

NORTHWESTERN UNIVERSITY  
PROJECT NAME \_\_\_\_\_  
JOB # \_\_\_\_\_

FOR: \_\_\_\_\_  
ISSUED: 2022.2

SECTION 2 0! "# \$ VARIABLE \$ FREQUENCY DRIVES (VFD) &

PART 1 - ' ENERAL

"." RELATED DOCUMENTS

- A. D() \*+, - & ), . - /, /() 0 1(23+&+2, & 24 56/ C2, 5()758 +, 709.+, - ' /, /() 0 ), . S9110/ : /, 5)(;  
C2, .+5+2, & ), . S1/7+7)5+2, B22< D+3+&+2, 0" S1/7+7)5+2, S/75+2, &8 )110; 52 56+& S/75+2, .

".2 SUMMARY

- A. S/75+2, +, 709. / & & / 1)()5/0; /, 702&/ . 8 1(/\$)&&/ : =0/ . 8 72 : =+, )5+2, VFD&8 ()5/ . >00 V ), . 0/&&8  
42( &1// . 72, 5(20 24 56(/ / \$16)&/ 8 &?9+( (/0\$7) - / +, . 975+2, : 252(&.
- B. H)( : 2, +7 ), )0; &+&.

". DEFINITIONS

- A. AO \$ A, )02- O95195.
- B. BAS: B9+0.+, - )952 : )5+2, & ; &5/ : .
- C. BI \$ B+, )( ; I, 195.
- D. BO \$ B+, )( ; O95195.

E713207(5)0.356603(.) - 11.7152( )3T6603(.) - 11.71503((5)0.35; 713207(0)4.71211.7149(+ )4.713()OOTLUT \* [(E7.99392( )0

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- P. OCPD: O3/(79(( / , 5 1(25/75+3/ . /3+7/.
- Q. PCC: P2+,5 24 72 : : 2 , 72910+, -.
- R. PID: C2,5(20 )75+2,8 1(212(5+2, )0 109& +,5/-( )0 109& . /(+3)5+3/.
- S. PWM: P90&/ \$\*+.56 : 2.90)5/ ..
- T. RFI: R) .+2\$4(/?9/ ,7; +,5/(4/( / ,7/.
- U. TDD: T25)0 . / : ) , . (6)( : 2,+7 79(( / ,5) . +&52(5+2, .
- V. THD(V): T25)0 6)( : 2,+7 3205) - / . / : ) , . .
- W. VFD: V)(+)=0/\$4(/?9/ ,7; : 252( 72,5(200/(.

".# ACTION SUBMITTALS

- A. P(2.975 D)5): F2( / )76 5;1/ ) , . ( )5+, - 24 VFD+, .+7)5/ .. 1,709. / 4/)59(/&8 215+2, &8 1/(42( : ) , 7/8 /0/75(+7)0 ( )5+, -&8 21/( )5+, - 76)( )75/(+&5+7&8 &6+11+, - ) , . 21/( )5+, - \* /+-65&8 ) , . 49(+&6/ . &1/7+)05+/& ) , . )77/&&2(+/&.

".! INFORMATIONAL SUBMITTALS

- A. S621 D( ) \*+, -&: F2( / )76 VFD+, .+7)5/ .. 1,709. / .+ : / ,&+2, / . 10) , &8 /0/3)5+2, &8 ) , . &/75+2, &8 ) , . 72, .9+5 / ,5( ; 027)5+2, & ) , . &+C/&8 : 29,5+, - )(( ) , - / : / ,5&8 ) , . . /5)+0&8 +,709.+ , - (/ ?9+(/ . 70/)( , 7/& ) , . &/ (3+7/ &1)7/ ) (29, . /?9+1 : / ,5.

- C. Q9(0+47)5+2, D)5): F2( ?9)0+4+/. 5/&5+, - ) - / , 7;.
- D. P(2.975 C/(5+47)5/&: F2( / )76 VFD8 4(2 : : ) , 94)759(/(.
- E. S29(7/ ?9)0+5; \$72, 5(20 (/ 12(5&.
- F. F+/0. ?9)0+5; \$72, 5(20 (/ 12(5&.
- ' . R/&905& 24 6)( : 2, +7 ) , )0; &+&.
- H. L2) . \$C9(( / , 5 ) , . O3/(02) . \$R/0); H / )5/( L+&5: C2 : 1+0/ )45/( : 252(& 6)3/ =// , +, &5)00/ . 8 ) , . )(( , - / 52 . / : 2, &5()5/ 56)5 &/0/75+2, 24 6/ )5/( & &9+5& )759)0 : 252( , ) : / 10)5/8 4900\$02) . 79(( / , 5&.
- I. L2) . \$C9(( / , 5 ) , . L+&5 24 S/55+, - & 24 A. A9&5)=0/ O3/(02) . R/0); &: C2 : 1+0/ )45/( : 252(& 6)3/ =// , +, &5)00/ . ) , . )(( , - / 52 . / : 2, &5()5/ 56)5 & \*+576 &/55+, - & 42( : 252(\$9 , , +, - 23/(02) . 1(25/75+2, &9+5 )759)0 : 252(& 52 =/ 1(25/75/ ..

".> CLOSEOUT SUBMITTALS

- A. O1/( )5+2, ) , . M)+, 5/ , ) , 7/ D)5): F2( VFD& 52 +, 709. / +, / : /(- / , 7; 8 21/( )5+2, 8 ) , . : )+ , 5/ , ) , 7/ : ) , 9)0&. I , ) . .+5+2, 52 +5/ : & &1/7+4/ . +, Section 01 7000 "Execution and Closeout Requirements," +, 709. / 56/ 42002 \*+, - :
- " . M) , 94)759(/(!& \* (+55/ , +, &5(975+2, & 42( 5/&5+, - ) , . ) . A9&5+, - 56/( : )0\$ : ) - , /5+7 7+(79+5 =(/ ) < / ( ) , . MCP 5(+1 &/55+, - &.
- 2. M) , 94)759(/(!& \* (+55/ , +, &5(975+2, & 42( &/55+, - 4+/0. \$) . A9&5)=0/ 23/(02) . (/0); &.
- . M) , 94)759(/(!& \* (+55/ , +, &5(975+2, & 42( 5/&5+, - 8 ) . A9&5+, - 8 ) , . (/ 1(2-( ) : : +, - : +7(21(27/ &&2( 72, 5(20 : 2. 90/&.

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B. T/&5+, - A- / , 7; Q9)0+4+7)5+2, &: M/ : =/( 72 : 1) , ; 24 NETA 2( ) , NRTL.

". T/&5+, - A- / , 7; % F+ / 0. S91/(3+&2(: C9(( / , 50; 7/(5+4+ / . =; NETA 52 &91/(3+&/ 2, \$&+5/ 5/ &5+, - .

C. E0/75(+7)0 C2 : 12, / , 5&8 D/3+7/&8 ) , . A77/ &&2(+ / &: L+&5/ . ) , . 0) = / 0 / . ) & . / 4+ , / . + , NFPA D08 = ; ) ?9)0+4+ / . 5/ &5+, - ) - / , 7; 8 ) , . : ) (< / . 42( + , 5/ , . / . 027)5+2, , . ) 110+7)5+2, .

D. C2 : 10; \* +56 NFPA D0.

E. IEC ( ) 5 / . 72 : 12, / , 5& ) ( / , 25 ) 77 / 15) = 0 / .

F. R / 4 / ( / , 7 / . S5 ) , . ) ( . & ) , . ' 9+ . / 0+ , / &:

". I , &5+595/ 24 E0/75(+7)0 ) , . E0/75(2, +7 E , -+ , / / (& (IEEE)

). IEEE ! "G\$"GG28 ' 9+ . / 42( H ) ( : 2, +7 C2, 5 / , 5 ) , . C2, 5(20.

2. U , . / ( \* (+5 / (& L) = 2( ) 52(+ / & ( ) & ) 11(21(+ 5 / )

). UL!0F

= UL!0FA

7. UL!0FC

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- " . VFD & ) , . 215+2 , & & 6)00 = / UL ! 0 F 0+&5 / . ) & ) 72 : 10 / 5 / ) & & / : = 0 ; . T6 / = ) & / VFD & 6)00 = / UL 0+&5 / . 42 ( " 00 < A SCCR \* +56295 56 / , / / . 42 ( + , 195 49 & / & . B ) & / VFD & \* +56 ( / . 0 ) = / 0 UL & 5+7 < / ( & ( / ? 9+ ( + , - ) . . +5+2 , ) 0 = ( ) , 76 7+ ( 79+5 1 ( 25 / 75+2 , ) ( / , 25 ) 77 / 15 ) = 0 / .
- 2. CE M) (< L T6 / = ) & / VFD & 6)00 72 , 42 ( : 52 56 / E9 ( 21 / ) , U , +2 , E0 / 75 ( 2 : ) - , / 5+7 C2 : 1 ) 5+ = 0+5 ; . + ( / 75+3 / 8 ) ( / ? 9+ ( / : / , 5 42 ( CE : ) (< + , - . T6 / VFD & 6)00 : / / 5 1 ( 2 . 975 & 5 ) , . ) ( . EN > " F00 \$ 42 ( 56 / F+ ( & 5 E , 3+ ( 2 , : / , 5 ( / & 5+ ( 75 / . 0 / 3 / 0 ( C ) 5 / - 2 ( ; C2 ) . B ) & / . ( +3 / & 56 ) 5 2 , 0 ; : / / 5 56 / S / 72 , . E , 3+ ( 2 , : / , 5 ( C ) 5 / - 2 ( ; C 8 C # ) & 6)00 = / & 9110+ / . \* +56 / E5 / ( , ) 0 4+05 / ( & 52 = ( + , - 56 / . ( +3 / + , 72 : 10+ ) , 7 / \* +56 56 / F+ ( & 5 E , 3+ ( 2 , : / , 5 0 / 3 / 0 & .

J. C2 : 10 ; \* +56 FM ' 02 = ) 0 ( / ? 9+ ( / : / , 5 & 42 ( VFD ! &

" . G DELIVERY 8 STORA ' E8 AND HANDLIN '

A. S52 ( / + , & 1 ) 7 / 56 ) 5 + & 1 / ( : ) , / , 50 ; / , 702 & / . ) , . ) + ( 72 , . +5+2 , / . .

" . " 0 PROJECT CONDITIONS

A. E , 3+ ( 2 , : / , 5 ) 0 L+ : +5) 5+2 , & : R ) 5 / / ? 9+ 1 : / , 5 42 ( 72 , 5+ , 929 & 21 / ( ) 5+2 , 8 7 ) 1 ) = 0 / 24 . ( +3+ , - 4900 02 ) . \* +56295 . / ( ) 5+ , - 8 9 , . / ( 56 / 42002 \* + , - 72 , . +5+2 , & 9 , 0 / & & 256 / ( \* + & / + , . +7 ) 5 / . :

- " . A : = / , 5 T / : 1 / ( ) 59 ( / : N25 0 / & & 56 ) , "# . / - F ( : + , 9 & " 0 . / - C ) , . . , 25 / E7 / / . + , - " 0 # . / - F ( # 0 . / - C ) .
- 2. A : = / , 5 S52 ( ) - / T / : 1 / ( ) 59 ( / : N25 0 / & & 56 ) , : + , 9 & # . / - F ( : + , 9 & 20 . / - C ) , . . , 25 / E7 / / . + , - "# 0 . / - F ( > 0 . / - C )
- . H9 : + . +5 ; : L / & & 56 ) , G ! 1 / ( 7 / , 5 ( , 2 , 72 , . / , & + , - ) .
- #. A05+59 . / : N25 / E7 / / . + , - 00 4 / / 5 ( " 00 ! : ) .

B. 1 , 5 / ( ( 915+2 , 24 EE+&5+ , - E0 / 75 ( +7 ) 0 S ; & 5 / : & : D2 , 25 + , 5 / ( ( 915 / 0 / 75 ( +7 ) 0 & ; & 5 / : & + , 4 ) 7+0+5+ / & 27791+ / . = : 56 / U , +3 / ( & +5 ; 2 ( 256 / ( & 9 , 0 / & & 1 / ( : +55 / . 9 , . / ( 56 / 42002 \* + , - 72 , . +5+2 , & ) , . 56 / , 2 , 0 ; ) 45 / ( ) ( ) , - + , - 52 1 ( 23+ . / 5 / : 12 ( ) ( ; / 0 / 75 ( +7 ) 0 & / ( 3+7 / ) 772 ( . + , - 52 ( / ? 9+ ( / : / , 5 & + , . +7 ) 5 / . :

- " . N25+4 ; 56 / U , +3 / ( & +5 ; , 2 4 / \* / ( 56 ) , & / 3 / , . ) ; & + , ) . 3 ) , 7 / 24 1 ( 212 & / . + , 5 / ( ( 915+2 , 24 / 0 / 75 ( +7 ) 0 & ; & 5 / : & .
- 2. 1 , . +7 ) 5 / : / 562 . 24 1 ( 23+ . + , - 5 / : 12 ( ) ( ; / 0 / 75 ( +7 ) 0 & / ( 3+7 / .
- . D2 , 25 1 ( 27 / / . \* +56 + , 5 / ( ( 915+2 , 24 / 0 / 75 ( +7 ) 0 & ; & 5 / : & \* +56295 56 / U , +3 / ( & +5 ; & \* ( +55 / , 1 / ( : + & & 2 , .
- #. C2 : 10 ; \* +56 NFPA D0E .

C. P ( 2 . 975 S / 0 / 75+2 , 42 ( R / & 5+ ( 75 / . S1 ) 7 / : D ( ) \* + , - & + , . +7 ) 5 / : ) E+ : 9 : . + : / , & +2 , & 42 ( VFD & 8 + , 709 . + , - 70 / ( ) , 7 / & = / 5 \* / / , VFD & 8 ) , . ) . A ) 7 / , 5 & 9 ( 4 ) 7 / & ) , . 256 / ( +5 / : & .

" . " " COORDINATION

A. C22 ( . + , ) 5 / 4 / ) 59 ( / & 24 : 252 ( & 8 02 ) . 76 ) ( ) 75 / ( + & 5+7 & 8 + , & 5 ) 00 / . 9 , +5 & 8 ) , . ) 77 / & & 2 ( ; . / 3+7 / & 52 = / 72 : 1 ) 5+ = 0 / \* +56 56 / 42002 \* + , - :

- " . T2 ( ? 9 / 8 & 1 / / . 8 ) , . 62 ( & / 12 \* / ( ( / ? 9+ ( / : / , 5 & 24 56 / 02 ) . .
- 2. R ) 5+ , - & ) , . 76 ) ( ) 75 / ( + & 5+7 & 24 & 9110 ; 7+ ( 79+5 ) , . ( / ? 9+ ( / . 72 , 5 ( 20 & / ? 9 / , 7 / .
- . A : = / , 5 ) , . / , 3+ ( 2 , : / , 5 ) 0 72 , . +5+2 , & 24 + , & 5 ) 00 5+2 , ( 27 ) 5+2 , .

B. C22 ( . + , ) 5 / & + C / & ) , . 027 ) 5+2 , & 24 72 , 7 / ( 5 / = ) & / & \* +56 ) 759 ) 0 / ? 9+ 1 : / , 5 1 ( 23+ . / . . C ) & 5 ) , 762 ( \$ = 205 + , & / ( 5 & + , 52 = ) & / & .



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), . +, 5/(, ) 0 762</&. VFD& 56)5 . 2 , 25 +, 709. / 722(.+, )5/ . AC 5(), &+/ , 5 &9(- / 1(25/75+2, &6)00 +, 709. / ) , /E5/(, ) 0 TVSS (T(), &+/ , 5 V205) - / S9(- / S911(/&&2()).  
2#. T6/ VFD &6)00 1(23+. / ) 1(2-( ) : : )=0/ 02&&\$24\$02) . (=2</ , =/05 1=(2</ , 72910+, -) F2( : \$ C (/0); 295195. T6/ .(+3/ &6)00 =/ 1(2-( ) : : )=0/ 52 &+- , ) 0 56/ 02&&\$24\$02) . 72 , .+5+2, 3+ ) </;1) . \*(, +, -8 F2( : \$C (/0); 2951958 ) , . 1 2( 23/(



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PART 3 - EXECUTION

. " ESAMINATION

J. D(+3/& 52 =/ 027)5/ . +, ) , 2( : ) 0 U , +3/( &+5; ) (/ ) 24 \* 2(<.

IDENTIFICATION

' . I. / , 5+4; VFD&8 72 : 12, / , 5&8 ) , . 72, 5(20 \* +(+, - . C2 : 10; \* +56 (/ ?9+( / : / , 5& 42( +. / , 5+4+7) 5+2, &1/7+4+ / . +, Section . / 0005 "Identification for Electrical Systems."

". I. / , 5+4; 4/ 0. \$+ , &5) 00 / . 72, . 9752(&8 +, 5/(72, , /75+, - \* +(+, - 8 ) , . 72 : 12, / , 5&8 1(23+ . / \* ) ( , +, - &+ - , &.

2. L) = / 0 / ) 76 VFD \* +56 / , - ( ) 3 / . , ) : / 10) 5 / .

. L) = / 0 / ) 76 / , 702&9( / \$ : 29, 5 / . 72, 5(20 ) , . 1+025 . / 3+7 / .

B. O1 / ( ) 5+ , - I , &5(975+2, & : F ( ) : / 1( +, 5 / . 21 / ( ) 5+ , - + , &5(975+2, & 42( VFD&8 +, 709 . + , - 72, 5(20 & / ?9 / , 7 / & ) , . / : / ( - / , 7; 1(27 / . 9 / & . F) = (+) 5 / 4 ( ) : / 24 + , + &6 / . : / 5) 08 ) , . 723 / ( + , &5(975+2, & \* +56 70 / ) ( ) 7 ; 0+7 10) &5+7. M29, 5 2, 4(2, 5 24 VFD 9, +5&.

# CONTROL WIRIN ' INSTALLATION

' . I , &5) 00 \* +(+, - = / 5 \* / / , VFD& ) , . ( / : 25 / . / 3+7 / & ) , . 4) 7+0+5; % & 7 / , 5( ) 0\$ 72, 5(20 & ; &5 / : . C2 : 10; \* +56 (/ ?9+( / : / , 5& +, Section . / 00. 5 "Control-7olta&e Electrical 8o #er Ca )les."

B. B9 , . 0 / 8 5( ) + , 8 ) , . &9112(5 \* +(+, - + , / , 702&9( / &.

C. C2 , , / 75 & / 0 / 752( & \* +576 / & ) , . 256 / ( ) 952 : ) 5+7 72, 5(20 . / 3+7 / & \* 6 / ( / ) 110+7) = 0 / .

". C2 , , / 75 & / 0 / 752( & \* +576 / & \* +56 72, 5(20 7+(79+5 + , =256 : ) , 9) 0 ) , . ) 952 : ) 5+7 12&+5+2, & 42( & ) 4 / 5; \$5; 1 / 72, 5(20 . / 3+7 / & &976 ) & 02 \* \$ ) , . 6+-6\$1( / &&9( / 795295&8 6+-6\$5 / : 1 / ( ) 59( / 795295&8 ) , . : 252( 23 / ( 02 ) . 1(25 / 752( &.

! FIELD QUALITY CONTROL

A. T / &5+ , - A - / , 7; : T6 / U , +3 / ( &+5; \* +00 / , - ) - / ) ?9) 0+4+ / . 5 / &5+ , - ) - / , 7; 52 1 / ( 42( : 5 / &5& ) , . + , &1 / 75+2, &.

B. M ) , 94) 759( / ( & F+ / 0. S / ( 3+7 / : E , - ) - / ) 4) 752( ; \$ ) 9562( +C / . & / ( 3+7 / ( / 1( / & / , 5) 5+3 / 52 + , &1 / 758 5 / &58 ) , . . ) A9&5 72 : 12, / , 5&8 ) && / : = 0+ / &8 ) , . / ?9+1 : / , 5 + , &5) 00) 5+2, &8 + , 709 . + , - 72 , , / 75+2, &.

C. P / ( 42( : 5 / &5& ) , . + , &1 / 75+2, &.

". M ) , 94) 759( / ( & F+ / 0. S / ( 3+7 / : E , - ) - / ) 4) 752( ; \$ ) 9562( +C / . & / ( 3+7 / ( / 1( / & / , 5) 5+3 / 52 + , &1 / 75 72 : 12, / , 5&8 ) && / : = 0+ / &8 ) , . / ?9+1 : / , 5 + , &5) 00) 5+2, &8 + , 709 . + , - 72 , , / 75+2, &8 ) , . 52 ) &&+&5 + , 5 / &5+ , - .

D. A77 / 15) , 7 / T / &5+ , - P ( / 1 ) ( ) 5+2, :

". T / &5 + , &90) 5+2, ( / &+&5 ) , 7 / 42( / ) 76 VFD / 0 / : / , 58 = 9&8 72 : 12, / , 58 72 , , / 75+ , - &9110; 8 4 / / . / ( 8 ) , . 72, 5(20 7+(79+5.

2. T / &5 72, 5+ , 9+5; 24 / ) 76 7+(79+5.

E. T / &5& ) , . I , &1 / 75+2, &:

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