'D +31((8" -1$"* ,&- 1 0&-D%'/ 2-"++)-" &, 12< PSI . %'%.) . 1'* 1 0&-D%'/ $" . 2"-1$)-" &, 1200F . %'%.) . . A((%'$"-'1(0"$$"* 21-$+ .)+$ #&. 2(6 0%$3 FDA -"/)(1$%&'+ 1'* 122-&41(+. T3" $1'D +31((8" +%G"* 1+ +#3"*)("*.
2. T3" 36*-& 2'") . 1$%# $1'D +31((%'#()*" 1 -"2(1#"18(" ,(";%8(" . " . 8-1'"B *"+%/'"* $& +"21-1$" $3" 1%- 1'* 01$"-. T3" ,(";%8(" . " . 8-1'" +31((#&'$1%' $3" 122-&2-%1$" 1%- #31-/" -"C)%-"* $& 1((&0 . 1;%.) . 01$"- +$&-1/". A S#3-1*"- 41(4" +31((8" (&#1$"* 1$ $3")22"- . &+$ 2&-$%&' &, $3" 4"++"(B 0%$3 1 2-&$"#$%4" 1##"++ #&4"-. T3" $1'D +3"((+31((8" &, #& . 2&+%$" . 1$"-%1(B #& . 2-%+"* &, ,%(1 . "'$ 0&)'* ,%8"-/(1++B &, +),,%#%"'$ 01(($3%#D'"++ $& #&'$1%' 01$"- H 1%- %' #& . 8%'1$%&'B $& 1 . 1;%.) . 0&-D%'/ 2-"++)-" &, 12< PSI. T3")'%$ +31((314" 1 +$1%'("++ +$""($3-"1*"* &- ,(1'/"* "(8&0 ,%$%'/B (&#1$"* 1$ $3" (&0"- . &+$ 2&-$%&' &, $3" $1'DB $& 1((&0 . 1;%.) . *-10 *&0' &, $3" +$&-"* 01$"-. T3" ,%$%'/ +31((%'#()*" 1 *%,,)+"-B *"+%/'"* $& "'31'#" 01$"- ,(&0 %' H &)$ &, $3" 4"++"(. T3" $1'D +31((8" . 1'),1#$)-"* "'$%-"(6 &, #&--&+%&' -"+%+$1'$. 1$"-%1(+. F18-%#1$"* +$""(4"++"(+B 03%#3 1-" +)+#"2$%8(" $& #&--&+%&'B 1-" '&$ 1##"2$18(".
5. T3" 4"++"(+31((8" %'+$1(("* 0%$3 %+&(1$%&' 41(4"+ %' +)#3 1 016 1+ $& 1((&0 $3")'%$ $& 8" *-1%'"* ,&- . 1%'$"'1'#" 2)-2&+"+B 0%$3&)$ $3" '""* $& *-1%' $3" 2-"++)-%G"* 2) . 2 *%+#31-/" (%'"B &- #1)+" $3" &2"-1$%&' &, $3" 2) . 2 +6+$" . $& 8" %'$"--)2$"*.
:. T3" 2) . 2 #&'$-&(+6+$" . +31((%'#()*" 1 P+(""2 . &*"% ,"1$)-"B 03%#3 +31((%'#-"1+" $3" +"$ 2&%'$ 01$"- 2-"++)-" +(11 . 3583(") 0 . . 7(#)-[illegible]

"1#3 2) . 2 &' $3" +6+$" . B 03%#3 +31((1*E)+$ $3" D%(&01$$ 2&0"- *"(%4"-"* 1'*)+"* 86 $3" 2) . 2 . &$&-+B 1+ -"C)%-"* $& . 1$#3 $3" +6+$" . ,(&0 *" . 1'* -"C)%-" . "'$ 1$ 1'6 /%4"' $% . "B 03%(" . 1%'$1%'%' / $3" +"$ 2&%'$ 2-"++)-" &, $3" +6+$" . . T3" &2"-1$%' / +2""* 1'* D%(&01$$ %'2)$ $& $3" 2) . 2 . &$&-+ +31((8" -"*)#"* $& $3" . %'%.) . '"#"++1-6 $& +1$%+,6 $3" ,(&0 *" . 1'*B 1'* $& -"*)#" . "#31'%#1(0"1- &, $3" "C)%2 . "'$. T3" #&'$-&(+6+$" . ",,%#%"'#6 +31((8" . 1%'$1%'"* 1$ I: 2"-#"'$B 1'* $3" +6+$" . 2&0"- ,1#$&- +31((8" .I< 1$ 1(($% . "+. T3" VFD +31((1(016+ +&,$ +$1-$ $3" 2) . 2 . &$&-+ %' &-*"- $& -"*)#" . & . "'$1-6 2&0"- *" . 1'*+B 1+ 0"((1+ $& "(% . %'1$" . "#31'%#1(1'* 36*-1)(%# +3&#D $& $3" +6+$" . 1'* $3" ,1#%(%$6.

2. T3" #&'$-&(+6+$" . +31((&2"-1$" "1#3 2) . 2 %'*"2"'*"'$(6 1'* %')'%+&' %' &-*"- $& . 1%'$1%' $3" +6+$" . &2"-1$%' / 2-"++)-" +"$ 2&%'$B 1+ 2-&/-1 . . "* 86 $3" &2"-1$%' / "'/%'""-. E1#3 &, $3" 2) . 2+ +31((314" %$+ &0' VFD %'4"-$"-.

5. A . %#-&2-&#"++&- 81+"* 2-&/-1 . . 18(" (&/%# #&'$-&(("- 7PLC9 +31((8" ,)-'%+3"* $& 2-&#"++ 1((&, $3" &2"-1$%&'1(%'2)$ 1'* &)$2)$ +%/'1(+B %'#()*%'/ 8)$ '&$ (% . %$"* $&B 2-"++)-" +"$ 2&%'$+B &2"-1$&- +"("#$&- +"$$%' /+B %'*%#1$&- (%/3$+ 1'* *%+2(16+B 1'* 1((1(1- . #&'*%$%&'+. T3" (&/%# 2-&/-1 . +31((8" ,1#$&-6 %'+$1(("* 1'* $"+$"* 0%$3%' $3" +6+$" . 1'* +31((314" 2-&4%+%&'+ ,&- ,%"(* -"2-&/-1 . . %' / $3-&) /3 $3")+" &, 1 2&-$18(" #& . 2)$"-.

F. P-"++)-" T-1'+*)#"-+:

1. A +6+$" . 2-"++)-" $-1'+*)#"- +31((8" %'+$1(("* &' $3" *%+#31-/" 3"1*"- &, $3" 2) . 2%'/ +6+$" . .
2. A +)#$%&' 2-"++)-" $-1'+*)#"- +31((8" %'+$1(("* &' $3" +)#$%&' 3"1*"- &, $3" 2) . 2%'/ +6+$" . .
5. A$ $3" *%+#-"$%&' &, $3" U'%4"-+%$6B #& . 2(%1'#" 0%$3 $3" -)(%'/ &, $3" U. S. D"21-$. "'$ &, E'"-/6 % . 2&+%'/ #& . 2(%1'#" 0%$3 ANSIJASHRAE S$1'*1-* I0.1 2010 A**"'*) . CV . 16 8" -"C)%-"*. I' +)#3 #1+"+B 1+ %'*%#1$"* &' $3" 2(1' *-10%'/+B 1 $3%-* -" . &$"(6 (&#1$"* 2-"++)-" $-1'+*)#"- +31((8" 2-&4%*"* ,&- %'+$1((1$%&' 1$ $3" ,)-$3"- . &+$ 2&%'$ &, $3" ,1#%(%$6B *"+%/'"* $& -"*)#" $3" D%(&01$$ -"C)%-" . "'$ &, $3" ,1#%(%$6B 86 "(% . %'1$%'/ $3" #1(#)(1$"* ,-%#$%&' (&++"+ *)-%'/ (&0 $& . "*%) . ,(&0 2"-%&*+. T3%+ $-1'+*)#"- +31((8" $3"

NORTHWESTERN UNIVERSITY
PROJECT NAME _____
JOB # _____

FOR: _____
ISSUED: 2022.2

I. T3" #&(&- $&)#3 +)-,1#" &2"-1$&- %'$"-,1#" 21'"(+31((%'#&-2&-1$" $3" ,&((&0%'/ *"+%/' #-%$"-%1 H #1218%(%$%"+:

1. I'#&-2&-1$" 1 <.=A D%1/&'1($&)#3 +)-,1#"B 0%$3 1 -"+&()$%&' &, 520 ; 25: P%;"(+B 1'*

NORTHWESTERN UNIVERSITY

<. T3" $1'D +31((8" %'+$1(("* 1$ $3" 122-&2-%1$" "("41$%&' -"C)%-"* %' &-*"- $& "'+)-" 31 $3" . 1;%.) . 2&$"'$%1(&2"-1$%'/ 2-"++)-" *&"+ '&$ ";#""* $3" -1$"* . 1;%.) . 0&-D%'/ 2-"++)-" &, $3" $1'D. T3" . 1;%.) . 2&$"'$%1(&2"-1$%'/ 2-"++)-" +31((8" #&'+%*"-"* $& 8" $3" +) . &, $3" G"-& ,(&0 +3)$ &,, 3"1* &, $3" 2) . 2 1$,)((+2""*B 2()+ $3" . 1;%.) . 2&$"'$%1(+)#$%&' 2-"++)-" 1$ $3" +6+$" . +)#$%&' 3"1*"-.

E. P&0"- 1'* C&'$-&(S6+$" . :

1. F)-'%+3 1 +%'/(" &- .)($%2(" "'#(&+)-" 2&0"- 1'* #&'$-&(+6+$" . %' NEMA 1 "'#(&+)-"+. T3" 2) . 2%'/ +6+$" . +"$ 2&%'$ 2-"++)-" +31((8" 1##)-1$"(6 -"/)(1$"* 86 $3" #&'$-&(+6+$" . . T3" #&'$-&(+6+$" . +31((%'#()*" 1' %'*%4%*)1(41-%18(" ,-"C)"'#6 *-%4" 7VFD9 ,&-"1#3 2) . 2 &' $3" +6+$" . B 03%#3 +31((1*E)+$ $3" D%(&01$$ 2&0"- *"(%4"-"* 1'*)+"* 86 $3" 2) . 2 . &$&-+B 1+ -"C)%-"* $& . 1$#3 $3" +6+$" . ,(&0 *" . 1'* -"C)%-" . "'$ 1$ 1'6 /%4"'$%. "B 03%(" . 1%'$1%'%'/ $3" +"$ 2&%'$ 2-"++)-" &, $3" +6+$" . . T3" &2"-1$%'/ +2""* 1'* D%(&01$$ %'2)$ $& $3" 2) . 2 . &$&-+ +31((8" -"*)#"* $& $3" . %'%.) . '"#"++1-6 $& +1$%+,6 $3" ,(&0 *" . 1'*B 1'* $& -"*)#" . "#31'%#1(0"1- &, $

2-&2&-$%&'1(81'*. W3"' 2-"++)-" *"4%1$"+ ,-& . $3" +"$ 2&%'$ %' 2-&2&-$%&' /-"1$"- $31' $3" %'$"-'1((6 1*Ɛ)+$"* 2-&2&-$%&'1(81'*ß $3" #&'$-&(("- +31((#&'$-&(-12%*(6 86 8621++%' / -1$" %' &-*"- $& ,&((&0 $3" -12%*(6 #31'/%'/ 2-"++)

NORTHWESTERN UNIVERSITY

NORTHWESTERN UNIVERSITY
PROJECT NAME _____
JOB # _____

FOR: _____

>9 O ' " 719 +%(" '#" $&)#3 21* $& .)$" $3" 1) * %8(" 1(1- . .
?9 O ' " 719 -"+"$ $&)#3 21* $& -"+"$ $3" +6+$" . #&',%/)-1%&'.

". T3" 2-&#"++ #&'$-&(("- +31((2"-,&- . $3" ,&((&0%' / . 1£&- ,) '#%&'+:

19 S$1-$ 1 ' * +$&2 1 2) . 2 *)-%' / '&- . 1(,(&0 #&' *%%&'+.
29 S$1-$ 1 ' * +$&2 2 2) . 2+ *)-%' / ";$-" . " ,(&0 #&' *%

NORTHWESTERN UNIVERSITY

NORTHWESTERN UNIVERSITY
PROJECT NAME _____
JOB # _____

FOR: _____

NORTHWESTERN UNIVERSITY
PROJECT NAME _____ FOR: _____

2%2%' /. C& . 2(6 0%$3 -"C)%-" . "'$+ ,&- 41(4"+ +2"#%,%"* %' S"#$%&' 22 0<25 LG"'"-1(D)$6
V1(4"+ ,&- P() . 8%' / P%2%' /L 1'* #& . 2(6 0%$3 -"C)%-" . "'$+ ,&- +$-1%'"-+ +2"#%,%"* %'
S"#$%&' 22 211: LP() . 8%' / S2"#%1($%"+.L

2. I'+$1((2-"++)-" /1/" 1$ +)#$%&' &, "1#3 2) . 2 1'* 2