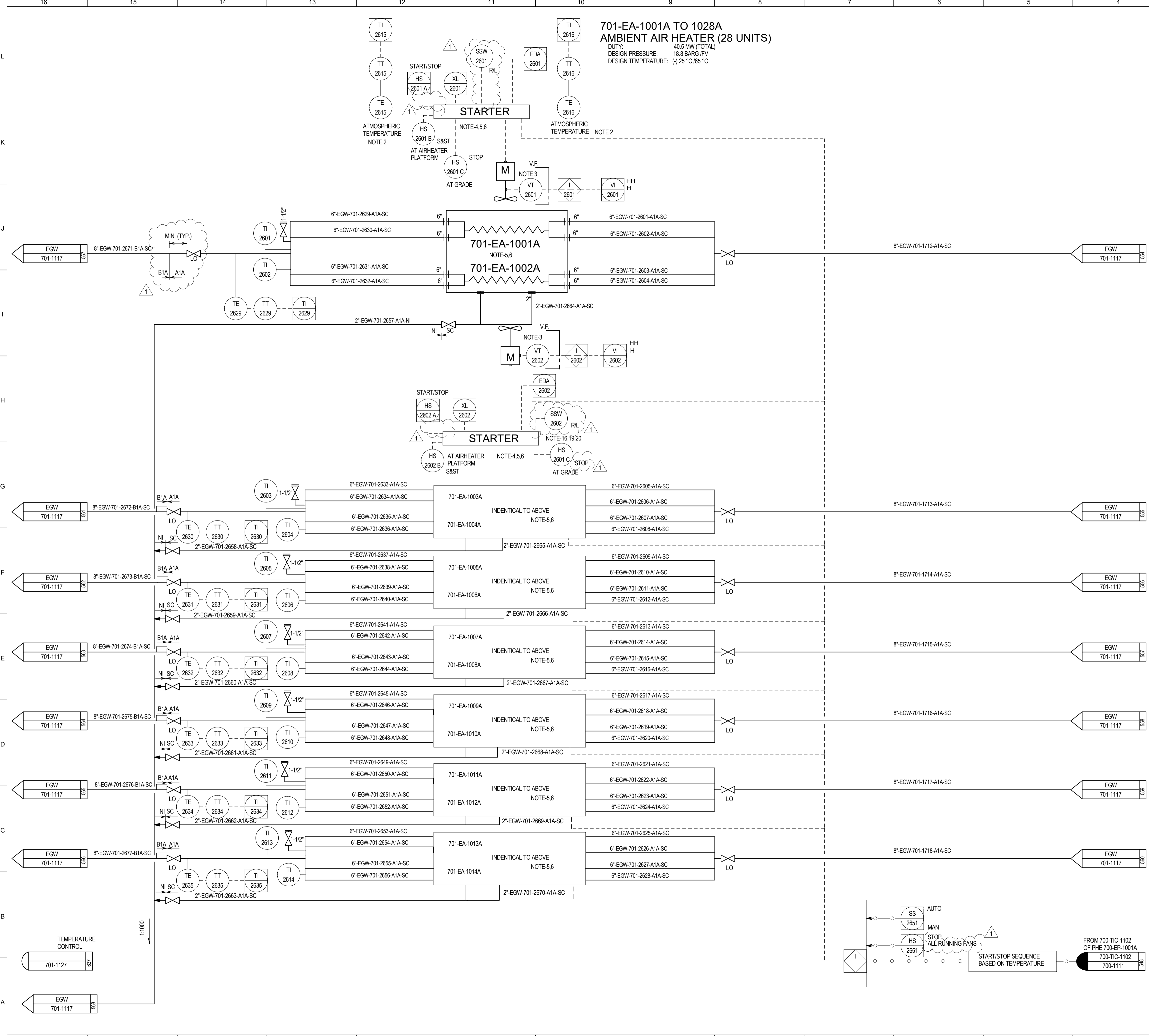


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701-EA-1001A TO 1028A AMBIENT AIR HEATER (28 UNITS)

DUTY: 40.5 MW (TOTAL)
DESIGN PRESSURE: 18.8 BARG F.V.
DESIGN TEMPERATURE: (+) 25 °C / 65 °C



- NOTES:
1. PIPING ARRANGEMENT SHALL BE SYMMETRICAL FOR PROPER DISTRIBUTION OF EGW TO AIR HEATER. REFER DETAIL-A OF P&ID B861-02-42-001-1192.
 2. TO BE INSTALLED DIAGONALLY OPPOSITE IN AIR HEATER AGAINST THE WIND DIRECTION TO AVOID INFLUENCE OF FAN AIR ON THE MEASUREMENT OF TEMPERATURE. THIS TEMPERATURE SHALL BE USED FOR PERFORMANCE ESTIMATION OF AIR HEATER.
 3. VIBRATION HIGH-HIGH ALARM & TRIPPING OF FAN SHALL BE SIMULTANEOUS. VENDOR SHOULD PROVIDE SIGNAL FOR EACH VAHH FOR ALARM/TRIPPING IN DCS/CONTROL PANEL.
 4. TYPICAL ARRANGEMENT FOR FAN.
 5. INLET-OUTLET, VENT-DRAIN VALVES AND NO. OF INSTRUMENTS ON BAY, FAN, MOTOR ETC. TO BE CONSIDERED SAME AS THAT OF BAY-1. (701-EA-1001A, 701-EA-1002A) FOR REST 13 BAYS. (I.E. FROM 701-EA-1003A TO 701-EA-1028A)
 6. THERE ARE TOTAL 28 NOS. OF AIR HEATERS FROM 701-EA-1001A TO 701-EA-1028A. TAG NOS. OF 701-HS-2601A/B/C 701-SSW-2601, 701-XL-2601, 701-VT/VAHV/VAHH-2601, 701-EDA-2601 ARE SHOWN FOR 701-EA-1001A. TAG NOS. OF 701-HS-2602A/B/C 701-SSW-2602, 701-XL-2602, 701-VT/VAHV/VAHH-2602, 701-EDA-2602 ARE SHOWN FOR 701-EA-1002A. SIMILARLY FOR AIR HEATERS 701-EA-1003A TO 701-EA-1028A. TAG NO. SHALL BE AS FOLLOWS. 701-HS-2603A/B/C TO 701-HS-2628A/B/C, 701-SSW-2603 TO 701-SSW-2628, 701-XL-2603 TO 701-XL-2628, 701-VT/VAHV/VAHH-2603 TO 701-VT/VAHV/VAHH-2628 AND 701-EDA-2603 TO 701-EDA-2628.
- GENERAL NOTES:
- A. ALL INSTRUMENT TAG NUMBERS TO BE PRE-FIXED BY UNIT NUMBER 701.
 - B. FOR STANDARD SYMBOLS/NOMENCLATURE, AND DETAILS/GENERAL REQUIREMENTS REFER DRAWING NO. B861-02-42-001-1191/1192
 - C. FOR INTERLOCK DESCRIPTION DETAILS REFER P&ID B861-02-42-001-1193

1	05.09.24	ISSUED FOR HAZOP	GSB	DR	JKS	SS
0	18.07.24	ISSUED FOR ENGINEERING	GSB	DR	JKS	SS
संख्या	तिथि	संशोधन	डॉन	द्वारा	जाँच	अनुमोदित
No.	DATE	REVISIONS	DRN	BY	CHKD	APPD.

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(भारत सरकार का उपक्रम)

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केएलएल
कोकण एल एन जी लिमिटेड
KLL
KONKAN LNG LIMITED

कोकण एल एन जी लिमिटेड
KONKAN LNG LIMITED
EPCM SERVICES FOR AMBIENT AIR HEATERS
AT KLL LNG TERMINAL

पाइपिंग एण्ड इंस्ट्रुमेंटेशन डायग्राम
PIPING AND INSTRUMENTATION DIAGRAM
AMBIENT AIR HEATERS
701-EA-1001A TO 701-EA-1014A

अनुमाप	कार्य संख्या	विभाग	अनुभाग	इकाई	आरेख संख्या	संशोधन
SCALE	JOB NO.	DEPT.	SECTN.	UNIT	DWG. No.	REV.
	B861	02	42	701	1126	1

701-EA-1001A TO 1028A
 AMBIENT AIR HEATER (28 UNITS)

DUTY: 40.5 MW (TOTAL)
 DESIGN PRESSURE: 18.8 BARG F.V.
 DESIGN TEMPERATURE: (+) 25 °C / 65 °C

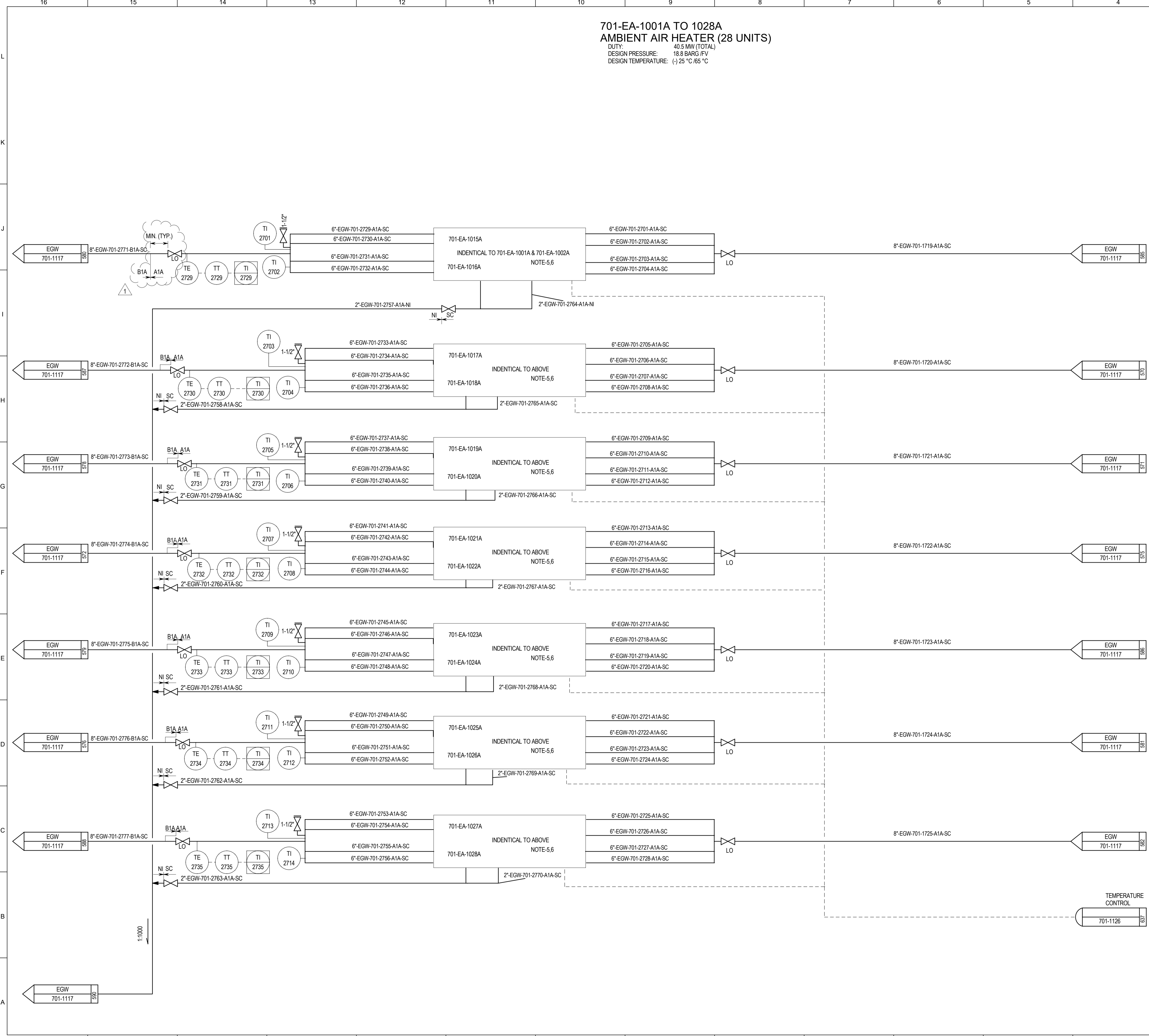
NOTES:

1. FOR NOTES REFER P&ID NO. B861-02-42-701-1126.

GENERAL NOTES:

- A. ALL INSTRUMENT TAG NUMBERS TO BE PRE-FIXED BY UNIT NUMBER 701.
- B. FOR STANDARD SYMBOLS/NOMENCLATURE, AND DETAILS/GENERAL REQUIREMENTS REFER DRAWING NO. B861-02-42-001-1191/1192.
- C. FOR INTERLOCK DESCRIPTION DETAILS REFER P&ID B861-02-42-001-1193.

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TEMPERATURE CONTROL

701-1126

1	06.09.24	ISSUED FOR HAZOP	GSB	DR	JKS	SS
0	18.07.24	ISSUED FOR ENGINEERING	GSB	DR	JKS	SS
संख्या	तिथि	संशोधन	डॉन	द्वारा	जाँच	अनुमोदित
No.	DATE	REVISIONS	DRN	BY	CHKD	APPD.

इंजिनियर्स
 इंडिया लिमिटेड
 (भारत सरकार का उपक्रम)

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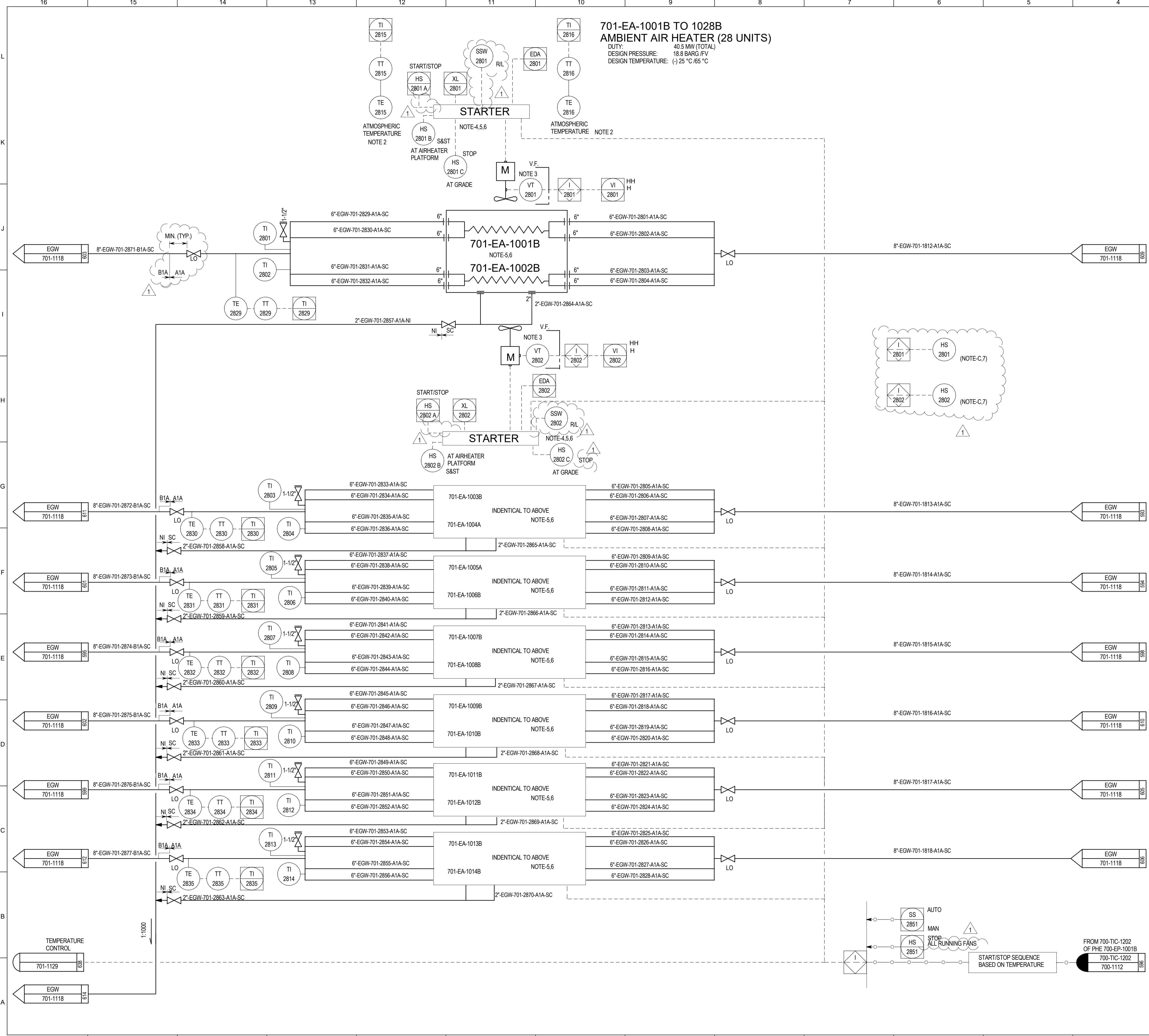
कोकण एल एन जी लिमिटेड
KONKAN LNG LIMITED
 EPCM SERVICES FOR AMBIENT AIR HEATERS
 AT KLL LNG TERMINAL

पाइपिंग एण्ड इंस्ट्रुमेंटेशन डायग्राम
 PIPING AND INSTRUMENTATION DIAGRAM
 AMBIENT AIR HEATERS
 701-EA-1015A TO 701-EA-1028A

अनुमाप	कार्य संख्या	विभाग	अनुभाग	इकाई	आरेख संख्या	संशोध
SCALE	JOB NO.	DEPT.	SECTN.	UNIT	DWG. No.	REV.
	B861	02	42	701	1127	1

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**701-EA-1001B TO 1028B
AMBIENT AIR HEATER (28 UNITS)**
DUTY: 40.5 MW (TOTAL)
DESIGN PRESSURE: 18.8 BARG F.V.
DESIGN TEMPERATURE: (+) 25 °C / 65 °C



- NOTES:
1. PIPING ARRANGEMENT SHALL BE SYMMETRICAL FOR PROPER DISTRIBUTION OF EGW TO AIR HEATER. REFER DETAIL-A OF P&ID B861-02-42-001-1192.
 2. TO BE INSTALLED DIAGONALLY OPPOSITE IN AIR HEATER AGAINST THE WIND DIRECTION TO AVOID INFLUENCE OF FAN AIR ON THE MEASUREMENT OF TEMPERATURE. THIS TEMPERATURE SHALL BE USED FOR PERFORMANCE ESTIMATION OF AIR HEATER.
 3. VIBRATION HIGH-HIGH ALARM & TRIPPING OF FAN SHALL BE SIMULTANEOUS. VENDOR SHOULD PROVIDE SIGNAL FOR EACH VAHH FOR ALARM/TRIPPING IN DCS/CONTROL PANEL.
 4. TYPICAL ARRANGEMENT FOR FAN.
 5. INLET-OUTLET, VENT DRAIN VALVES AND NO. OF INSTRUMENTS ON BAY, FAN, MOTOR ETC. TO BE CONSIDERED SAME AS THAT OF BAY-1. (701-EA-1001B, 701-EA-1002B) FOR REST 13 BAYS. (I.E. FROM 701-EA-1003B TO 701-EA-1028B)
 6. THERE ARE TOTAL 28 NOS. OF AIR HEATERS FROM 701-EA-1001B TO 701-EA-1028B. TAG NOS. OF 701-HS-2801A/B/C, 701-SSW-2801, 701-XL-2801, 701-VT/M/VAH/VAHH-2801, 701-EDA-2801 ARE SHOWN FOR 701-EA-1001B. TAG NOS. OF 701-HS-2802A/B/C, 701-SSW-2802, 701-XL-2802, 701-VT/M/VAH/VAHH-2802, 701-EDA-2802 ARE SHOWN FOR 701-EA-1002B. SIMILARLY FOR AIR HEATERS 701-EA-1003B TO 701-EA-1028B, TAG NO. SHALL BE AS FOLLOWS, 701-HS-2803A/B/C TO 701-HS-2828A/B/C, 701-SSW-2803 TO 701-SSW-2828, 701-XL-2803 TO 701-XL-2828, 701-VT/M/VAH/VAHH-2803 TO 701-VT/M/VAH/VAHH-2828 AND 701-EDA-2803 TO 701-EDA-2828.
 7. TO BE LOCATED AT SAFE LOCATION NEAR EGW CIRCULATION PUMPS AREA (UNIT NO. 701). THE PUSH BUTTONS SHALL BE MOUNTED AT PLACE, WHERE IT IS EASILY VISIBLE AND ACCESSIBLE TO THE OPERATOR. ESD SWITCHES TO BE PROTECTED FROM ACCIDENTAL IMPACT.
- GENERAL NOTES:
- A. ALL INSTRUMENT TAG NUMBERS TO BE PRE-FIXED BY UNIT NUMBER 701.
 - B. FOR STANDARD SYMBOLS/NOMENCLATURE, AND DETAILS/GENERAL REQUIREMENTS REFER DRAWING NO. B861-02-42-001-1191/1192
 - C. FOR INTERLOCK DESCRIPTION DETAILS REFER P&ID B861-02-42-001-1193

1	05.09.24	ISSUED FOR HAZOP	GSB	DR	JKS	SS
0	24.07.24	ISSUED FOR ENGINEERING	GSB	DR	JKS	SS
संख्या	तिथि	संशोधन	डॉन	द्वारा	जाँच	अनुमोदित
No.	DATE	REVISIONS	DRN	BY	CHKD	APPD.

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ENGINEERS INDIA LIMITED
(A Govt. of India Undertaking)

कोकण एल एन जी लिमिटेड
KONKAN LNG LIMITED
EPCM SERVICES FOR AMBIENT AIR HEATERS AT KLL LNG TERMINAL

पाइपिंग एण्ड इंस्ट्रुमेंटेशन डायग्राम
PIPING AND INSTRUMENTATION DIAGRAM
AMBIENT AIR HEATERS
701-EA-1001B TO 701-EA-1014B

अनुमाप	कार्य संख्या	विभाग	अनुभाग	इकाई	आरेख संख्या	संशो
SCALE	JOB NO.	DEPT.	SECTN.	UNIT	DWG. No.	REV.
	B861	02	42	701	1128	1

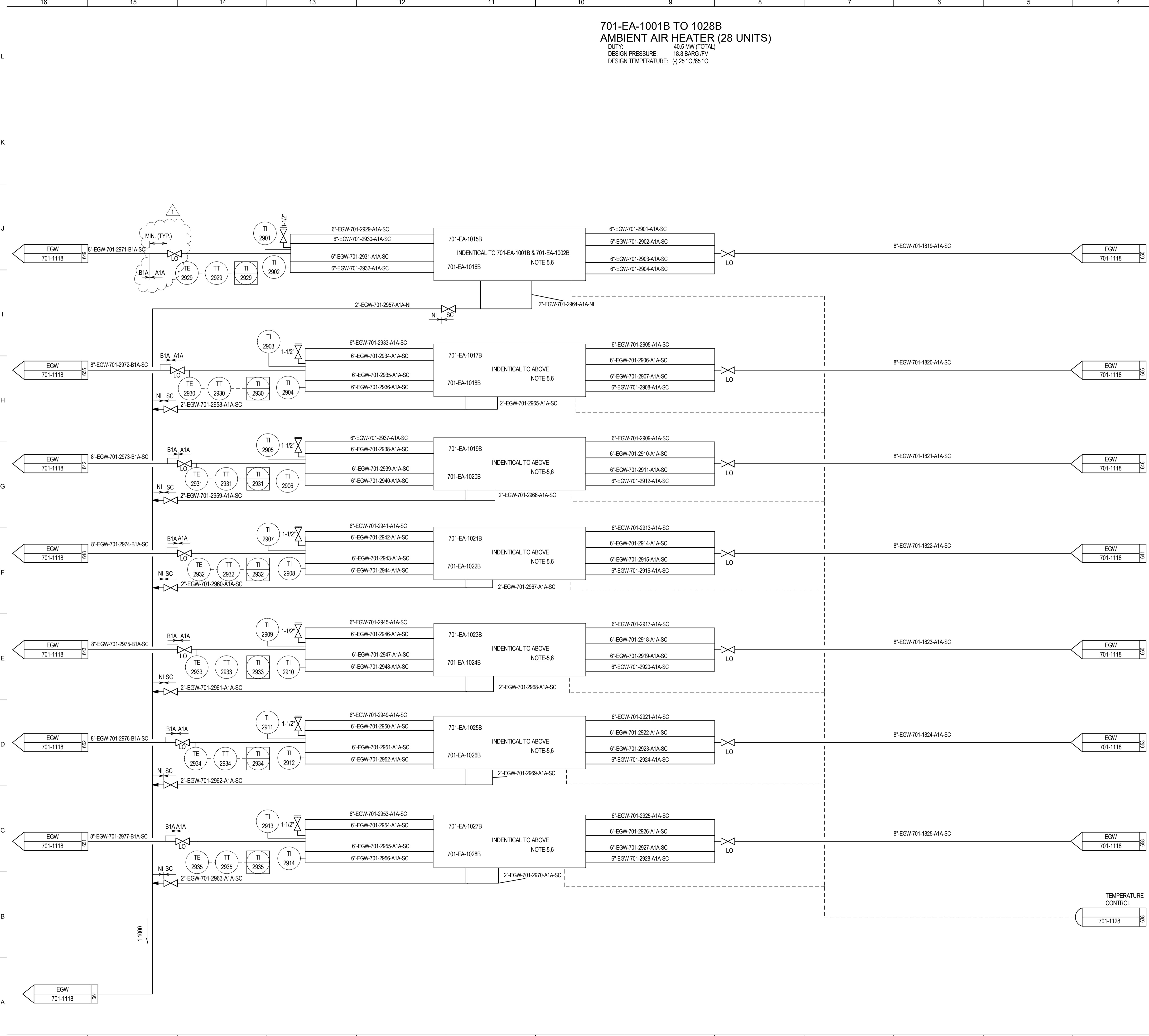
701-EA-1001B TO 1028B
 AMBIENT AIR HEATER (28 UNITS)

DUTY: 40.5 MW (TOTAL)
 DESIGN PRESSURE: 18.8 BARG F.V.
 DESIGN TEMPERATURE: (+) 25 °C / 65 °C

NOTES:
 1. FOR NOTES REFER P&ID NO. B861-02-42-701-1128.

GENERAL NOTES:
 A. ALL INSTRUMENT TAG NUMBERS TO BE PRE-FIXED BY UNIT NUMBER 701.
 B. FOR STANDARD SYMBOLS/NOMENCLATURE, AND DETAILS/GENERAL REQUIREMENTS REFER DRAWING NO. B861-02-42-001-1191/1192
 C. FOR INTERLOCK DESCRIPTION DETAILS REFER P&ID B861-02-42-001-1193

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1	06.09.24	ISSUED FOR HAZOP	GSB	DR	JKS	SS
0	24.07.24	ISSUED FOR ENGINEERING	GSB	DR	JKS	SS
संख्या	तिथि	संशोधन	डॉन	द्वारा	जाँच	अनुमोदित
No.	DATE	REVISIONS	DRN	BY	CHKD	APPD.

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कॉकण एल एन जी लिमिटेड
KONKAN LNG LIMITED
 EPCM SERVICES FOR AMBIENT AIR HEATERS
 AT KLL LNG TERMINAL

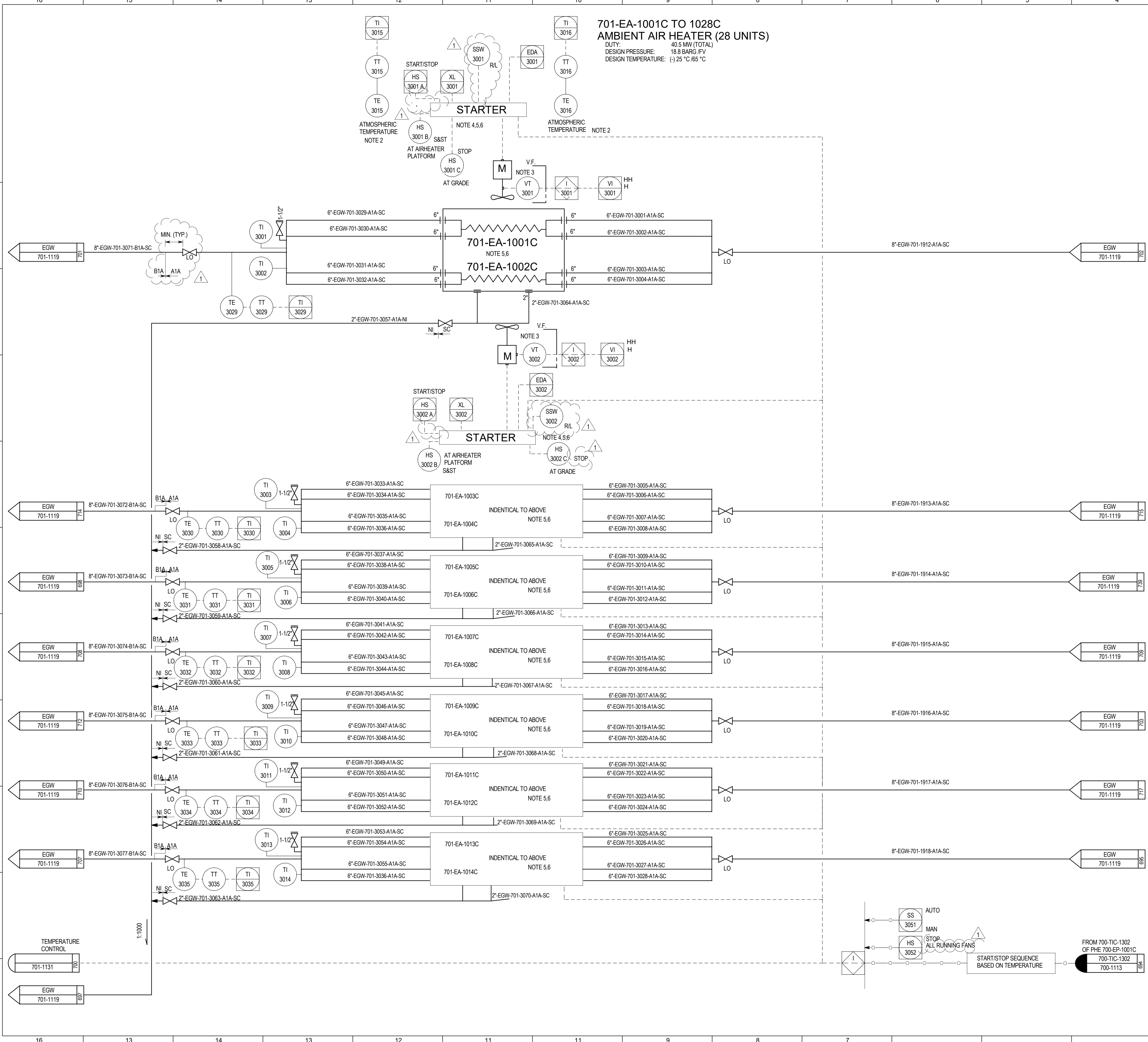
पाइपिंग एण्ड इंस्ट्रुमेंटेशन डायग्राम
 PIPING AND INSTRUMENTATION DIAGRAM
 AMBIENT AIR HEATERS
 701-EA-1015B TO 701-EA-1028B

अनुमाप	कार्य संख्या	विभाग	अनुभाग	इकाई	आरेख संख्या	संशोधन
SCALE	JOB NO.	DEPT.	SECTN.	UNIT	DWG. No.	REV.
	B861	02	42	701	1129	1

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701-EA-1001C TO 1028C AMBIENT AIR HEATER (28 UNITS)

DUTY: 40.5 MW (TOTAL)
DESIGN PRESSURE: 18.8 BARG F.V.
DESIGN TEMPERATURE: (+) 25 °C / 65 °C



- NOTES:
1. PIPING ARRANGEMENT SHALL BE SYMMETRICAL FOR PROPER DISTRIBUTION OF EGW TO AIR HEATER. REFER DETAIL-A OF P&ID B861-02-42-001-1192.
 2. TO BE INSTALLED DIAGONALLY OPPOSITE IN AIR HEATER AGAINST THE WIND DIRECTION TO AVOID INFLUENCE OF FAN AIR ON THE MEASUREMENT OF TEMPERATURE. THIS TEMPERATURE SHALL BE USED FOR PERFORMANCE ESTIMATION OF AIR HEATER.
 3. VIBRATION HIGH-HIGH ALARM & TRIPPING OF FAN SHALL BE SIMULTANEOUS. VENDOR SHOULD PROVIDE SIGNAL FOR EACH VAHH FOR ALARM/TRIPPING IN DCS/CONTROL PANEL.
 4. TYPICAL ARRANGEMENT FOR FAN.
 5. INLET-OUTLET, VENT-DRAIN VALVES AND NO. OF INSTRUMENTS ON BAY, FAN, MOTOR ETC. TO BE CONSIDERED SAME AS THAT OF BAY-1. (701-EA-1001C, 701-EA-1002C) FOR REST 13 BAYS. (I.E. FROM 701-EA-1003C TO 701-EA-1028C)
 6. THERE ARE TOTAL 28 NOS. OF AIR HEATERS FROM 701-EA-1001C TO 701-EA-1028C. TAG NOS. OF 701-HS-3001A/B/C 701-SSW-3001, 701-XL-3001, 701-VT/VAH/VAHH-3001, 701-EDA-3001 ARE SHOWN FOR 701-EA-1001C. TAG NOS. OF 701-HS-3002A/B/C 701-SSW-3002, 701-XL-3002, 701-VT/VAH/VAHH-3002, 701-EDA-3002 ARE SHOWN FOR 701-EA-1002C. SIMILARLY FOR AIR HEATERS 701-EA-1003C TO 701-EA-1028C, TAG NO. SHALL BE AS FOLLOWS.
701-HS-3003A/B/C TO 701-HS-3028A/B/C, 701-SSW-3003 TO 701-SSW-3028, 701-XL-3003 TO 701-XL-3028, 701-VT/VAH/VAHH-3003 TO 701-VT/VAH/VAHH-3028 AND 701-EDA-3003 TO 701-EDA-3028.
- GENERAL NOTES:
- A. ALL INSTRUMENT TAG NUMBERS TO BE PRE-FIXED BY UNIT NUMBER 701.
 - B. FOR STANDARD SYMBOLS/NOMENCLATURE, AND DETAILS/GENERAL REQUIREMENTS REFER DRAWING NO. B861-02-42-001-1191/1192
 - C. FOR INTERLOCK DESCRIPTION DETAILS REFER P&ID B861-02-42-001-1193

No.	DATE	REVISIONS	DRN	BY	CHKD	APPD.
1	05.09.24	ISSUED FOR HAZOP	GSB	DR	JKS	SS
0	24.07.24	ISSUED FOR ENGINEERING	GSB	DR	JKS	SS


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KONKAN LNG LIMITED
 EPCM SERVICES FOR AMBIENT AIR HEATERS
 AT KLL LNG TERMINAL

पाइपिंग एण्ड इंस्ट्रुमेंटेशन डायग्राम
PIPING AND INSTRUMENTATION DIAGRAM
AMBIENT AIR HEATERS
701-EA-1001C TO 701-EA-1014C

अनुमाप SCALE	कार्य संख्या JOB NO.	विभाग DEPT.	अनुभाग SECTN.	इकाई UNIT	आरेख संख्या DWG. No.	संशोधन REV.
1:1000	B861	02	42	701	1130	1

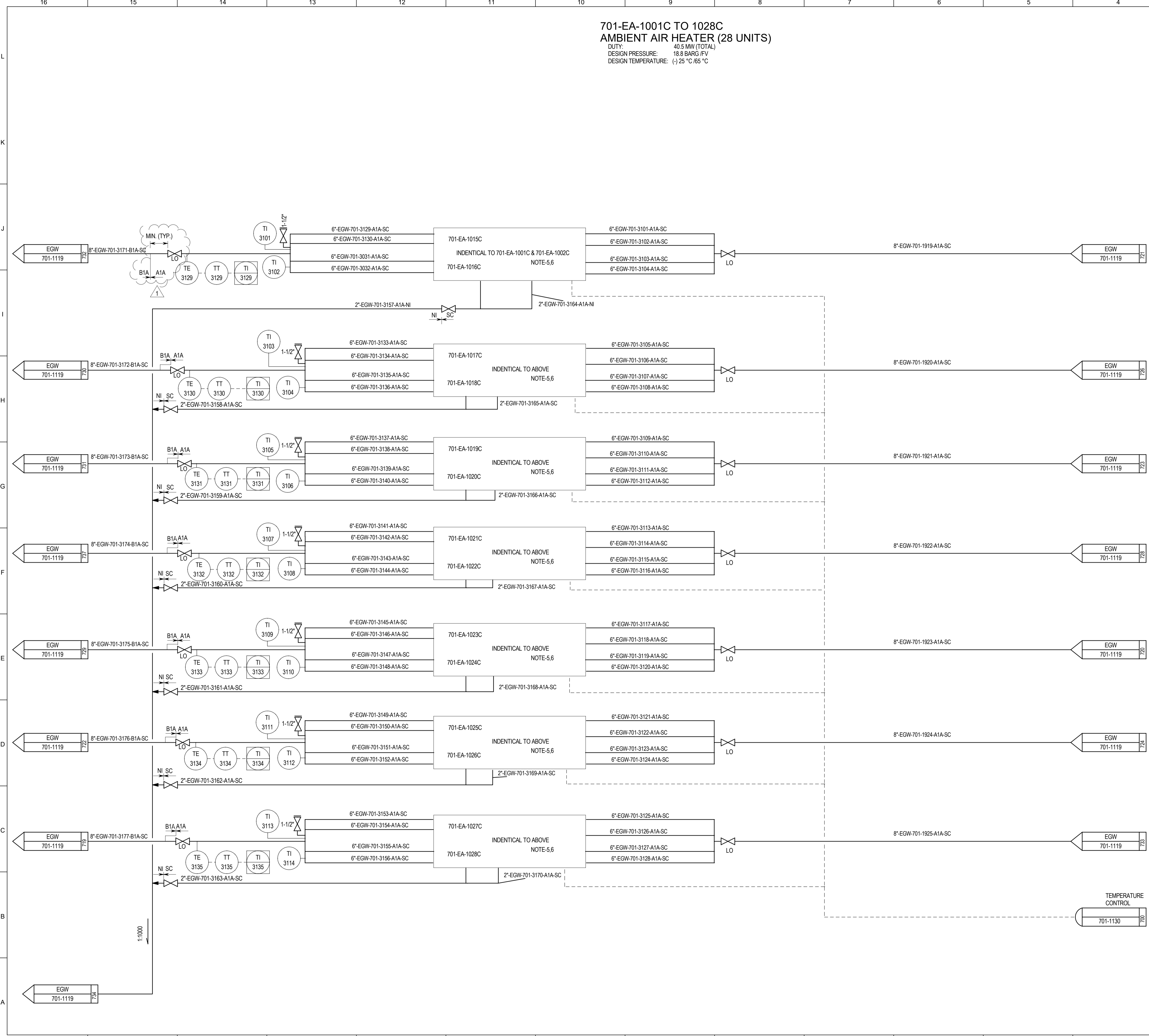
701-EA-1001C TO 1028C
 AMBIENT AIR HEATER (28 UNITS)

DUTY: 40.5 MW (TOTAL)
 DESIGN PRESSURE: 18.8 BARG F.V.
 DESIGN TEMPERATURE: (+) 25 °C / 65 °C

NOTES:
 1. FOR NOTES REFER P&ID NO. B861-02-42-701-1130.

GENERAL NOTES:
 A. ALL INSTRUMENT TAG NUMBERS TO BE PRE-FIXED BY UNIT NUMBER 701.
 B. FOR STANDARD SYMBOLS/NOMENCLATURE, AND DETAILS/GENERAL REQUIREMENTS REFER DRAWING NO. B861-02-42-001-1191/1192
 C. FOR INTERLOCK DESCRIPTION DETAILS REFER P&ID B861-02-42-001-1193

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1	06.09.24	ISSUED FOR HAZOP	GSB	DR	JKS	SS
0	24.07.24	ISSUED FOR ENGINEERING	GSB	DR	JKS	SS
संख्या	तिथि	संशोधन	डॉन	द्वारा	जाँच	अनुमोदित
No.	DATE	REVISIONS	DRN	BY	CHKD	APPD.

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कॉकण एल एन जी लिमिटेड
KONKAN LNG LIMITED
 EPCM SERVICES FOR AMBIENT AIR HEATERS
 AT KLL LNG TERMINAL

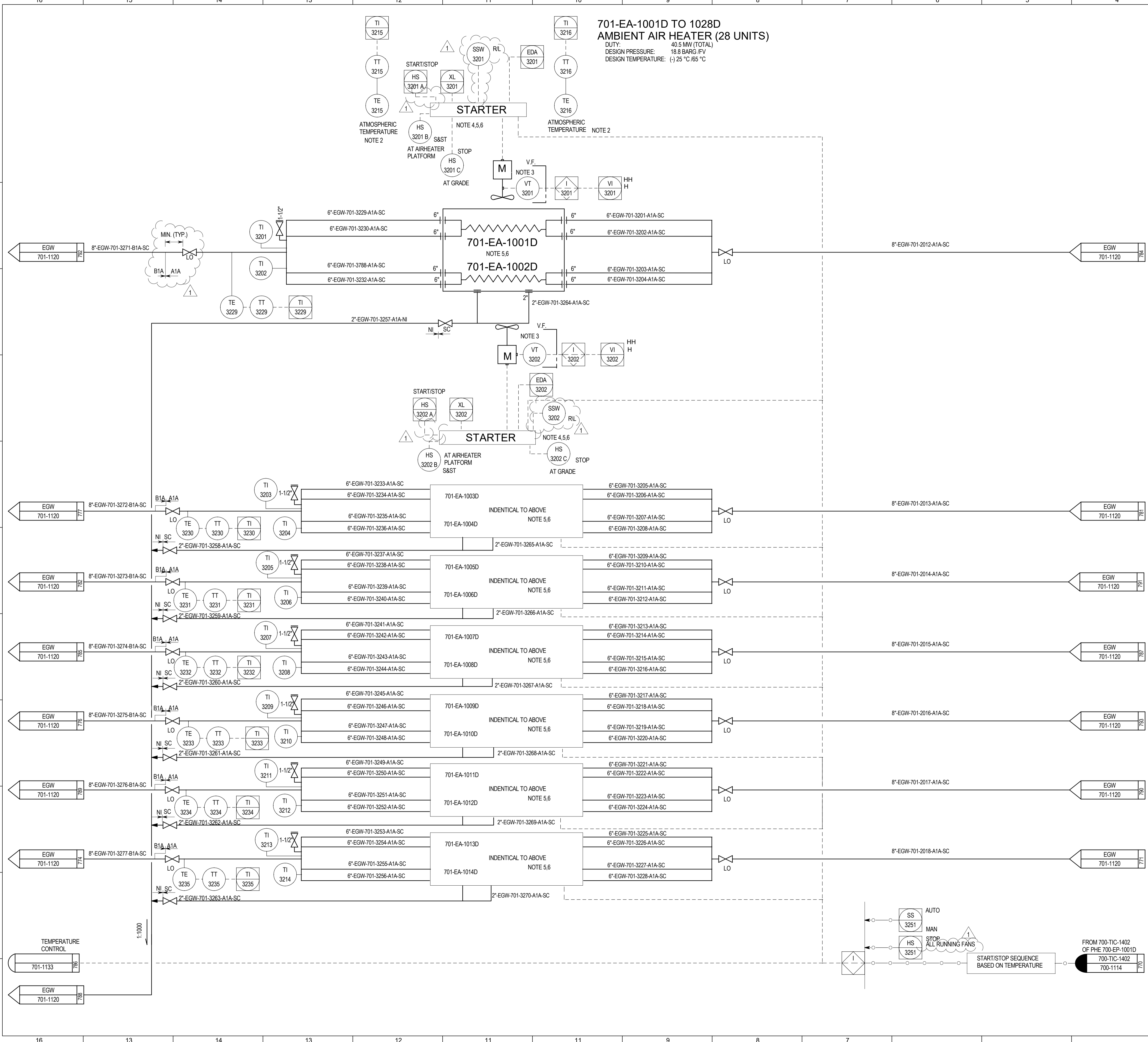
पाइपिंग एण्ड इंस्ट्रुमेंटेशन डायग्राम
 PIPING AND INSTRUMENTATION DIAGRAM
 AMBIENT AIR HEATERS
 701-EA-1015C TO 701-EA-1028C

अनुमाप	कार्य संख्या	विभाग	अनुभाग	इकाई	आरेख संख्या	संशोधन
SCALE	JOB NO.	DEPT.	SECTN.	UNIT	DWG. No.	REV.
1:1000	B861	02	42	701	1131	1

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701-EA-1001D TO 1028D AMBIENT AIR HEATER (28 UNITS)

DUTY: 40.5 MW (TOTAL)
DESIGN PRESSURE: 18.8 BARG F.V.
DESIGN TEMPERATURE: (+) 25 °C / 65 °C



- NOTES:
1. PIPING ARRANGEMENT SHALL BE SYMMETRICAL FOR PROPER DISTRIBUTION OF EGW TO AIR HEATER. REFER DETAIL-A OF P&ID B861-02-42-001-1192.
 2. TO BE INSTALLED DIAGONALLY OPPOSITE IN AIR HEATER AGAINST THE WIND DIRECTION TO AVOID INFLUENCE OF FAN AIR ON THE MEASUREMENT OF TEMPERATURE. THIS TEMPERATURE SHALL BE USED FOR PERFORMANCE ESTIMATION OF AIR HEATER.
 3. VIBRATION HIGH-HIGH ALARM & TRIPPING OF FAN SHALL BE SIMULTANEOUS. VENDOR SHOULD PROVIDE SIGNAL FOR EACH VAHH FOR ALARM/TRIPPING IN DCS/CONTROL PANEL.
 4. TYPICAL ARRANGEMENT FOR FAN.
 5. INLET-OUTLET, VENT-DRAIN VALVES AND NO. OF INSTRUMENTS ON BAY, FAN, MOTOR ETC. TO BE CONSIDERED SAME AS THAT OF BAY-1 (701-EA-1001D, 701-EA-1002D) FOR REST 13 BAYS. (I.E. FROM 701-EA-1003D TO 701-EA-1028D)
 6. THERE ARE TOTAL 28 NOS. OF AIR HEATERS FROM 701-EA-1001D TO 701-EA-1028D. TAG NOS. OF 701-HS-3201A/B/C TO 701-SSW-3201, 701-XL-3201, 701-VT/VIAH/VAHH-3201, 701-EDA-3201 ARE SHOWN FOR 701-EA-1001D. TAG NOS. OF 701-HS-3202A/B/C TO 701-SSW-3202, 701-XL-3202, 701-VT/VIAH/VAHH-3202, 701-EDA-3202 ARE SHOWN FOR 701-EA-1002D. SIMILARLY FOR AIR HEATERS 701-EA-1003D TO 701-EA-1028D, TAG NO. SHALL BE AS FOLLOWS. 701-HS-3203A/B/C TO 701-HS-3228A/B/C, 701-SSW-3203 TO 701-SSW-3228, 701-XL-3203 TO 701-XL-3228, 701-VT/VIAH/VAHH-3203 TO 701-VT/VIAH/VAHH-3228 AND 701-EDA-3203 TO 701-EDA-3228.
- GENERAL NOTES:
- A. ALL INSTRUMENT TAG NUMBERS TO BE PRE-FIXED BY UNIT NUMBER 701.
 - B. FOR STANDARD SYMBOLS/NOMENCLATURE, AND DETAILS/GENERAL REQUIREMENTS REFER DRAWING NO. B861-02-42-001-1191/1192
 - C. FOR INTERLOCK DESCRIPTION DETAILS REFER P&ID B861-02-42-001-1193

1	05.09.24	ISSUED FOR HAZOP	GSB	DR	JKS	SS
0	24.07.24	ISSUED FOR ENGINEERING	GSB	DR	JKS	SS
संख्या	तिथि	संशोधन	डॉन	द्वारा	जाँच	अनुमति
No.	DATE	REVISIONS	DRN	BY	CHKD	APPD.

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ENGINEERS INDIA LIMITED
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कोकण एल एन जी लिमिटेड
KONKAN LNG LIMITED
EPCM SERVICES FOR AMBIENT AIR HEATERS AT KLL LNG TERMINAL

पाइपिंग एण्ड इंस्ट्रुमेंटेशन डायग्राम
PIPING AND INSTRUMENTATION DIAGRAM
AMBIENT AIR HEATERS
701-EA-1001D TO 701-EA-1014D

अनुमाप	कार्य संख्या	विभाग	अनुभाग	इकाई	आरेख संख्या	संशोधन
SCALE	JOB NO.	DEPT.	SECTN.	UNIT	DWG. No.	REV.
	B861	02	42	701	1132	1

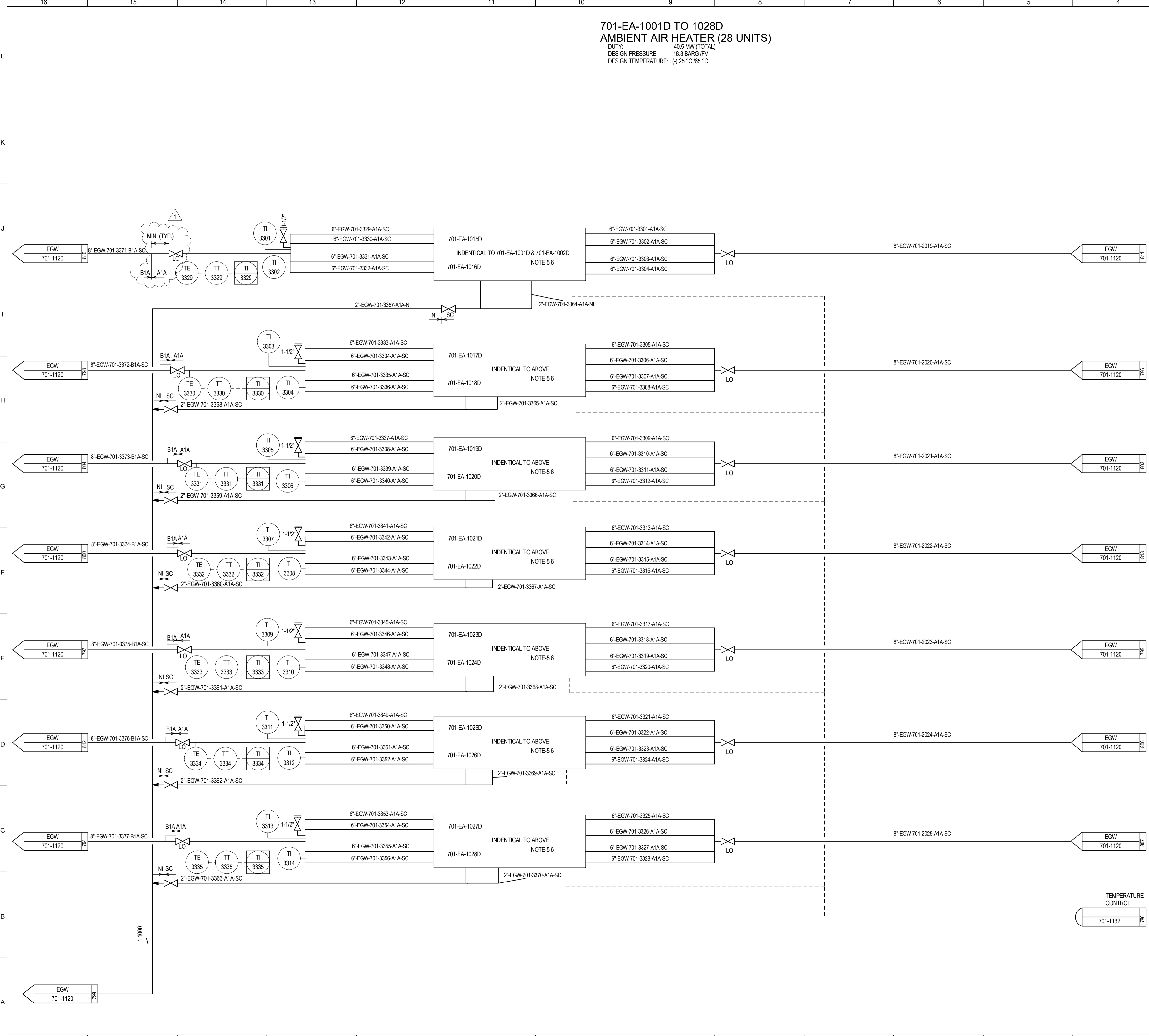
701-EA-1001D TO 1028D
 AMBIENT AIR HEATER (28 UNITS)

DUTY: 40.5 MW (TOTAL)
 DESIGN PRESSURE: 18.8 BARG FV
 DESIGN TEMPERATURE: (+) 25 °C / 65 °C

NOTES:
 1. FOR NOTES REFER P&ID NO. B861-02-42-701-1132.

GENERAL NOTES:
 A. ALL INSTRUMENT TAG NUMBERS TO BE PRE-FIXED BY UNIT NUMBER 701.
 B. FOR STANDARD SYMBOLS/NOMENCLATURE, AND DETAILS/GENERAL REQUIREMENTS REFER DRAWING NO. B861-02-42-001-1191/1192.
 C. FOR INTERLOCK DESCRIPTION DETAILS REFER P&ID B861-02-42-001-1193

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0	24.07.24	ISSUED FOR ENGINEERING	GSB	DR	JKS	SS
संख्या	तिथि	संशोधन	डॉन	द्वारा	जाँच	अनुमोदित
No.	DATE	REVISIONS	DRN	BY	CHKD	APPD.

इंजिनियर्स
 इंडिया लिमिटेड
 (भारत सरकार का उपक्रम)

ENGINEERS INDIA LIMITED
 (A Govt. of India Undertaking)

कॉकण एल एन जी लिमिटेड
KONKAN LNG LIMITED
 EPCM SERVICES FOR AMBIENT AIR HEATERS
 AT KLL LNG TERMINAL

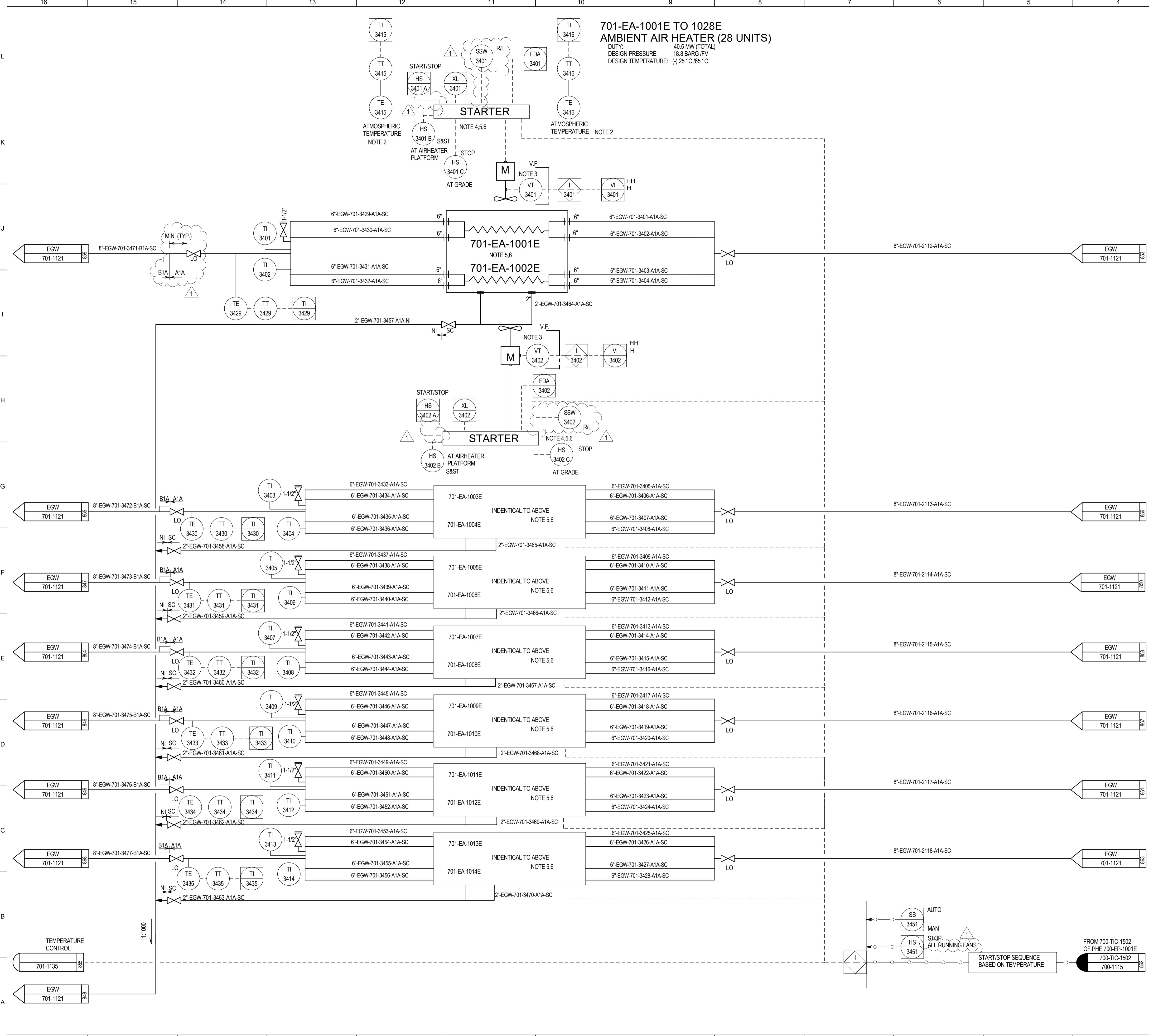
पाइपिंग एण्ड इंस्ट्रुमेंटेशन डायग्राम
 PIPING AND INSTRUMENTATION DIAGRAM
 AMBIENT AIR HEATERS
 701-EA-1015D TO 701-EA-1028D

अनुमाप	कार्य संख्या	विभाग	अनुभाग	इकाई	आरेख संख्या	संशोधन
SCALE	JOB NO.	DEPT.	SECTN.	UNIT	DWG. No.	REV.
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701-EA-1001E TO 1028E AMBIENT AIR HEATER (28 UNITS)

DUTY: 40.5 MW (TOTAL)
DESIGN PRESSURE: 18.8 BARG F.V.
DESIGN TEMPERATURE: (+) 25 °C / 65 °C



- NOTES:
1. PIPING ARRANGEMENT SHALL BE SYMMETRICAL FOR PROPER DISTRIBUTION OF EGW TO AIR HEATER. REFER DETAIL-A OF P&ID B861-02-42-001-1192.
 2. TO BE INSTALLED DIAGONALLY OPPOSITE IN AIR HEATER AGAINST THE WIND DIRECTION TO AVOID INFLUENCE OF FAN AIR ON THE MEASUREMENT OF TEMPERATURE. THIS TEMPERATURE SHALL BE USED FOR PERFORMANCE ESTIMATION OF AIR HEATER.
 3. VIBRATION HIGH-HIGH ALARM & TRIPPING OF FAN SHALL BE SIMULTANEOUS. VENDOR SHOULD PROVIDE SIGNAL FOR EACH VAHH FOR ALARM/TRIPPING IN DCS/CONTROL PANEL.
 4. TYPICAL ARRANGEMENT FOR FAN.
 5. INLET-OUTLET, VENT-DRAIN VALVES AND NO. OF INSTRUMENTS ON BAY, FAN, MOTOR ETC. TO BE CONSIDERED SAME AS THAT OF BAY-1. (701-EA-1001E, 701-EA-1002E) FOR REST 13 BAYS. (I.E. FROM 701-EA-1003E TO 701-EA-1028E)
 6. THERE ARE TOTAL 28 NOS. OF AIR HEATERS FROM 701-EA-1001E TO 701-EA-1028E. TAG NOS. OF 701-HS-3401A/B/C 701-SSW-3401, 701-XL-3401, 701-VT/VI/VAHH/VAHH-3401, 701-EDA-3401 ARE SHOWN FOR 701-EA-1001E. TAG NOS. OF 701-HS-3402A/B/C 701-SSW-3402, 701-XL-3402, 701-VT/VI/VAHH/VAHH-3402, 701-EDA-3402 ARE SHOWN FOR 701-EA-1002E. SIMILARLY FOR AIR HEATERS 701-EA-1003E TO 701-EA-1028E. TAG NO. SHALL BE AS FOLLOWS. 701-HS-3403A/B/C TO 701-HS-3428A/B/C, 701-SSW-3403 TO 701-SSW-3428, 701-XL-3403 TO 701-XL-3428, 701-VT/VI/VAHH/VAHH-3403 TO 701-VT/VI/VAHH/VAHH-3428 AND 701-EDA-3403 TO 701-EDA-3428.
- GENERAL NOTES:
- A. ALL INSTRUMENT TAG NUMBERS TO BE PRE-FIXED BY UNIT NUMBER 701.
 - B. FOR STANDARD SYMBOLS/NOMENCLATURE, AND DETAILS/GENERAL REQUIREMENTS REFER DRAWING NO. B861-02-42-001-1191/1192
 - C. FOR INTERLOCK DESCRIPTION DETAILS REFER P&ID B861-02-42-001-1193

1	05.09.24	ISSUED FOR HAZOP	GSB	DR	JKS	SS
0	24.07.24	ISSUED FOR ENGINEERING	GSB	DR	JKS	SS
संख्या	तिथि	संशोधन	डॉन	द्वारा	जाँच	अनुमति
No.	DATE	REVISIONS	DRN	BY	CHKD	APPD.

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(भारत सरकार का उपक्रम)

ENGINEERS INDIA LIMITED
(A Govt. of India Undertaking)

कोकण एल एन जी लिमिटेड
KONKAN LNG LIMITED
EPCM SERVICES FOR AMBIENT AIR HEATERS AT KLL LNG TERMINAL

पाइपिंग एण्ड इंस्ट्रुमेंटेशन डायग्राम
PIPING AND INSTRUMENTATION DIAGRAM
AMBIENT AIR HEATERS
701-EA-1001E TO 701-EA-1014E

अनुमाप	कार्य संख्या	विभाग	अनुभाग	इकाई	आरेख संख्या	संशो
SCALE	JOB NO.	DEPT.	SECTN.	UNIT	DWG. No.	REV.
	B861	02	42	701	1134	1

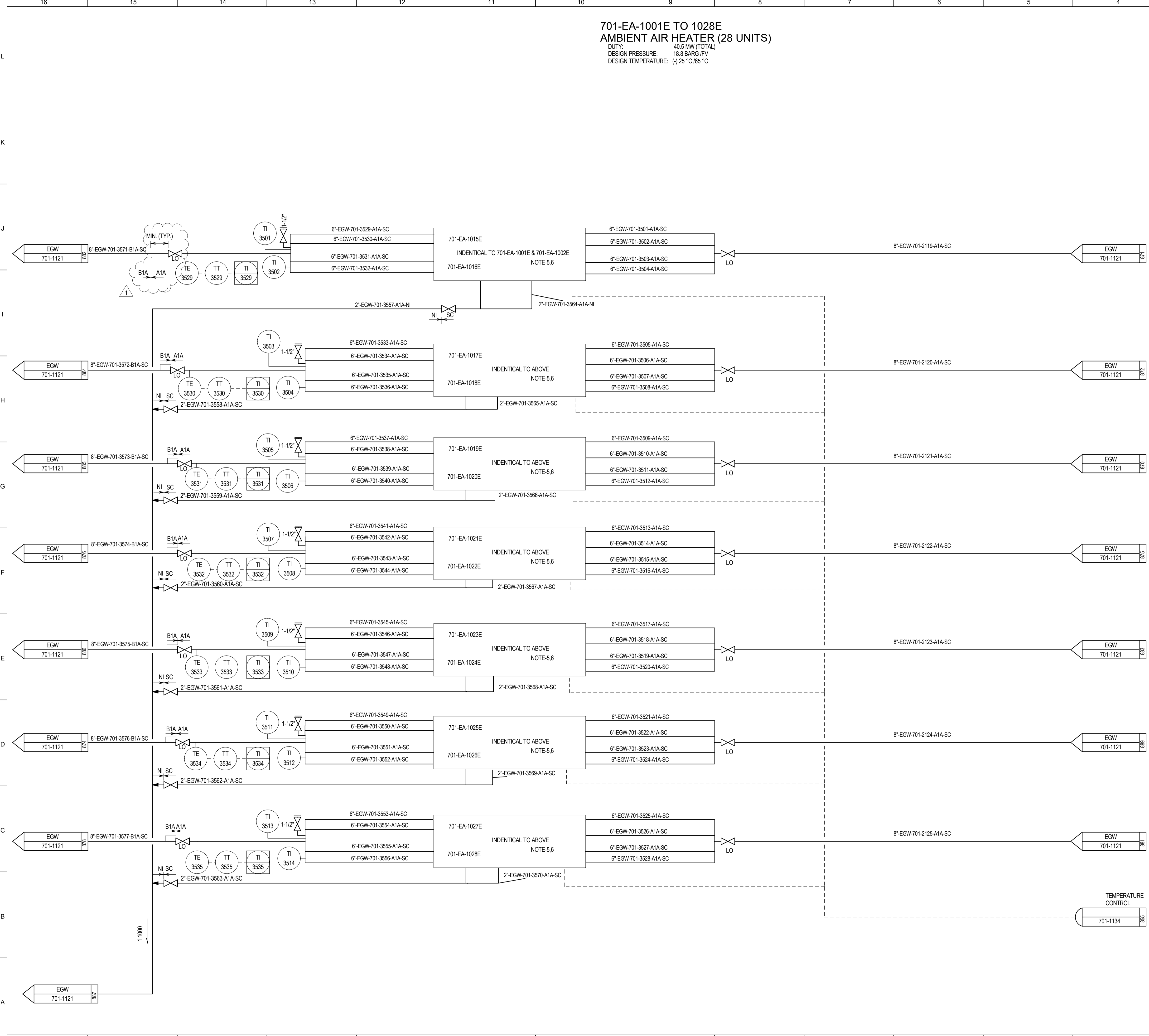
701-EA-1001E TO 1028E
 AMBIENT AIR HEATER (28 UNITS)

DUTY: 40.5 MW (TOTAL)
 DESIGN PRESSURE: 18.8 BARG F.V.
 DESIGN TEMPERATURE: (+) 25 °C / 65 °C

NOTES:
 1. FOR NOTES REFER P&ID NO. B861-02-42-701-1134.

GENERAL NOTES:
 A. ALL INSTRUMENT TAG NUMBERS TO BE PRE-FIXED BY UNIT NUMBER 701.
 B. FOR STANDARD SYMBOLS/NOMENCLATURE, AND DETAILS/GENERAL REQUIREMENTS REFER DRAWING NO. B861-02-42-001-1191/1192
 C. FOR INTERLOCK DESCRIPTION DETAILS REFER P&ID B861-02-42-001-1193

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0	24.07.24	ISSUED FOR ENGINEERING	GSB	DR	JKS	SS
संख्या	तिथि	संशोधन	डॉन	द्वारा	जाँच	अनुमोदित
No.	DATE	REVISIONS	DRN	BY	CHKD	APPD.

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कॉकण एल एन जी लिमिटेड
KONKAN LNG LIMITED
 EPCM SERVICES FOR AMBIENT AIR HEATERS
 AT KLL LNG TERMINAL

पाइपिंग एण्ड इंस्ट्रुमेंटेशन डायग्राम
 PIPING AND INSTRUMENTATION DIAGRAM
 AMBIENT AIR HEATERS
 701-EA-1015E TO 701-EA-1028E

अनुमाप	कार्य संख्या	विभाग	अनुभाग	इकाई	आरेख संख्या	संशोधन
SCALE	JOB NO.	DEPT.	SECTN.	UNIT	DWG. No.	REV.
1:1000	B861	02	42	701	1135	1

वेलडेड ट्यूब से ट्यूबशीट जोड़ों
के लिए मानक विनिर्देश

STANDARD SPECIFICATION FOR
WELDED
TUBE TO TUBESHEET JOINTS

5	20 05 19	REAFFIRMED AND REISSUED AS STANDARD SPECIFICATION	<i>NK 20/05/19</i>	KA	KJF	RKT
4	07 06 13	REAFFIRMED AND REISSUED AS STANDARD SPECIFICATION	TK	KA	RKT/SC	DM
3	28 01 08	REAFFIRMED AND REISSUED AS STANDARD SPECIFICATION	KA	PK	AKM	VC
2	01 09 99	REVISED AND REISSUED AS STANDARD SPECIFICATION	HN	PK	RKA	AS
1	04 05 89	ISSUED AS STANDARD SPECIFICATION	RKA	BSG	VKM	RNS
Rev. No.	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
Approved by						

Abbreviations:

API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
AWS	American Welding Society
OD	Outside diameter
TEMA	Tubular Exchangers Manufacturers' Association
TIG	Tungsten inert gas shielded arc

Static Equipment Standards Committee

Convenor: Mr. KJ Harinarayanan

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CONTENTS

1.0	SCOPE	4
2.0	APPLICABLE CODES AND STANDARDS	4
3.0	WELDING PROCESS AND JOINT DETAIL	4
4.0	WELDING PROCEDURE QUALIFICATION	4
5.0	WELDERS QUALIFICATION	6
6.0	PREPARATION OF TUBES AND TUBESHEET	6
7.0	WELDING	6
8.0	EXAMINATION OF JOINTS	7
9.0	TUBE EXPANDING	7
10.0	REPAIRS	7
11.0	TEST AND REPAIR REPORTS	7
	APPENDIX-1 - JOINT DETAILS	
	APPENDIX-2 - DETAILS OF TEST SPECIMENS	

1.0 SCOPE

- 1.1 This specification covers minimum requirements for the welding and testing of tube to tubesheet joints of shell and tube heat exchangers and air coolers. It is the Fabricator's responsibility to furnish sound, leak free joints. For the purpose of this specification, the terms "joints" shall be construed to mean "tube-to-tube sheet joints".

2.0 APPLICABLE CODES AND STANDARDS

The latest edition of the following codes and standards shall be complied with:

- a) ASME Section VIII Division I
- b) ASME Section V
- c) ASME Section IX
- d) TEMA for tubular exchangers
- e) API 661 for air coolers
- f) AWS

3.0 WELDING PROCESS AND JOINT DETAIL

- 3.1 Manual or automatic Tungsten Inert Gas shielded Arc (TIG) welding shall be used. All joints shall be made by using minimum two weld passes. The first pass should be preferably made without filler wire to ensure root fusion. The second or final pass shall be with filler wire. Any other welding process can be used only after obtaining written approval from the Authorised Inspector.
- 3.2 Joint detail shall be as indicated on the Purchaser drawings by giving reference to figure numbers in Appendix-1 of this specification. In absence of any Purchaser drawings or indication regarding type of joint, Figure 2 or Figure 3 shall be used depending upon whether tube thickness is ≥ 2 mm or < 2 mm respectively.

4.0 WELDING PROCEDURE QUALIFICATION

- 4.1 Welding Procedure Specification shall be compiled by the Fabricator and submitted to the Authorised Inspector for approval before the qualification tests are performed. Mock up test shall commence only after approval is obtained from the Authorised Inspector.

- 4.2 Welding procedure qualification test is required to be carried out if:-

- a) Authorised Inspector requires the test to be carried out.
- b) There exists no previous qualification tests within last three years for the proposed combination of tube and tubesheet P number and group number (as per ASME Section IX), tube outside diameter (OD), tube thickness, tubesheet thickness, tube pitch, tube pitch pattern, welding procedure and joint detail. All other factors remaining same, the procedure test need not be repeated if the job tubesheet thickness exceeds 40 mm and qualification exists for 40 mm or higher tubesheet thickness.

For plug type air coolers additional procedure qualification test is required to be performed for any of the following conditions:

- i) The job has lower clearances between tube and any of the header plates like top/bottom/end/stiffener/pass partition plate compared to earlier tests.
- ii) The job has lower plug size for the same tube size compared to earlier tests.

- iii) The job has higher plugsheet thickness compared to earlier tests.
- c) Code or requisition or bid document requires the test to be carried out.
- 4.3** If required as per 4.2 above, the Fabricator shall perform a procedure qualification test, at least two weeks before the scheduled beginning of production. Procedure shall be qualified for the same hand position as is being proposed for production. Procedure test shall consist of the welding of nine tubes for square pitch and eight tubes, (three, two and three tubes per row arrangement) if on a triangular pitch. This shall be done for each set of combination of tube and tubesheet P number and group number, welding procedure, joint detail, tube OD, tube thickness, tube pitch, tube pitch pattern, tubesheet thickness. Additionally for air cooler, tests shall be done for each tube size with lowest plug size, lowest clearance between tube and any of the header plates, and the lowest plugsheet thickness to be used on the job. Thickness of the tubesheet used for procedure testing shall be same as used for job, except that for carbon steel and austenitic stainless steel materials, it need not exceed 40 mm, unless otherwise indicated. Refer Appendix-2 of this specification for test specimen details.
- 4.4** The following data report (six copies) shall be furnished for review to Authorised Inspector with the weld samples as outlined below.
- a) Complete details of welding procedure employed indicating various machine settings, welding rods, inert gas composition & purities, flow rate, weld sequence etc.
- b) Mechanical properties and chemical composition of tubesheet, tubes and filler metal.
- c) The hardness of the weld, the tube, the tubesheet heat affected zone and the tubesheet base metal after each pass.
- d) The complete test sample shall be cut (by sawing) as per Appendix 2 of this specification. These shall then be subjected to various tests etc. as outlined below:
- i) Section 1 shall be polished, etched and microphotographed for examination of depth of weld, penetration and definition of boundaries. The minimum leak path of each weld shall be not less than the nominal thickness of the tube. The weld leg shall also be measured and shall be minimum 1.4 times the nominal thickness of the tube.
- ii) Section 2 (two specimens) shall be subjected to tear test. These specimens shall be tongue bent to show the extent of weld penetration. The underside of the weld shall show evidence of adequate & uniform weld penetration.
- iii) A section 10 mm thick containing the tube end welds shall be sawed from section 3 and radiographed for weld quality. The radiograph shall be submitted to Authorised Inspector. No cracks or crack like or visual defects are acceptable. Acceptance shall be as per Appendix 4 of ASME Section VIII Division 1. In case the radiograph is not acceptable, welding procedures shall be suitably modified so that proper weld and acceptable radiographs are obtained. These shall be proved by retests.
- iv) Section 4 shall be etched and polished and given to Authorised Inspector.
- e) A tension strength test shall be carried out as per ASME Section VIII Division I Appendix A. This strength test shall be performed at room temperature for each combination set of tube and tubesheet P number and group number, tube OD, tube thickness and joint detail. The breaking loads shall be at least equal to the load required for breaking the tube using the minimum specified ultimate tensile strength of tube as indicated in certificates issued by the tube supplier. When tube material is to a

specification which does not call for mechanical tests to be performed, ultimate tensile strength of the tube material shall be considered as four times the allowable stress at room temperature as indicated by the ASME Section II Part D, or other relevant code. Failure of the test piece at the weld shall not be a cause for rejection in case the minimum strength is attained, but the fracture should be examined for any evidence of faulty workmanship.

- 4.5 Fabricator is advised to satisfy himself that the procedures employed are the best for the job and would enable him to give workmanship guarantee for the equipment. Authorised Inspector's approval shall in no way relieve the Fabricator of his responsibility and guarantee to supply the equipment as per the conditions of the purchase order.

5.0 WELDERS QUALIFICATION

The purpose of this operator qualification test is to demonstrate that both the welding operator and the welding machines are capable of producing satisfactory joints. Once welding procedures have been qualified as above, welding operators employed on welding shall be required to prove their ability by making test samples similar to that prescribed above for welding procedure qualification. Welding operators may be qualified based on para 4.4 d (i), 4.4 d (ii), and 4.4 d (iii) above only, provided same welding machines & welding procedures are used. This welding operator qualification test should also be carried out if the welding operator has not executed similar welding six months prior to production. Repeat tests may be called for in the course of manufacture to determine the consistency of operator or machine to produce sound welds.

6.0 PREPARATION OF TUBES AND TUBESHEET

- 6.1 Tubeholes shall be to special close fit tolerance as per TEMA for shell and tube exchangers and as per API 661 for air coolers. Tube holes shall be free from any burns and the bundle side edge of tube holes shall be chamfered or radiused. Tube holes shall have smooth finish to 63 AARH.
- 6.2 Prior to assembly, the tubesheet and tube ends (inside and outside for a distance equal to the tubesheet thickness + 30 mm) shall be cleaned and degreased to free from dirt, grease etc. It is essential that the solvent used for degreasing be chloride free and sulfide free and non residue forming. The solvent should not lead to any possible fire hazard.
- 6.3 The tubes shall be positioned in the tubesheets by 30° tapered drift pin.
- 6.4 Before welding tube to tubesheet, the tubesheets shall be heated to a temperature as required to remove any last traces of moisture or solvent which may remain after the cleaning operation. Any specific requirement for application of preheat shall be established as a part of the welding procedure qualification test and should account for increased restraint offered by the larger assembly during production.

7.0 WELDING

Tubes shall be individually welded, using the procedure approved by the Authorised Inspector. Systematic welding procedure shall be adopted so as to result in minimum tubesheet distortion. All tubes are to have initial pass completely cleaned as necessary, visually examined and tested as per para 8.1 below, if required, before subsequent layers are applied. Welds shall be suitably finished and any spillage or spatter on tubesheet removed. Spillage of weld metal into the bores of tube is not permitted.

8.0 EXAMINATION OF JOINTS

- 8.1 Joints shall be subjected to air-soap solution test after first weld pass with air at 1.25 kg/cm² (g). Procedures outlined in ASME Section V, Article 10 shall be followed.
- 8.2 After completion of welding, the tubesheet face, the welds and internal tube surfaces to a distance of 25 mm beyond the fusion line must be cleaned thoroughly by wire brushing and examined carefully for surface defects. Defects such as cracks, surface breaking porosity, slag inclusions and lack of fusion are not acceptable.
- 8.3 After the visual inspection, a liquid penetrant examination in accordance with ASME Section VIII Division I, Appendix-8 & Section V, Article 6 shall be done. Before conducting this test, the faces of the carbon steel tubesheets shall be cleaned thoroughly by wire brush and solvents to remove all weld slag, rust and scale.
- 8.4 When specified on the drawings or requisition, a halide test shall be performed after the tests as per para 8.1, 8.2, and 8.3 above have been successfully completed. Procedures for halide test shall be as per ASME Section V, Article 10, Appendix - III Halogen diode detector probe test.
- 8.5 After the final tube expanding (refer para 9.0) has been completed, the liquid penetrant examination as outlined in para 8.3 above shall be repeated.
- 8.6 Whenever a halide test has been specified, an envelope test shall also be done as a further test for leaks after final tube expanding. For this test, tubesheets shall be securely wrapped in plastic sheets and the shell allowed to remain under test pressure with halogen tracer, for a period of 10 to 12 hours. Then with the detection set at a maximum sensitivity, the probe shall be inserted through the plastic cover at the bottom of the tubesheets and readings taken to observe if any leakage has occurred.
- 8.7 Final acceptance hydraulic pressure test shall be conducted after tube expansion at hydrotest pressure for at least one hour.

9.0 TUBE EXPANDING

After the tests outlined in 8.1, 8.2, 8.3, and 8.4 have been successfully completed and all leaking welds repaired, the tubes shall be "contact expanded" with a PARALLEL type expander. Contact expanding is intended to bring the tube OD into contact with the tube hole. Contact expanding shall begin 12 mm from the tubesheet face and extend to 3 mm from the back face. The contact expansion shall have thinning of 3-5% which shall be ensured by measuring the inside diameter of tubes.

10.0 REPAIRS

If leaks are found during any of the above testing procedures these shall be reported to the Authorised Inspector and after obtaining his approval, repairs shall be made by removing the defects down to sound parent metal and repeating the qualified weld procedures. All weld repairs shall be retested in accordance with procedures outlined in para 8.0 above.

11.0 TEST AND REPAIR REPORTS

Test and repair reports shall be included in the Data Folder. These reports shall also indicate the number of leaks discovered on each test and the extent of the repair done.

APPENDIX 1 - JOINT DETAILS

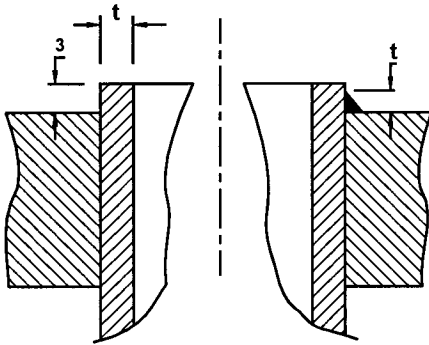


FIG-1

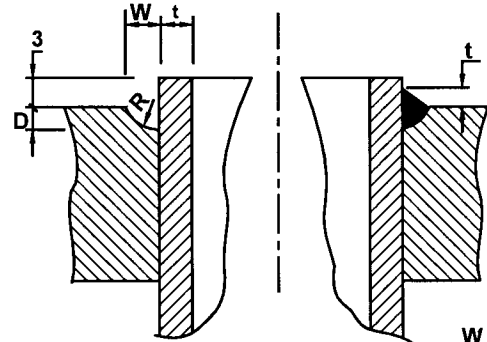
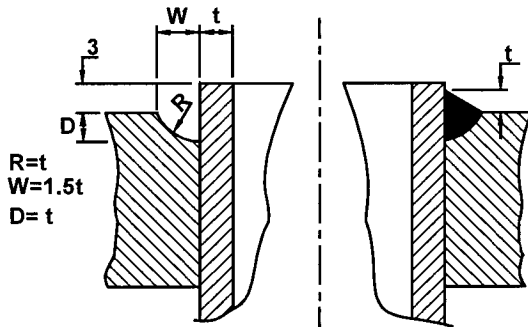


FIG-2

$W = t$
 $R = t$
 $D = t$ FOR $t \leq 3$
AND
 $= 0.6t$ FOR $t > 3$



$R = t$
 $W = 1.5t$
 $D = t$

FIG-3

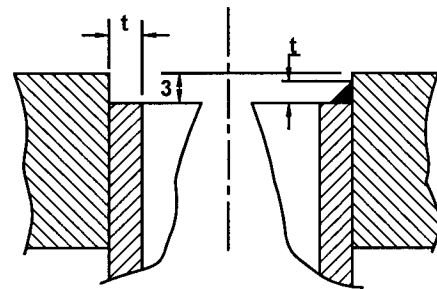


FIG-4

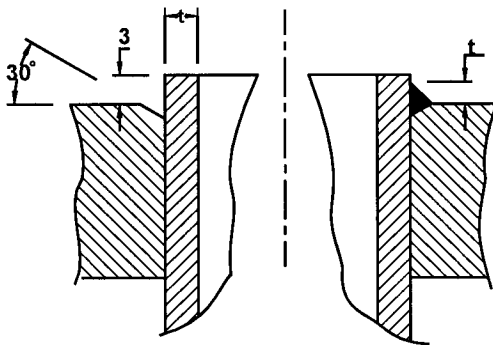
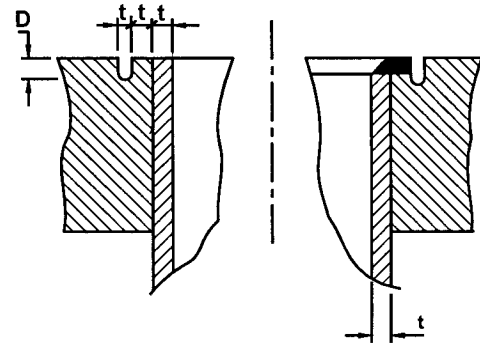


FIG-5



$D = 1.5t$ TO $2t$

FIG-6

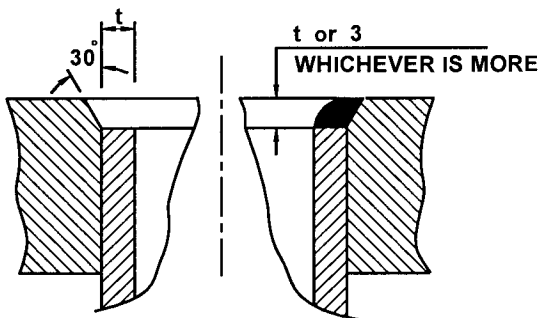


FIG-7

t or 3
WHICHEVER IS MORE

APPENDIX 2 - DETAILS OF TEST SPECIMENS

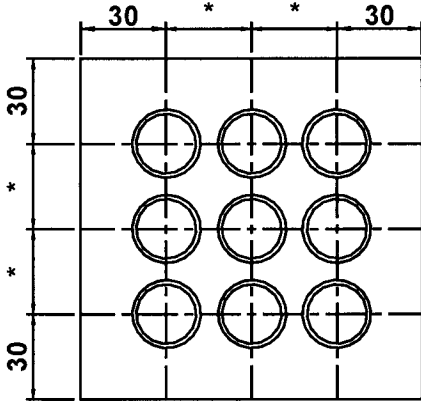


FIG-11

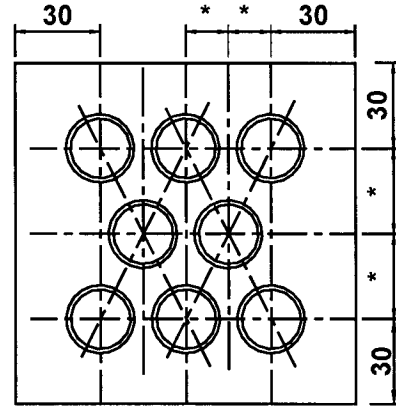
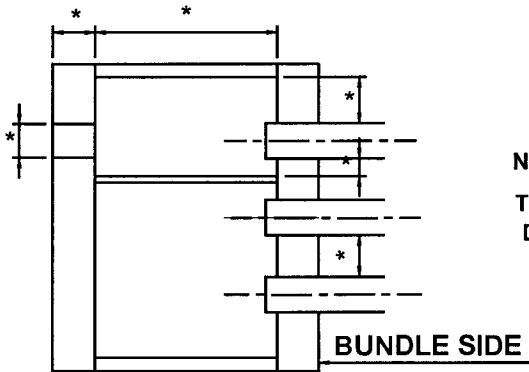


FIG-12



NOTE:-

THE MOCKUP ASSEMBLY SHOULD HAVE THE DIMENSIONS/THICKNESS MARKED '*' AS PER JOB

FIG-13 FOR PLUG TYPE AIRCOOLERS

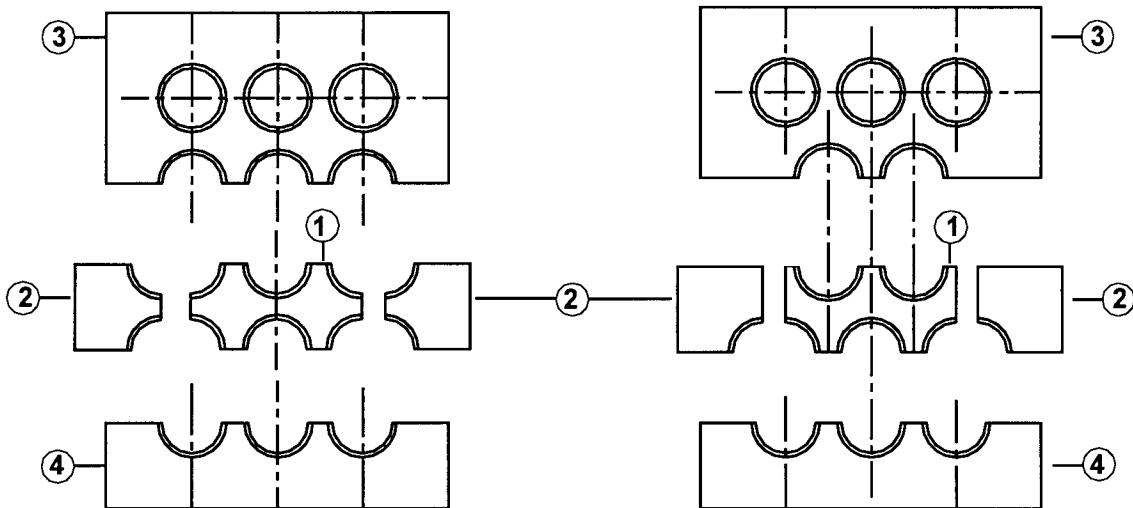


FIG-14

FIG-15

LEGEND

- 1. FOR MICROPHOTOGRAPHIC EXAMINATION
- 2. FOR TEAR TEST
- 3. FOR RADIOGRAPHIC EXAMINATION

एयर कूल्ड हीट एक्सचेंजर्स
के लिए

सामान्य विनिर्देश

GENERAL SPECIFICATION
FOR
AIR COOLED HEAT EXCHANGERS

6	08-05-2024	° REVISED & REISSUED AS STANDARD SPECIFICATION	MKP	TKh	KA/NK	MN
5	18-09-2018	REVISED & REISSUED AS STANDARD SPECIFICATION	SK	KA	KJH	RKT
4	18-08-2010	REVISED & REISSUED AS STANDARD SPECIFICATION	KA	RKT	AKM DM	ND
3	25-03-2009	REVISED AND REISSUED AS STANDARD SPECIFICATION	KA	PK	AKM	ND
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
						Approved by

Abbreviations:

ACHE	Air-cooled heat exchangers	PTC	Production test coupons
AI	Authorised Inspector	SS	Stainless steel
API	American Petroleum Institute	SPDT	Single pole double throw
ASME	American Society of Mechanical Engineers	STAAD	Software for structural design
ASTM	American Society of Testing of Materials	UL	Underwriters Laboratory
AWS	American Welding Society	UST	Ultrasonically Tested
BIS	Bureau of Indian Standards		
BHN	Brinell hardness number		
BV	Bureau Veritas		
CA	Corrosion Allowance		
CAF	Compressed Aramide Fibre		
CCE	Chief Controller of Explosives		
CIMFR	Central Institute of Mining & Fuel Research		
CS	Carbon Steel		
DFT	Dry Film Thickness		
DNV	Det Norske Veritas		
DP	Dye Penetrant Test		
DPDT	Double pole double throw		
FM	Factory Mutual		
FRP	Fibre Reinforced Plastics		
HAZ	Heat Affected Zone		
HIC	Hydrogen Induced Cracking		
HP	Horse Power		
HTRI	Heat Transfer Research Institute		
IEC	International Electrochemical Commission		
I/P	Current to pneumatic converter		
LAS	Low Alloy Steel		
LP	Liquid Penetrant Test		
LTCS	Low temperature CS		
MDMT	Minimum design metal temperature		
MP	Magnetic Particle Test		
NACE	National Association of Corrosion Engineers		
OD	Outside Diameter		
PESO	Petroleum & Explosives Safety Organization		

Static Equipment Standards Committee

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Co-Convenor: Mr. K. Anjaneyulu

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Mr. Avdesh Agrawal (SCM-Inspection)

A. SCOPE

This specification covers the general requirements for the thermal and mechanical design, materials, fabrication, workmanship, inspection, testing and supply of ACHE and is intended to supplement the minimum requirements of the applicable codes and standards.

In case Purchaser furnishes thermal design, Clause-7.0 under Section-7 of this specification on thermal design is not to be considered. In case thermal and mechanical designs are done and engineering drawings furnished by Purchaser, then details given in these engineering drawings take precedence over this specification.

This specification shall not be considered limiting and it shall be Vendor's responsibility to comply with all requirements of Material Requisition/Purchase Requisition/Bid Documents (referred to as enquiry documents), to which this specification is attached.

B. SPECIFIC REQUIREMENTS

The Standard applicable for ACHEs shall be API Standard 661, Seventh Edition July 2013 except to the extent modified hereunder. The section, paragraph and figure numbers refer to those used in API 661. "New" applies to entirely new paragraph presently not included and to be inserted in the numbering order of API-661. "Addition" applies to an addition to the original Para. "Modified" applies to modification of applicable portion of the API-661 Para.

4. GENERAL

4.1 The pressure design code shall be ASME Section VIII Division 1, unless specified (Modified) otherwise. Hereinafter referred to as 'Code.

4.4 (Addition) For ACHE to be installed in India, Vendor shall comply with all applicable local regulations like approval from CIMFR, PESO, and CCE etc. for all electrical and instrument items.

4.6 (Addition) Service of the ACHE (sour service or wet hydrogen sulphide service) shall be as indicated in the Requisition.

5. PROPOSALS

5.11 (New) The proposal shall include power consumed by the motor and required motor HP.

6. DOCUMENTATION

Vendor shall furnish documents as per Vendor Data Requirements specified in the requisition.

7. DESIGN

7.0 (New) Thermal Design

7.0.1 The Vendor shall do thermal rating when specified. Thermal design proposed by the Vendor will have to be in order as per HTRI software. This includes adequacy of heat transfer area and tube and airside pressure drops. If any modifications are required to be carried out by the Vendor in order to make the thermal design acceptable as per HTRI software, the same will be done without any cost and delivery implications.

7.0.2 If an ACHE has to satisfy more than one process condition, separate "Equipment Data Sheet" shall be furnished for each condition. The relevant process condition number shall be given in the heading of each sheet.

7.0.3 ACHE design shall take into account operation at part load. This is important for viscous materials ($\geq 5\text{cP}$) and those with high pour points. Vendor shall consider the following:

The inside tube wall temperature shall be a minimum of $10\text{ }^{\circ}\text{C}$ ($18\text{ }^{\circ}\text{F}$) above the pour point. This condition shall be satisfied for the lowest part-load design case with the air entering at winter design temperature. The provision of counter or parallel flow piping arrangement, air re-circulation and/or heating coils may be necessary to achieve this.

In cases where the process fluid may solidify or become highly viscous when flow is interrupted or for systems where there is a maximum allowable cooling rate, e.g. deposition of ammonium carbonate, steam heating & control shall be incorporated for start up & shut down.

7.0.4 The varying air temperature across the rows of a single pass condenser results in unequal performance. Employing variable fins per inch in the individual rows with the lowest in the bottom row and highest in the top row should eliminate this.

7.1 Tube Bundle Design

7.1.0 (New) Vendor shall strictly follow the design information issued by the Purchaser. Any comment and/or reservations shall be resolved with the Purchaser at the bidding stage. Reservations or deviations not accepted during bidding stage shall not be reopened during job execution.

7.1.1.8 (Addition) There shall be practically no air gaps in bolted joints (plenum to beam, in between parts of plenum etc.). However, these gaps shall be limited to 0.5 mm (maximum).

7.1.1.13 (New) The bundle side frame shall have minimum 5 mm thickness for tube lengths less than 6 m and bundle width up to 2 m and shall have 8 mm thickness (minimum) for greater tube lengths or bundle widths. Only one joint is permitted in the frame. The weld, if any, shall be full penetration weld, shall be ground flush from inside and DP tested.

7.1.1.14 Tube to tube sheet joints

(New) Tube to tube sheet joints shall be expanded type except that the tube to tube sheet joints shall be welded for the following cases:

- a) Critical service requirements such as lethal, hydrogen service with hydrogen partial pressure $> 7\text{ kg/cm}^2$ (g), etc.
- b) For duplex and super duplex materials where reliable expanded joints are difficult to achieve.
- c) When specified in Process Licensor's requirements or datasheet.
- d) Tube hardness or yield strength exceeds that of tube sheet.
- e) When design pressure $> 50\text{ kg/cm}^2$ (g) and design temperature is $> 400\text{ }^{\circ}\text{C}$.
- f) When design pressure $> 70\text{ kg/cm}^2$ (g) and design temperature is $> 300\text{ }^{\circ}\text{C}$.
- g) For sour service with SS tubes and tube sheet.

7.1.3. Tube Bundle Design Temperature

7.1.3.1 (Addition) ACHE MDMT shall be taken lower of 0 °C or the design temperature specified in the equipment drawing or Design Basis.

7.1.3.2 (Addition) Extruded fins may be used for design temperature up to 288 °C (maximum).
Embedded 'G' fins may be used for design temperature up to 400 °C (maximum).
Beyond 400 °C, only welded fins shall be used. For ACHEs in offshore service, extruded fins shall be preferred.

7.1.6 Headers

7.1.6.0 Type of header

(New) The type of header as specified by Purchaser shall be adopted. In general cover plate type headers shall be used when fouling resistance is greater than 0.0004 hr^m²C/kcal. Plug headers shall be provided for services such as hydrogen, lethal, sour, amine, design pressure greater than 50 kg/cm² (g).

7.1.6.1.2 (Addition) If the operating temperature exceeds 180 °C, a split header shall be provided after first tube pass of multi pass bundle.

7.1.6.1.4 (Modified) Header shall be designed so that the inter pass cross-sectional flow area is at least 130% of the flow area in the previous tube pass.

7.1.6.1.6 (Addition) The minimum tube sheet thickness for expanded tube to tube sheet joint shall be 25mm for CS and LAS materials with 3mm CA and 22mm for SS material with no CA, to ensure two grooves for expansion. For higher CA, minimum thickness shall be increased by the additional CA (e.g. CA in excess of 3 mm for CS or LAS, etc.).

7.1.6.1.9 (New) Even number of passes are preferred for simplicity in piping layout. Process nozzles shall be at the fixed header end to minimise thermal expansion stresses. Pass partition plates shall be provided with one 6mm diameter drain hole.

7.1.6.2 Removable Cover Plate and Removable Bonnet Headers

7.1.6.2.2 (Modified) Removable bonnet headers shall not be used.

7.1.6.2.3 (Modified) Bolted joints shall be designed with confined gasket only. Refer figure 4 A and B for typical confined joint detail. Use stud bolts for header flange and cover plate joint.

7.1.6.3 Plug Headers

7.1.6.3.4 (New) For strength welded tube to tube sheet joint, if clearance between the top/bottom/side/partition plate and tube is less than 18mm or the plug size is less than tube OD plus 9mm, then Vendor shall demonstrate his experience by giving past references and by performing mock up to prove his capability in this regard. The mock-up shall be done before the submission of design or drawings.

7.1.7 Plugs for Tube Access

7.1.7.6 (Addition) Plug shall not project into the header box. In case of sour and lethal service, double plug shall be used for CS and LAS materials.

- 7.1.8 **Gasket**
- 7.1.8.7
(Modified) Metal Jacketed (3 mm thick) gaskets shall be 13mm (minimum) wide all around. CAF (2 mm thick) gaskets shall be 19 mm (minimum) wide all round. Width of the gasket at pass partition shall be equal to the pass partition plate thickness.
- 7.1.8.8 (c) The weld and HAZ is not harder than the parent material and has the same corrosion (new) resistance.
- 7.1.8.8 (d) The pass partition ribs of metal-jacketed gaskets may be tack welded to the inside of (new) peripheral section.
- 7.1.8.10
(New) The selection of gaskets in header flanges depends on the temperature, pressure and corrosivity of the fluid to be sealed. For cover type header, the gasket shall be CAF or metal-jacketed type with the metal compatible with cover and flange material. CAF may be used only for water, air, steam (up to 150 °C) with ASME 150 Class and if permitted as per Purchaser's specifications. CAF shall be 2mm thick only. Asbestos not to be used if not specifically permitted.
- For plug headers, only solid soft metal gaskets are to be used.
- 7.1.9 **Nozzles and other connections**
- 7.1.9.0
(New) Maximum nozzle size shall be limited to 12"NB and where possible shall be restricted to 8"NB by splitting large flows into multi nozzles, if necessary. Header boxes having length more than 1800mm shall have minimum two nozzles for process inlet and outlet.
- 7.1.9.5
(Modified) All connections shall be flanged irrespective of flange rating.
- 7.1.9.7
(Addition) Bolt holes shall straddle principal centrelines.
- 7.1.9.8
(Addition) Fabricated transition pieces wherever indicated in this clause shall not be permitted. Swaged CS nozzles shall be normalised if the thickness exceeds 16mm or if they are not formed in the normalising range. Hot-formed SS nozzles to be solution annealed. Slip-on flanges shall not be used. Lap joint stub in flanges shall not be used.
- 7.1.9.11/14/17/20
(Modified) Threaded connections shall not be used.
- 7.1.9.15
(Modified) If specified by Purchaser, additional chemical cleaning connection shall be minimum 2"NB. The type and location shall be as specified.
- 7.1.9.16
(Modified) Multi-purpose connections shall be as per Design Basis.
- 7.1.9.22
(New) All process nozzles of 3" NB and above shall be provided with 3 no. stiffeners and process nozzles of 2" NB and below shall be provided with 2 no. stiffeners. Size of stiffener shall be 50 wide x 8thk.
- 7.1.10 **Maximum allowable moments and forces for nozzles and headers**
- 7.1.10.5
(New) Nozzles shall be designed for two times the nozzle load limit given in API 661. For Air coolers of 600# nozzle flange rating and above, the same shall be 3 times API 661 limit. Structural components shall be designed considering three times nozzles loads as given in API

irrespective of flange rating. Nozzle loads in excess of these loads, if specified by purchaser, shall be considered.

7.1.11 **Tubes**

7.1.11.3 (Addition) For extruded fins (integral type) the minimum tube thickness applies to the inner tube.

7.1.11.5 (Addition) Fins serrated on the outside edge may be used only for CS fins.

7.1.11.7 (Addition) L-fins shall not be used.

7.1.11.14 (New) The mechanical bond between tube and embedded fins shall be tested as follows:

- i) Cut fin to obtain a sector with a chord of approx. 12mm at the root of the fin.
- ii) Pull out the fin sector by hanging weights or any other appropriate method. Acceptance criteria shall be a force of at least 3.0 kg.
- iii) 1% of the total number of tubes per size, fin diameter, fin pitch shall be tested at two locations along the tube length. Tubes, which pass the test, may be used after stitching of fin portions across the cut.
- iv) In the event of any tube failing to comply with pull out test requirements, a further two tubes shall be re-tested and, if the results are satisfactory, the tubes can be accepted. If, however, the further test results are unsatisfactory, the entire lot of tubes shall be rejected.
- v) The pulling test shall not be carried out within 25mm from each fin connection point.

Two cross-section cutaways shall be made for inspection of tube grooving and fin bonding per each machine setting (i.e. one tube for each type of tube and fin detail and minimum one test per order).

7.1.11.15 (New) The number of fins shall not exceed 433 per meter (11 per inch).

7.2 **Air side Design**

7.2.1.6 (Addition) If the control of air flow is to be achieved by use of auto variable fans or variable speed drives at least 50% of the fans are to be made auto variable, unless specified otherwise. Auto variable fans or variable speed drives, if used, shall be located towards that end of the bundle where inlet nozzle(s) is/are located.

7.2.1.8 Drivers, gear boxes, transmission components, instrumentation, louver actuator and (Addition) positioner etc. shall not be installed in the hot air stream.

7.2.2 **Noise Control**

7.2.2.1 Permissible noise level of the ACHE measured shall not exceed 85 dB (A) with all fans running at full load with measurement taken at 1 m from bundle on the header access walkways and 1 m from the bay limits on the motor maintenance platform. The permissible noise levels 1 m below the motor shall be 90 dB (A) maximum. Vendor shall demonstrate these noise level limits during run-in tests. Vendor shall guarantee these sound levels.

7.2.3 **Fans and Fans Hubs**

7.2.3.1 (Modified) Two or more fans aligned in the direction of tube length shall be provided for each bay. All fans in a bay shall be arranged for independent operation. Common fans cooling more than one process duty shall be used only on approval from Purchaser.

7.2.3.5 (Addition) Fans shall be designed for a noise level of maximum 80dB(A), keeping in mind the overall limits as per 7.2.2.1. Fan tip speed shall be suitably selected. Fan manufacturer shall furnish noise level datasheet for fans.

7.2.3.11(b) (Modified) Pneumatic actuator shall be equipped with a positioner. Each actuator shall have an integral positioner mechanism and mechanical maximum and minimum stops, adjustable over the full range. Exposed actuator shafts shall be chrome protected. Each actuator shall be provided with flexible hose (s), terminating in a 1/4" NPT screwed female connection.

The actuators shall be suitable for an air supply pressure of 9.5 kg/cm²(g) design, 7 kg/cm²(g) normal and 2.5 kg/cm²(g) minimum. Purchaser will specify the exact air supply pressure. Any pressure reduction system on the supply air, if required, shall be in Vendor's scope.

In general, an actuator operating range of 0.2 to 1.0 kg/cm²g is preferred.

7.2.3.11(c) (Addition) In case of loss of air pressure or control signal, the blades shall lock at maximum air flow position unless specified otherwise. In the event that the fan fails to respond in in this manner, means shall be included by the Vendor to physically lock the blades in high pitch position. Auto variable fans to be shop adjusted for variation between zero performance and design pitch required. Positioner to be supplied and set for full signal pressure range. Signal pressure for auto variable fan shall be 0.2 to 1.0 kg/cm²-(g) for zero flow to design flow unless specified otherwise. HP of motor to be selected based on the airflow at design pitch. Provide one I/P converter per item, unless specified otherwise. One volume booster shall be provided for each auto-variable fan.

I/P converter shall be of electronic feedback type unless specified otherwise and shall be yoke mounted. It shall have an integral terminal housing. I/P converter with flying leads shall not be acceptable. Unless otherwise mentioned, it shall be intrinsically safe. Pneumatic connections shall be 1/4" NPT (F). The electrical connections shall be 1/2" NPT (F). If they are different, suitable adapters shall be provided. The overall accuracy of the I/P converter shall be better than $\pm 0.3\%$.

7.2.3.17 (New) Fan shall be selected so that the design under fouled condition satisfies the following requirements with reference to fan performance curves:

- a) The design point shall lie on the performance curve for which fan blade angle is at least 5 degrees and preferably 10 degrees less than the largest blade angle at which fans operate satisfactorily.
- b) The design point shall not lie on the performance curve in proximity to the stall region which the manufacturer shall indicate in the fan curves.

7.2.3.18 Air Cooler fans shall be procured from EIL approved suppliers list attached elsewhere (New) in the Package/Material Requisition.

7.2.3.19 (New) Fan datasheet shall be forwarded to motor supplier and frame size shall be able to take all torque/ loads/ thrust imposed by fan. Vendor shall submit necessary calculation after order.

Vendor shall obtain and furnish the fan details from fan supplier as per the fan specification sheet including fan GD² value, torque vs speed curves, fan rpm etc. Vendor shall also furnish the drive make, motor make and frame size. Based on this data, the drive details shall be developed by vendor and submitted to EIL. Vendor shall furnish these drive details to the drive supplier and get the confirmation from him on the adequacy of the drive to transmit the required power. Vendor shall furnish to the motor supplier the requirements of GD², torque vs speed characteristics of fan and loads on motor from the drive affecting the selection of motor bearing, rating & frame size etc. Vendor shall ensure that the motor supplier has selected suitable motor as per motor specifications and datasheets for the conditions specified. Vendor shall obtain EIL approval for drive selection before procurement of the same.

Vendor shall furnish design calculation for fan shaft and motor shaft to EIL along with fan characteristic curves & motor datasheet for review/information. EIL comments, if any shall be fully complied with, and if required shaft size to be revised as per calculations without any cost and time implications.

7.2.3.20 Fan blades and assembly shall be balanced as per requirements of API 661 para (New) 7.2.3.7 and Balancing shall be according to ISO 21940 with balance quality grade G 6.3 or better

7.2.4 Fan Shafts and Bearings

7.2.4.0 (New) Fans shall be provided with QD bushes (minimum 10mm thickness) for attachment to fan shaft. Fan assemblies shall be fitted with their own thrust bearing situated at the drive end and a steady bearing at the outer end. The thrust bearing shall be capable of carrying any thrust loads transmitted by the driver. The thrust bearing inner race shall be mechanically locked by means of split rings to prevent accidental downward movement of shaft.

7.2.6 Fan Guards

7.2.6.1 (Modified) Removable galvanised steel fan guard shall be provided on each fan for forced as well as induced draft units. A hinged door shall be provided on the fan guard of fan diameter greater than 2m, to attend to problems without removing entire fan guard.

7.2.7.2 Electric Motor Drivers

7.2.7.2.1 (Addition) All electrical equipment shall be selected to suit the specified hazardous area classification, and the environment in which these have to operate. Area classification shall be as specified in the enquiry documents.

Vendor shall provide plate guards made from galvanized steel plates on the motor assemblies to avoid ingress of rainwater and capable of withstanding washing down by water hose. Details of the guards shall be developed by the vendor and submitted for information.

7.2.7.2.10 (New) Start and stop switches shall be provided for ACHE motors. Emergency stop switch shall also be provided at the grade. Supply of switches shall be as per requisition/ bid document.

7.2.8 Couplings and Power Transmissions

7.2.8.2 Belt Drives

7.2.8.2.1 Belt drives shall be high torque type, positive drive belts and shall be procured from (Modified) EIL approved suppliers list attached elsewhere in the Package/Material requisition.

7.2.8.2.4 (Addition) Belt drive tensioning means shall be adjustable without the need to remove the guard and without losing the alignment of the pulleys.

7.2.8.2.14 Pulley wheel shall be of cast iron or steel. All pulleys shall be dynamically balanced.

(New) Pulleys shall be thoroughly cleaned of rust, grease, and dirt and shall be shop coated. Belt drive pulleys shall be supplied by Vendors approved by belt supplier indicated in Para 7.2.8.2.1 and shall be certified accordingly.

7.2.8.2.15 Belts shall be heavy duty, oil resistant, antistatic, fire resistant and have neutral twist
(New) and shall be selected to suit the specified hazardous area classification. Belt drives shall not be used for offshore applications where only gear box shall be used.

7.2.9 **Vibration Sensors / Probes & Transmitters / Vibration Cut-out Switches**

(Modified) Vibration Sensors / Probes & Transmitters shall be provided by vendor for vibration measurement and automatically stop fans at high vibration, unless specified otherwise. Vibration Sensors / Probes & Transmitters shall have the features as mentioned under point-(A) below and Vibration switches shall meet requirements given under point (B) below.

(A) Vibration Sensors / Probes & Transmitters (as applicable):

- a) Fans to be provided with Vibration Sensors / Probes & Transmitters for trip and alarm to Purchaser's PLC. Start and stop push button at operating platforms shall be provided. Stop push button shall be provided at grade also.
- b) Vibration Sensors / Probes shall be inertia sensitive type with the vibration range suitable for the offered fan. Alarm and Trip Value shall be provided by vendor.
- c) The Vibration transmitters shall be two wired system, loop powered with 24V DC, 4-20 mA output, load driving capacity of 500 ohm (minimum).
- d) Vibration Sensors / Probes & Transmitters shall be weatherproof to IP65, Intrinsically Safe suitable for specified area classification (IEC Zone 1, Gas Group-IIC). In addition to the certification from authorized agencies like CIMFR, FM, UL etc., the Probes/ Transmitters shall have the valid approval from statutory authorities of place of installation which is PESO/ CCE in case of Indian installations.
- e) Vibration Sensors / Probes & Transmitters assembly shall have two cable entries as a minimum, each of ½" NPT size. In case vendor standard model does not support two entries, the Transmitter housing shall be supplied with integrally mounted 3-way junction box. The junction box shall be certified for specified area classification. Flying Lead wires are not acceptable. Additional openings shall be plugged with metallic blind plug.
- f) Vibration Sensors / Probes & Transmitters shall be located at motor suspension beams as close to the motor as possible. Probes/ Transmitters shall be readily accessible for maintenance from platform without any interference.
- g) Cable between Vibration Sensor/Probe & Vibration transmitter shall also be supplied by the vendor (consider cable distance of 30m for each Vibration Sensor / Vibration transmitter) along with junction box for termination of purchaser 12/6 (shall be informed during detailed engineering) pair signal cable. Junction box shall be weather proof to IP-65. Cable shall be armoured type only. Further cabling from Junction box to purchaser's PLC/DCS shall be in Purchaser's scope.
- h) All cable glands from sensor to transmitter and from transmitter to junction box shall be supplied by vendor. Cable glands shall be with PVC cover suitable for armoured cable. All Cable entry to sensor/ transmitter & junction box to transmitter shall be ½ inch NPT. Vendor shall also provide cable gland for purchaser cable from junction box of 1.5 inch NPT. All unused entry ports in the junction box shall be provided with weather proof metallic plugs.
- i) Vibration Sensors / Probes & Transmitters shall be supplied from manufacturer of repute and model shall have proven references of operating for a period of minimum 6 months, in the similar type of application. Vibration Sensors / Probes & Transmitters of prototype design or not having proven references shall not be supplied.

(B) Vibration Cut-out Switches:

- a) Vibration switch shall have 2 nos. independent contacts for further wiring by Purchaser, one for alarm in DCS & other for tripping in MCC. Vibration high high alarm and tripping of fan shall be simultaneous. Start and stop push button at operating platforms shall be provided. Stop push button shall be provided at grade also.
- b) Vibration switch shall be inertia sensitive type with the vibration range suitable for the offered fan. Set point shall be adjustable throughout the range i.e. 0 to 100%, and shall be adjustable externally without opening the switch housing. Switch shall have local as well as remote reset facility.
- c) Unless specified otherwise, switch shall be hermetically sealed type and provide two independent gold-plated contacts i.e. either by one DPDT (preferable) or two SPDT type each rated for 240V AC, 5A and 110V DC, 0.5A.
- d) Switch enclosure shall be weatherproof to IP65. Unless otherwise specified, the housing shall also be certified flameproof and explosion proof suitable for specified area classification (IEC Zone 1, Gas Group IIC). In addition to the certification from authorised agencies like CIMFR, FM, UL etc., the switch shall have the valid approval from statutory authorities of place of installation, which is PESO/CCE in case of Indian installations.
- e) The switch assembly shall have two cable entries as a minimum, each of 1/2" NPT size. In case vendor standard model does not support two entries, the switch housing shall be supplied with integrally mounted 3-way junction box. The junction box shall be certified flameproof/explosion proof meeting above requirements.
- f) Vibration switch shall be located at motor suspension beams as close to the motor as possible. Switches shall be readily accessible for re-setting from maintenance platform without any interference.
- g) Vibration cut-out switches shall be supplied from manufacturer of repute and the proposed model shall have proven references of operating for a period of minimum 6 months, in the similar type of application. Switches of prototype design or not having proven references shall not be supplied.

7.2.10 **Louvers**

7.2.10.15 Requirements for each pneumatic actuator: -

(Addition)

- (a) The positioner shall have mechanical pneumatic louver position feedback. For electrical or electronic control signals, a I/P converter located at grade or local platform shall be used.

I/P converter shall be of electronic feedback type unless specified otherwise and shall be yoke mounted. It shall have an integral terminal housing. I/P converter with flying leads shall not be acceptable. Unless otherwise mentioned, it shall be intrinsically safe. Pneumatic connections shall be 1/4" NPT (F). The electrical connections shall be 1/2" NPT (F). If they are different, suitable adapters shall be provided. The overall accuracy of the I/P converter shall be better than $\pm 0.3\%$.
- b) Each change in signal shall give a proportional change in louver angle from fully closed to fully open repeatable to within 5 degrees for the same instrument air pressure signal, increasing or decreasing.
- c) There shall be a minimum of one actuator per bay, a minimum of one actuator per unit and minimum of one actuator per 15 m² of louver surface area.
- d) The actuators shall be suitable for an air supply pressure of 10.5 kg/cm² (g) design, 4 to 7 kg/cm² (g) normal and 2.5 kg/cm² (g) minimum. Purchaser will specify the exact air

- supply pressure. Any pressure reduction system on the supply air shall be in Vendor's scope.
- e) The signal to actuator shall be 0.2 to 1.0 kg/cm² (g) for fully closed to fully open position unless specified otherwise.

- 7.2.10.17 (Modified) Where a single controller operates more than one actuator, isolation valves or other means shall be provided by Vendor to allow maintenance.
- 7.2.10.19 (Modified) With loss of control air pressure the louver shall lock in at 'fully open position' unless specified otherwise.
- 7.2.10.20 (Addition) Provision shall be kept for manual operation of all louvers.
- 7.2.10.21 (Addition) Provide legible indicator that indicates "angles of louver blade" and "open" or "closed" position.
- 7.2.10.26 Louvers shall be procured from EIL approved suppliers list attached elsewhere in the (New) Package/Material Requisition.

7.3 Structural Design

- 7.3.1.1 (Addition) For ACHE to be installed in India, the Codes for structural design shall be Indian Standard unless specified otherwise.
- 7.3.1.5 (Modified) For induced draft units, tube bundles shall be removable without requiring removal of the platforms. For forced draft units, the bundles shall be removable without separately supporting or dismantling of the fan, plenum, or platforms and without requiring disturbance of the structure or adjacent bays.
- 7.3.1.7 (New) The structural design shall be done on a reputed software package based on stiffness method of analysis e.g. STAAD PRO. Beams of length 6 m and below shall not have a splice joint, however for length above 6 m one splice joint may be permitted subject to the following:
- i) It is not located at the point of maximum bending moment or shear.
- ii) It shall be full penetration weld duly DP tested.
- iii) Suitable size of connecting plate shall be welded on both sides of the web and preferably inside of flange.
- 7.3.1.8 (New) In order to meet the vibration requirements it is preferred that the drive assembly shall not be suspended from plenum but supported on the main column.
- 7.3.1.9 (New) The structural assembly shall be done by bolting only so that the same can be easily dismantled. However, structural modules like platforms and brackets may be pre-welded and bolted to columns at site. Steel structure shall be shop assembled.
- 7.3.1.10 (New) Piping support loads on structure, if specified by Purchaser, during detailed engineering shall be considered by Vendor.

7.3.2 Vibration Testing

- 7.3.2.2 (Addition) Vibration check shall be made on each motor (both driving and non-driving ends). This shall be done at shop. Motor base plate, fan or motor supporting beams, main structure columns with all machines running individually and also with all machines running together at their full load. Motor and bearing blocks shall also be checked for any abnormal heating by running all the machines for sufficient time. Vendor shall arrange necessary instrumentation for carrying out the vibration check and shall carry out modifications, if required.

7.3.3 Structural Design Loads and Forces

7.3.3.5 Thermal force reaction shall be based upon an effective coefficient of friction equal to 0.3.
(Addition)

7.3.3.7 For ACHE to be installed in India, Wind load shall be in accordance with IS-875, unless stated otherwise.
(Modified)

7.3.3.8 For ACHE to be installed in India, Earthquake forces shall be in accordance with IS-1893, unless stated otherwise.
(Modified)

7.3.4 Plenums

7.3.4.6 Minimum thickness of steel sheet material used in construction of plenums shall be 2.8 mm (12 gauge) minimum, if the construction is transition type or straight box type. If it is inclined panel type as in case of induced draft then the minimum thickness shall be 3 mm for fan diameter up to 1.2 m (i.e. 4 feet) and 4 mm for larger size of fans.
(Modified)

7.3.5 Mechanical Access Facilities

7.3.5.1 Access platform shall be provided on all four sides of a continuous bank of bundles. Stair shall be provided on one side and ladder on the other side.
(Modified)

7.3.5.2 Maintenance platform shall be provided, unless specified otherwise, beneath each drive assembly to provide access for removal and replacement of all drive components. An unobstructed platform area extending at least 900 mm in any plan dimension on all sides of the driver and drive components shall be provided. However, such platforms shall not extend beyond the bay plan limits. Ladders shall be provided for access to induced fan for maintenance.
(Modified)

Fan and motor assemblies shall be designed for remote lubrication from maintenance platform without shutting down the equipment. Suitable SS tubing (1/4" diameter) shall be provided outside the fan and motor guards to permit lubrication of fan shaft bearing and motor shaft bearing without shutting down the fans and/or motors. These connections shall be accessible from maintenance platform and terminated at one point. Vendor to develop detailed drawing.

7.3.5.3 Platform for header access shall have minimum clear width of 900 mm.
(Addition)

7.3.5.4 Grating shall be provided. These shall be anti-skid type, removable with maximum length of 1.5 m.
(Addition)

7.3.5.9 Headroom clearance of 2200mm below motor suspension shall be maintained.
(New)

7.3.6 Lifting Devices

7.3.6.1 Positioning of lifting lugs shall be such that horizontal balance of bundles is obtained.
(Addition)

7.4 Roofing

(New) Roofing shall be provided if specified by Purchaser and covering shall be of asbestos sheet unless specified otherwise.

8. MATERIALS

8.1.1 All materials shall be new. Material of construction may be specified in the

(Addition) requisition or data sheets in the general terms. Materials shall conform to relevant ASME specifications, or equivalent thereof.

MDMT shall be taken as 0°C or the design temperature specified in drawing or datasheet whichever is lower, unless specified otherwise in design basis or datasheets or drawings. For low temperature service (0°C and colder), unless exempted by ASME Section VIII, Div. 1, Paragraph UG-20 (f) and Paragraph UCS-66, all Carbon & Low alloy Steel materials (for pressure parts and attachments to pressure parts) shall be impact tested at the MDMT or colder and meet requirements of ASME, Section VIII, Division 1, Paragraph UG-84.

8.1.2
(Modified) Cast iron including nodular ductile iron shall not be used for pressure components in any service.

8.1.3/5
(Modified) For painting and hot dip galvanizing refer clause 11.2

8.1.7
(New) Pressure part plates having thickness 16 mm to 50 mm (both inclusive) shall be UST as per ASTM A-435.

Pressure part plates having thickness above 50 mm and all plates to be used for tube sheet and plug sheet shall be UST as per ASTM A-578 Level B. No laminations or inclusions shall be permitted.

8.1.8
(New) **Tubes**

- i. All the tubes shall be seamless and cold drawn.
- ii. Product analysis of tubes shall be carried out and reported.
- iii. CS tubes shall be in annealed condition.
- iv. SS tubes shall be in solution-annealed condition.
- v. Actual yield strength and maximum hardness of tubes should be checked at the time of procurement and it should be ensured that these are lower than those of tube sheet, in order to achieve a sound expanded tube-to-tube sheet joint.
- vi. Tubes shall be eddy current tested in addition to hydro test at the mill. For eddy current testing entire metal column of the tube shall be used.
- vii. Hydro test pressure shall be higher of actual exchanger pressure or as required as per ASME Section II.

8.1.9
(New) All pipes shall be seamless and hot finished. dimensions and tolerances shall be in accordance with ASME 36.10 or 36.19 as applicable per material specification.

8.1.10
(New) **CS or LTCS MATERIALS (Pressure Parts or Non-pressure parts welded to pressure parts or parts wetted by the fluid in tube side)**

- a) Carbon content shall not exceed 0.23%.
- b) Plates shall be in normalised condition.
- c) Use of SA 515 is not permitted.
- d) CS plates above 50 mm thickness shall also meet the following additional requirements of SA-20:

- i) Vacuum treatment as per the supplementary requirement S1. If vacuum degassing is not reported in the test certificates, through thickness test as per SA 770 shall be conducted and minimum reduction in area of 35 % shall be ensured.
- ii) Charpy V-notch test as per supplementary requirement S5 of specification SA-20. Material meant to be used for design temperatures warmer than 0°C, impact test shall be carried out at 0°C or MDMT whichever is lower and acceptance criteria for energy absorption shall be as per Table A2.15 of SA-20. In case acceptance criteria is not available in SA-20, then applicable design code shall be referred unless otherwise specified in requisition. Orientation of test bar shall be transverse to rolling direction.
- e) Unless specified otherwise in requisition or bid document, all CS materials specified as HIC tested shall meet the requirements of specification: 6-79-0012 or 6-79-0013 (as applicable).
- f) CS pipes shall be SA-106 Gr. B for MDMT greater than – 29 °C, unless otherwise specified. For MDMT less than and equal to – 29 °C, CS pipes shall be SA 333 Gr. 1 or 6.

8.1.11
(New)

LAS MATERIALS (Pressure Parts or Non-pressure parts welded to pressure parts or parts wetted by the fluid in tube side)

- a) All LAS plates, pipes and forgings except C-½Mo materials shall be in normalised and tempered conditions.
- b) Accelerated cooling from an austenitizing temperature by liquid quenching followed by tempering (N + ACC. + T) is also acceptable for plates. Irrespective of thickness, LAS plates shall meet the requirements of API RP 934 (part as applicable).
- c) For 1¼Cr- ½Mo materials the maximum room temperature tensile strength of all pressure containing components, materials and welds shall be 100000 psi.
- d) For LAS tubes (SA 209 and 213) hardness test shall be performed on outside of the tubes as per ASTM A-450.
- e) For LAS plates above 50 mm thickness, following supplementary requirements of SA-20 shall also apply.
 - i) Vacuum treatment as per supplementary requirement S1. If vacuum degassing is not reported in the test certificates, through thickness test as per SA 770 shall be conducted and minimum reduction in area of 35 % shall be ensured.

- ii) Charpy V-notch impact test as per supplementary requirement S5 with:

Test temperature: Minus 18 °C or MDMT whichever is lower. For 5Cr-0.5Mo materials, test temperature shall be 0 °C.

Acceptance Criteria: As per Code

Orientation of test bar: Transverse to the direction of rolling.

8.1.12
(New)

SS MATERIALS (Pressure Parts or Non-pressure parts welded to pressure parts or parts wetted by the fluid in tube side)

- a) All SS material (300 series) shall be in the solution annealed and pickled condition. All stabilised grades of SS (i.e. SS 321, SS 347 etc.) shall be given stabilisation treatment in addition to solution annealing. For all stabilized grades of stainless-steel materials, soaking temperatures for stabilization heat treatment shall be 915°C ± 10°C and soaking period shall be minimum of 4 hours (2 hours for thickness ≤ 3.5mm).

- b) All SS (300 series) plates shall be hot finished with No. 1 finish on both sides. Cold rolled plates, if permitted by requisition, shall have No. 2B finish.
- c) SS (300 series) materials shall be procured with the IGC test as per ASTM-A 262 (test shall be carried out, after the specified heat treatment and sensitisation per specification) with acceptable corrosion rate and practices as under:
 - i) All services except nitric acid service - Practice E shall be followed. Specimen after exposure shall be bent as per mentioned in A 262 Practice E and shall be examined at a magnification of 200 X. The bent specimen shall be free of any cracks or grain droppings. The microscopic examination result shall be submitted to AI for approval
 - ii) Nitric acid service - Practice C corrosion rate <635 micro-m per annum.
- d) All Duplex and Super Stainless steel materials shall meet the requirements of 6-79-0015.

8.1.13 (New) All forgings except nozzle flanges less than 10"NB shall be 100% UST as per ASTM A-388. Acceptance standard shall be as per AM 3.3.4 of ASME Sec VIII Div. 2.

8.1.14 (New) All steel sections, plates and other miscellaneous structural steel materials shall be free from loose mill scales, rust as well as oil, mud, paint or other coatings.

The materials, construction specifications such as dimensions, shape, weight, tolerances, testing etc. for all structural materials shall conform to IS 2062 Grade A or equivalent, unless specified otherwise.

8.4 Louvers

8.4.2 (Addition) Louver bearings shall be guaranteed for life and shall never require lubrication.

8.4.3 (Modified) Louver blades shall be made of corrosion-resistant material like aluminium. Louver frame shall be made of aluminium or steel. Steel louver frames shall be hot dip galvanized.

8.5 Other Components

8.5.1 (Addition) Aluminium fin material shall not be less than 99.5% pure (SB 209 Alloy 1060). For offshore applications fin shall be to SB 209 Alloy 3003 Temper O.

8.5.2 (Modified) **Fan blade material**
Fan blades shall be of aluminium alloy. Aluminium alloys for fan blades shall be selected to be resistant to stress corrosion cracking. Fan hub and blade material shall be non-sparking type. Copper content in aluminium blade should not exceed 0.4%.

If specifically indicated by Purchaser, FRP blades may be used. FRP blades shall be used only for forced draft units. FRP blade fans shall meet all the requirements of EIL specification 6-15-0072.

8.5.6 (Modified) Solid metal gaskets for shoulder plugs shall be dead soft annealed. It is recommended that Soft Iron and Soft SS gaskets for plugs shall have hardness of minimum 15 BHN less than the material of plug and plug sheet. Hardness of Soft Iron gaskets shall not exceed 90 BHN and that of Soft SS gaskets shall not exceed 140 BHN. This shall be a hold point for AI.

8.5.7 (New) Fan shaft shall be to either SA 105 or EN 24 (hardened and tempered and UST). CS pipes may be used for shaft housing. Bearing housing shall be to SA 105.

8.5.8 Material for instrumentation valves and tubing shall be SS. All instrumentation shall

- (New) be suitable for the hazardous area classification for electrical safety.
- 8.6
(New) In case fire proofing of air cooler structure is required, structure columns and beams shall be provided with welded nuts as per EIL standard.
- 9. FABRICATION**
- 9.1.1.1
(Addition) All welding procedures shall be submitted to AI for approval. All welding shall be done with electrodes, fillers and fluxes of reputed make with proven reproducibility of results. Brand names shall be specifically approved by AI. Only low hydrogen electrodes shall be used for all CS pressure parts welds.
- 9.1.1.3
(Addition) Backing strips shall not be used.
- 9.1.1.5
(Addition) Hardness limitations for base metal, HAZ and welds shall be as per 6-15-0091.
- 9.1.1.6
(New) Repairs to base material and welds shall not be made without the approval of the Purchaser or AI.
- 9.1.1.7
(New) Requirements of 6-79-0016 shall be complied with for welding of Duplex and Super Duplex materials.
- 9.1.1.8
(New) Non-pressure attachments, such as lugs or structural steel supports, shall be attached to the pressure parts with a continuous weld. All double fillet welds in contact with hydrogen stream shall be vented. All LAS weld attachment to pressure retaining component shall be full penetration weld and ground to a smooth concave contour.
- 9.1.2 **Plug Headers**
- 9.1.2.1
(Modified) Partition plates and stiffening plates to plugsheet and tubesheet welding shall be full penetration welds.
- 9.1.3 **Removable Cover Plate and Removable Bonnet Headers**
- 9.1.3.3
(New) Stiffener plates 6 mm thickness shall be provided to stiffen the flanges of all flanged headers at a spacing of approximately 250 mm. These shall be spaced as not to interfere with the bolts and nozzles.
- 9.2 Post Weld Heat Treatment**
- 9.2.3
(Addition) For hydrogen, sour, amine and caustic service, minimum stress relieving temperature for Carbon Steel. For Alloy steel, the minimum stress relieving temperature shall be as per Code.
- 9.3 Tube-to-tube sheet Joints**
- 9.3.3 **Expanded tube-to-tube sheet joints**
- 9.3.3.0
(New) Expanded tube-to-tube sheet joints shall be in accordance with EIL specification no. 6-15-0004.
- 9.3.4 **Welded tube-to-tube sheet joints**
- 9.3.4.0
(New) Welded tube-to-tube sheet joints shall be in accordance with EIL specification no. 6-15-0003 for ferritic and austenitic materials. Seal welded joints are not acceptable.

9.6 Alignment and Tolerances

9.6.1 Gasket flange faces on stacked units shall not be out of parallel by more than 0.8 mm
(Addition) (1/32 inches).

9.6.5 The face of each gasket contact surface shall lie between two parallel planes 0.8 mm
(New) (1/32 inches) apart.

9.6.6 Tolerance on tube length after fining shall be $-0\text{mm}, +3.0\text{mm}$
(New) Tolerance on fin OD shall be $-0\text{mm}, +0.8\text{mm}$

9.8 Finishing

(New) All welds in the area 250 mm from the ends in the bottom of header (where the header is resting on frame channel) shall be ground flush. In a split header all welds in bottom plate of top header and top plate of bottom header shall be ground flush. Inside corners of openings for nozzles to be rounded off to 3 mm radius.

10. INSPECTION, EXAMINATION AND TESTING

10.0 All materials for pressure parts and non-pressure parts welded to pressure parts shall
(New) be accompanied by mill test certificates duly certified by reputed third party agency or by the representative of the Purchaser. In absence of mill test certificates the material shall be got tested and certified from a reputed third-party agency like EIL, Lloyds, BV, DNV, etc. and the test results shall be submitted in lieu of mill test certificates. All cost towards such testing and inspection shall be borne by Vendor. All material shall be inspected at Vendor's or sub vendor's shop for verification prior to use on the job. The decision of AI to accept or reject materials on the basis of such testing shall be final.

All structural material shall be accompanied by quality certificates. In case the certificates are not available, or are incomplete or when the material quality differs from standard specification, such materials shall not be used. However, Vendor shall get all appropriate tests conducted in approved test houses for such materials as directed by AI without claim to extra cost and submit the same to the Inspector for his approval. AI may approve the use of such materials entirely at his discretion.

All flame proof electrical equipment manufactured in the country shall have CCE approval certificates along with a valid BIS license. Electrical equipment with area classification as Type 'e' or Type 'n' shall have CCE approval. All imported electrical equipment shall have a similar certificate from the country of origin.

10.1 Quality Control

10.1.2 Radiography

(Modified) Minimum radiography shall be spot. Radiography shall be 100% if the thickness of weld exceeds 30mm for CS and for all thickness of LAS plates. For hydrogen, lethal, sour, amine and caustic service 100% radiography shall be done irrespective of thickness.

- Radiography can be substituted by 100 % UST provided either a print out is submitted or AI witnesses the examination. If radiography is being substituted by UST, magnetic particle examination shall be carried out in addition to UST.

However, when supplemental requirements as per Para 12 are applicable or if required by Code, substitution is not permitted and 100% radiography only shall be done.

Wherever radiography is indicated as full all long and circumferential seams including flange to neck, pipe to pipe and pipe to fitting shall be 100% radiographed.

- 10.1.4
(Modified) When spot radiography is indicated, it shall mean 10% of weld length (minimum one shot) for each weld configuration to be radiographed with a minimum of six radiographs of at least 250 mm length each in one header box as detailed below:
- One shot each of the four long seams between top/bottom plate and tube sheet/plug sheet.
 - One shot for any one of the welds of side plate to top and bottom plates.
 - One shot for any one of the welds of side plate to tube sheets and plug sheet.
- 10.1.6
(Addition) When set-on connections are used, the header plates shall be UST in the area of attachment for a radial distance equal to twice the thickness of plate and no laminations shall be permitted.
- 10.1.7(d)
(Modified) Weld hardness shall be as per Table 12. However, additional hardness limitations for materials, welds and HAZ wherever specified on drawings or datasheets or specifications and for LAS materials shall be as per 6-15-0091. Hardness for Duplex and Super duplex materials, welds and HAZ shall be as per 6-79-0015 and 6-79-0016. Hardness limitation for tube-to-tube sheet welding shall be established on a mock up.
- 10.1.8/9
(Modified) Tubes shall be manufactured full length without any circumferential welds.
- 10.1.15
(New) All nozzle attachment welds and pass partition plate to header plate attachment welds shall be examined by MP or LP test for crack detection. Examination shall apply to root pass after back chipping or flame gauging (where applicable) and to the complete weld.
- 10.1.16
(New) When impact tests are required on material as per Code or specification the welds shall also be qualified for impact test. In such case following special requirements shall apply to the welding procedure qualification:
- Qualification tests shall be made on plates of the ASME specification as specified for the ACHE using welding electrodes of AWS/SFA specification and wire & flux of the specification and brand as are to be used on the job.
 - Welding current and travel speed shall be considered essential variables in order to ensure that production welding is substantially equivalent to the procedure qualification.
 - Welded test plates shall be subjected to a total thermal history expected of the finished ACHE. Additionally, one extra stress relieving cycle shall be considered for site repair.
 - Charpy V-notch impact tests shall be made on the weld and heat affected zone of the test plate for each welding procedure to be qualified. Test procedure shall be in accordance with UG 84 of Code. Test temperature shall be MDMT. Impact energy requirements shall be as per Table 2.15 of SA 20 of ASME Sec. II Part A or UG 84 of Code whichever is stringent.
- 10.1.17
(New) MP or DP test of finished welds shall apply also to all header materials greater than 38 mm thickness.
- 10.1.18
(New) It shall be ensured that all LAS and SS materials are finally check tested by a PMI analyser before despatch of the equipment. All LAS weld joints shall be UT examined from accessible side after PWHT.
- 10.1.19
(New) In addition to stamping the specification and manufacturers' symbol as specified in ASME, on one of the ends the size of the studs shall be clearly punch marked. Similarly, the nuts shall have the size punch marked on one of the faces. In case of tapped hole, the size shall be punch marked near the hole without disturbing the gasket seating area. Further, for all alloy and SS bolts & nuts shall also be identified by distinct colour marking at the stud end and bolt side face.

10.2 Pressure Test

10.2.3 Potable water with chlorides less than 25 ppm by weight shall be used in hydrostatic testing of units with SS or monel materials exposed to the test medium.
(Modified)

10.3 Shop Run-In Tests

(Modified) Vibration test, noise level test, etc. those are necessary to ensure smooth running of ACHEs shall be conducted by Vendor at shop or site. If the site erection is not in Vendor's scope, Vendor shall provide site supervision and supply all necessary material and instrumentation.

11. PREPARATION FOR SHIPMENT

11.1 General

11.1.1 All units shall be dry, thoroughly cleaned and free from loose scale and other foreign matters before shipment.
(Modified)

11.1.2 Tube bundles shall be completely dried by passing hot air for sufficient time until no increase in relative humidity of outgoing air is observed. Alternatively, vacuum drying is also acceptable. After drying all CS and LAS bundles shall be purged with dry nitrogen at 0.25 kg/cm². The bundle shall be provided with pressure gage to monitor nitrogen pressure and 1/2" non-return valve.
(Addition)

11.1.3 All connections not provided with blind shall be provided with gasketed steel covers fastened by four bolts or 50% of the required flange bolting whichever is greater.
(Modified)

11.1.6 Fin tubes shall be protected with heavy-duty wire mesh duly stiffened to prevent damage by personnel walking on top during shipping, handling, erection etc. The protective cover including the heavy-duty wire mesh shall be hot dip galvanised.
(New)

11.1.7 During transport and storage, a maximum of two bundles may be stacked provided sufficient precaution is taken to prevent damage.
(New)

11.1.8 Complete Packing list with Box numbers, Part nos., Part Name, weight of Boxes shall be furnished along with consignment/documentation to site/ warehouse in sufficient copies. Storage Instructions shall be furnished along with consignment and necessary cautions to be mentioned on the parts and components while packing.
(New)

11.2 Surfaces and finishes

11.2.3 The primer shall be inorganic zinc silicate (65-75 microns dry film thickness) for design temperatures up to 400°C and Heat Resistant Silicone Aluminium Paint (20 microns dry film thickness) for design temperatures above 400°C, unless stated otherwise. The header shall also be given final coat of paint as specified by Purchaser. The air side face of tube sheet shall be painted after stress relieving (in case of CS or LAS) and before drilling of tube holes. The paint shall be suitable for corrosive industrial and coastal environment as applicable.
(Addition)

11.2.5 All structural steel not galvanised shall be prepared to near white sandblast finish to ISO 8501-1, grade Sa 2^{1/2} and then given an inorganic zinc silicate primer coat of 0.075mm DFT.
(New)

11.2.6 All structural parts of tube bundle frame, plenum chamber, motor suspension assembly, shaft housing, gratings for stairs and platform, all guards etc. shall be hot dip galvanised. Bolting shall be electro galvanised.
(New)

12. SUPPLEMENTAL REQUIREMENTS

12.1 General

(Modified)

The supplemental requirements shall apply if the design pressure exceeds $70 \text{ kg/cm}^2(\text{g})$ or when the plate thickness of a box type header exceeds 50 mm or when the exchanger is in lethal or critical service. Whether the service is lethal or critical shall be defined by Purchaser.

12.2 Design

12.2.1

(Addition)

Top/bottom plate to tubesheet/plugsheet joints shall be butt welds with tube sheet/plug sheet having a hub meeting the requirements of Fig UW 13.3 (a) or (b) of Code.

12.2.2

(Modified)

All tubes shall be strength welded to tube sheet. Seal welding is not permitted.

12.3 Examination

12.3.15

(New)

PTCs are required for all butt welds if the weld thickness exceeds 50mm for CS and 25mm for LAS, or when required by the specifications or Code. The following shall apply: -

- a) Two PTCs representative of the weld between top/bottom plate and tube sheet/ plug sheet shall be provided for each procedure, position and thickness. One of the test plates shall be provided for the closing joint of the plug type header.
- b) PTC shall be from material of the same heat and thickness as of parent metal. During and after welding PTC shall be subjected to same heat treatment as and together with the course they represent, extra PTC shall be preserved to take care of eventuality of retests.
- c) Following tests shall be carried out as per methods of testing given in Code:
 - i) One transverse tension test. (Ultimate Tensile Strength, Yield Strength and percentage elongation shall not be less than those specified for base material)
 - ii) Two side bend tests with weld located in the center of bend.
 - iii) One hardness test on PTC weld and HAZ
 - iv) Micro and macro examination of welds.
 - v) For CS material charpy V notch tests on weld and HAZ shall be carried out as follows:
 - a. For low temperature service ($\text{MDMT} < 0 \text{ }^\circ\text{C}$) the test temperature shall be MDMT.
 - b. For service with $\text{MDMT} > \text{ or equal to } 0 \text{ }^\circ\text{C}$, the test temperature shall be $0 \text{ }^\circ\text{C}$.
 - c. The acceptance criteria for energy absorption shall be as per table A 2.15 of SA 20 of ASME Sec. II part A or UG-84 of Code whichever is more stringent.
 - vi) For LAS material charpy V notch tests on weld and HAZ shall be carried out. Test temperature and acceptance criteria shall be as indicated in Para 8.1.11 (d)(ii) above.

13. SPARES

(New)

Mandatory and 2 years maintenance spares including spares for electrical and instrumentation parts shall be as indicated in the *enquiry documents*. Vendor shall include the mandatory spares in his item rate and indicate unit rate for 2 years maintenance spares, unless specified otherwise.

एयर कूलड हीट एक्सचेंजर्स में प्रचलित
फ़ैबर रिइन्फोर्स्ड प्लास्टिक पंखों
के लिए मानक विनिर्देश

STANDARD SPECIFICATION FOR FIBRE
REINFORCED PLASTIC FANS USED IN AIR
COOLED HEAT EXCHANGERS

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Approved by						

Abbreviations:

API	:	American Petroleum Institute
ASTM	:	American Society for Testing and Materials
BS	:	British Standard
IS	:	Indian Standard
ISO	:	International Organization for Standardisation

Static Equipment Standards Committee

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CONTENTS

1.0	SCOPE.....	4
2.0	CODES.....	4
3.0	DESIGN.....	4
4.0	MATERIALS.....	5
5.0	MANUFACTURING.....	5
6.0	QUALITY ASSURANCE SYSTEM.....	6
7.0	TESTING.....	6
8.0	INSPECTION.....	7
9.0	DATA INTERFACING	8
10.0	SPARES.....	9

1.0 SCOPE

This Specification covers the minimum requirements of fibre reinforced plastic fans to be used for forced draft air-cooled heat exchangers supplied as per API 661.

This Specification shall not be considered as limiting and it shall be Vendor's responsibility to comply with all requirements of Requisition or Bid documents to which it is annexed.

In case Licensor's specification is also attached with Requisition or Bid documents, it shall normally govern. However, in the event of conflict between this Specification and Licensor's specification, normally stringent of the two shall govern. It shall be the duty of the Vendor to resolve this conflict prior to taking up the manufacture.

2.0 CODES

- 2.1 API Standard 661, Seventh Edition, July 2013, Reaffirmed, June 2018 Petroleum, Petrochemical, and Natural Gas Industries —Air-cooled Heat Exchangers.

3.0 DESIGN

- 3.1 The fans shall be high efficiency fans based on the Best Available Technology (BAT).
- 3.2 Design and selection shall be done using established computerised design and selection tools. The same shall be based on data determined using wind tunnel testing or actual test rigs.
- 3.3 Design output shall indicate the allowable deflection of the blade established on model testing. These shall be given at each point to be loaded as per the LOAD SIMULATION TEST (Refer para 7.2.3 below).
- 3.4 The natural frequency of the fan and fan components shall meet requirements of API 661 para 7.2.3.14. Vendor shall guarantee that there shall be no vibration in the fan components.
- 3.5 The calculated stress of blades and hub shall be less than the fatigue stress determined as per para 7.1.1 below.
- 3.6 **The fan tip speed** shall not exceed 60 meters per second. Noise limitations (refer para 3.7 below) may require lower speeds.
- 3.7 **Noise level** - The fans shall be designed for 80 dB (A) maximum sound pressure level at 1 m below the fan, also keeping in mind the overall limits specified for the air cooler. The design and fan selection software should be able to calculate sound pressure level in dB (A) at any distance from the fan and also be capable of calculating sound level with many fans of same supplier under simultaneous operation in the vicinity. Fan tip speed shall be suitably selected. Fan manufacturer shall furnish noise level datasheet for fans.

Permissible noise level of the ACHE measured shall not exceed 85 dB (A) with all fans running at full load with measurement taken at 1 m from bundle on the header access walkways and 1 m from the bay limits on the motor maintenance platform. The permissible noise levels 1 m below the motor shall be 90 dB (A) maximum. Vendor shall demonstrate these noise level limits during run-in tests. Vendor shall guarantee these sound levels

- 3.8 The fan assembly shall be designed to prevent reverse flow at the hub.
- 3.9 Flanged bushing of minimum 9 mm thickness shall be provided for attachment to fan shaft.
- 3.10 The fan selection at design conditions shall meet requirements of API 661 para 7.2.1.7.

3.11 Auto variable pitch fans shall comply with the following:

- a) Pneumatic actuator shall be equipped with a positioner. Each actuator shall have an integral positioner mechanism and mechanical maximum and minimum stops, adjustable over the full range. Exposed actuator shafts shall be chrome protected. Each actuator shall be provided with flexible hose (s), terminating in a 1/4" NPT screwed female connection. The actuators shall be suitable for an air supply pressure of 9.5 kg/cm²(g) design, 7 kg/cm²(g) normal and 2.5 kg/cm²(g) minimum. Purchaser will specify the exact air supply pressure. Any pressure reduction system on the supply air, if required, shall be in Vendor's scope.
- b) In case of loss of supply air pressure or control signal, the blades shall lock at maximum airflow position unless specified otherwise. In the event that the fan fails to respond in this manner, means shall be included by the Vendor to physically lock the blades in high pitch position. Auto variable pitch fans to be shop adjusted for variation between zero performance and design pitch required. Positioner to be supplied and set for full signal pressure range. Signal pressure for auto variable fan shall be 0.2 to 1.0 kg/cm² (g) for design flow to zero flow unless specified otherwise. Motor rating (in kW) to be selected based on the airflow at design pitch. Provide one I/P converter per item, unless specified otherwise. One volume booster shall be provided for each auto-variable fan.

I/P converter shall be of electronic feedback type unless specified otherwise and shall be yoke mounted. It shall have an integral terminal housing. VP converter with flying leads shall not be acceptable. Unless otherwise mentioned, it shall be intrinsically safe. Pneumatic connections shall be 1/4" NPT (F). The electrical connections shall be 1/2" NPT (F). If they are different, suitable adapters shall be provided. The overall accuracy of the I/P converter shall be better than $\pm 0.3\%$.

- c) Hub and fan assemblies employing lubricated joints shall be designed to minimise lubrication maintenance through use of bearings not requiring periodic re-lubrication.

4.0 MATERIALS

- 4.1 All materials shall be new. Recycled or reprocessed materials shall not be used.
- 4.2 The glass fibre fabric shall meet the requirements of IS 11273, IS 11320, IS 11551, BS EN14118, BS 3749 or other equivalent codes.
- 4.3 The selected resin shall be based on proven track record and meet the performance and properties requirements for the service intended.
- 4.4 The material of hub parts shall be Aluminum, Stainless Steel or Carbon Steel. Carbon Steel materials shall be hot dip galvanized / electro zinc plated as per ASTM A123, A143, A153, A384, A385 or zinc plated as per ASTM B633 requirement for type LS coating.

5.0 MANUFACTURING

- 5.1 The blades shall be made by either a 'fully mechanized process' or 'semi mechanized process with minimal manual intervention' in order to ensure a quality product. Hand lay-up or spray up moulding processes are not acceptable.
- 5.2 The leading edge of the blades shall be provided with additional protection to prevent leading edge erosion, if required.

5.3 Anti static coating - The blades shall be either intrinsically UV protected or provided with an established, well proven antistatic coating of conductive paint of thickness 25 microns (minimum) so as to make the blade conductive and meet the requirements of para 7.2.1 (h) below.

6.0 QUALITY ASSURANCE SYSTEM

6.1 Fan manufacturer shall have a written down quality system and this shall also specify the sampling frequency and the acceptable limits for the following:

- a) Ends and picks per unit length of the glass fibre fabric.
- b) Resin content.
- c) Resin viscosity and density
- d) Mixing ratio of resin components.
- e) Glass content in laminate.
- f) Lay-up pattern of fiberglass weaves.
- g) Hardness check on blades to ensure proper curing.

7.0 TESTING

The tests and inspections outlined in this Specification are minimum and shall be carried out for quality assurance and for job records. However, the specified tests shall not prohibit the Vendor from making additional tests or inspections to establish or improve quality. Results of the additional tests or inspections shall be reported for records.

7.1 Model Testing

7.1.1 Fatigue stress limits shall be established by any of the following:

- a) Fatigue testing shall be done on sample blades by applying a sinusoidal load superimposed on a static load. The stress levels at the most critical sections of the blade and hub are to be monitored. The stress vs cycle plot shall be generated by testing several blades at different load levels and fatigue limit shall be determined.
- b) Sample blades shall be tested to destruction under static load and the breaking stress calculated. A minimum safety factor of 10 shall be applied to this stress to arrive at the fatigue limit.

7.1.2 Natural frequency of blades shall be experimentally determined for the entire range of blades using an accelerometer and a vibration analyzer. The computer program output for natural frequency shall be authenticated based on these data.

7.1.3 As a minimum, scaled model testing shall be done in wind tunnel to generate non-dimensional characteristics of the fan performance curves. Derating shall be done to account for the influence of tip clearance, aerodynamic disturbances, inlet shape etc. The curves generated by computer software shall be updated based on these experimental curves and derating factors. Sound level measurements shall also be conducted during model testing and the software for sound level calculation shall be updated based on these results.

7.2 Production Testing

7.2.1 Test coupons of the laminates shall be prepared by the same process as used for the production. Testing shall be done for each lot of laminate to establish the following requirement:

- a) **Tensile strength** shall be determined as per IS 1998 or ASTM D638 or equivalent. Minimum acceptable value is 2000 kg/cm².
- b) **Flexural strength** shall be determined as per ASTM D790 or equivalent. Minimum acceptable value is 2000 kg/cm².
- c) **Inter laminate shear strength** shall be determined as per ASTM D952 or equivalent. Minimum acceptable value is 100 kg/cm².
- d) **Modulus of elasticity** shall be determined as per ASTM D638 or equivalent. Minimum acceptable value is 98,000 kg/cm².
- e) **Elongation** as per ASTM D638 or equivalent. Minimum acceptable value is 4%.
- f) **Water absorption** shall be tested as per ASTM D570 or equivalent. Maximum acceptable value shall be 2%.
- g) **Minimum heat distortion temperature** shall be 60°C for forced draft fans.
- h) **Surface resistivity** shall be determined in accordance with IS 3396 or equivalent. Two specimens shall be used and the surface resistivity of both specimens shall be reported. Both specimens shall have surface resistivity less than 1×10^8 ohms; otherwise the material shall be rejected.

7.2.2 Light impact test shall be done on each blade using a load of minimum 15 grams to check for homogeneity of the composite structure. No variation in the sound shall be noticed while tapping the complete blade surface.

7.2.3 **Load Simulation Test:** Three times the maximum anticipated loads (i.e. centrifugal forces, aerodynamic loads, self weight etc.) shall be simulated on each blade by loading the blade at discrete locations along the full length. The blade shall be observed for crack, fracture and permanent deformation. Deflection at the load points and tip shall be measured and shall be within acceptable limits as defined in the quality assurance system.

7.2.4 Fan blades and assembly shall be balanced as per requirements of API 661 para 7.2.3.7 and 7.2.3.8. Balancing shall be according to ISO 21940 with balance quality grade G 6.3 or better.

8.0 INSPECTION

8.1 The authorised inspector shall review the following:

- a) Test reports on raw materials like fibre, resin.
- b) Test certificates of all metallic parts including hub parts.
- c) Quality Assurance manual. The inspector shall also verify whether the internal inspection has been carried out as laid out in the Quality Assurance manual.

8.2 Fan supplier shall furnish Certificate of Compliance (COC) for the following

- a) Tests for mechanical properties as per para 7.2.1 (a) to (h) above.
- b) Load simulation test on each blade as per para 7.2.3 above.

8.3 Fan supplier shall perform balancing of blade & hub as per API 661 at his shop. The same may be witnessed by Authorized Inspector. Further, complete balancing of blade & hub shall be performed by Air Cooler vendor at shop / site and the same shall be witnessed by Authorized Inspector.

8.4 Authorized inspector shall witness final visual & dimensional check of the fan.

9.0 DATA INTERFACING

9.1 Air cooler vendor shall furnish the following to the fan manufacturer:

- a) Fan diameter, airflow required at design ambient temperature, static pressure, minimum motor rating (kW), limitation of fan speed.
- b) Site conditions giving fan elevation above sea level, design ambient temperature, minimum ambient temperature.
- c) Limitation of size of the inlet cone and fan ring, inlet obstruction details, type of plenum (box or conical).
- d) Limitation of sound level from fan and the arrangement of fans in the bay.
- e) Minimum shaft size in the bushing.
- f) Type of fans required (Manually adjustable or Auto variable pitch).
- g) For auto variable pitch fans, the control air supply pressure (design, normal and minimum).

9.2 Fan manufacturer shall furnish the following:

- a) The characteristic fan performance curves along with shaft power at design ambient and minimum ambient temperatures.
- b) Confirmation of fan diameter for airflow, static pressure, motor rating etc.
- c) Fan noise datasheet as per API 661. For many fans located in one bank of air coolers, the noise level shall consider all fans in operation.
- d) Fan assembly drawing indicating all materials of construction, bush details, etc.
- e) The inlet cone details and inlet obstruction details considered for design of the fan.
- f) For auto variable pitch fans, detailed drawing along with all the features and materials of construction.
- g) Instructions for installation, operation and maintenance.
- h) The results of production tests done as per para 7.2.1 and 7.2.3 above.

10.0 SPARES

10.1 Fan manufacturer shall supply the following spares unless specified otherwise:

- a) One blade per type and size.
- b) One set of clamping bolts per fan.
- c) For auto variable pitch fans, spares recommended for the auto variable pitch arrangement.
- d) Spares for two years operation and maintenance

स्टैटिक ईक्विपमेन्ट (प्रेशर वैसल्स हीट
एक्सचेन्जर्स) के
आवश्यक कठोरता के लिए
मानक विनिर्देश

**STANDARD SPECIFICATION
FOR
HARDNESS REQUIREMENT
OF
STATIC EQUIPMENTS
(PRESSURE VESSELS, HEAT EXCHANGER)**

4	27.12.19	REAFFIRMED & REISSUED AS STD SPEC	PKP	NSK	KJH	RKT
3	05 11 14	REVISED & REISSUED AS STD. SPEC.	TK	KA	RKT	SC
2	29 06 09	REAFFIRMED & REISSUED AS STD SPEC.	VB	RKG	AKM	N DUARI
1	26 03.04	REAFFIRMED AND REISSUED AS STANDARD SPECIFICATION	NSK	PK	SSA	SKG
0	15 03 96	ISSUED AS STANDARD SPECIFICATION	RV	SSA	RKA	AS
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
Approved by						

Abbreviations:

ASTM	:	American Society for Testing & Materials
BHN	:	Brinell Hardness Number
HAZ	:	Heat Affected Zone
PWHT	:	Post Weld Heat Treatment

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CONTENTS

1.0	SCOPE	4
2.0	HARDNESS REQUIREMENTS	4
3.0	WELDING QUALIFICATION TEST	4
4.0	PRODUCTION TEST	4
5.0	APPROVAL	5

1.0 SCOPE

This specification covers general requirement of hardness of base metal, weld and heat-affected-zone (HAZ) and is applicable to all C-½ Mo, Cr-Mo steels and other materials whenever asked for in drawings/ specifications/standards. All testing shall be done after PWHT.

2.0 HARDNESS REQUIREMENTS

Hardness in base metals, weld and heat affected zone as per ASTM E10 shall not exceed the following:

For P1 materials	- 200 BHN
For P3 & P4 materials	- 225 BHN
For P5 & P6 materials	- 235 BHN

3.0 WELDING QUALIFICATION TEST

3.1. For each welding procedure qualification six tests shall be made, three in weld metal and three in HAZ. Hardness requirements shall be as per cl. 2.0 above.

3.2. In addition to the requirement of 3.1 above, Vickers Micro hardness test shall be made on a full cross-section at 25 mm intervals beginning at 3 mm from the top surface with 5 kg load or with a load approved by the authorized inspector. Tests shall be made at each level for each of the following locations as per ASTM E 92:

Three tests shall be made in the weld metals, two tests in HAZ and one test in the base metal in accordance with Fig.1 and the hardness shall not exceed the following in base metal, weld metal and HAZ.

For P1 materials	- 210 VHN
For P3 & P4 materials	- 237 VHN
For P5 & P6 materials	- 247 VHN

4.0 PRODUCTION TEST

4.1 All pressure containing weld metals are to be checked for hardness of weld and HAZ after PWHT but before hydro-test. The hardness shall not exceed the value stipulated.

4.2 Each longitudinal seam shall be checked both internally and externally near the center and at one end.

4.3 Each circumferential weld shall be checked at four locations approximately 90° apart, both internally and externally.

4.4 Each nozzle weldments shall be checked at two locations, 180° apart, both internally and externally.

5.0 APPROVAL

In case the hardness as obtained on production test is more than the limit specified in 2.0 above, the vendor shall submit the corrective procedure to lower the hardness in writing to EIL and/or authorized inspection agency for review/approval.

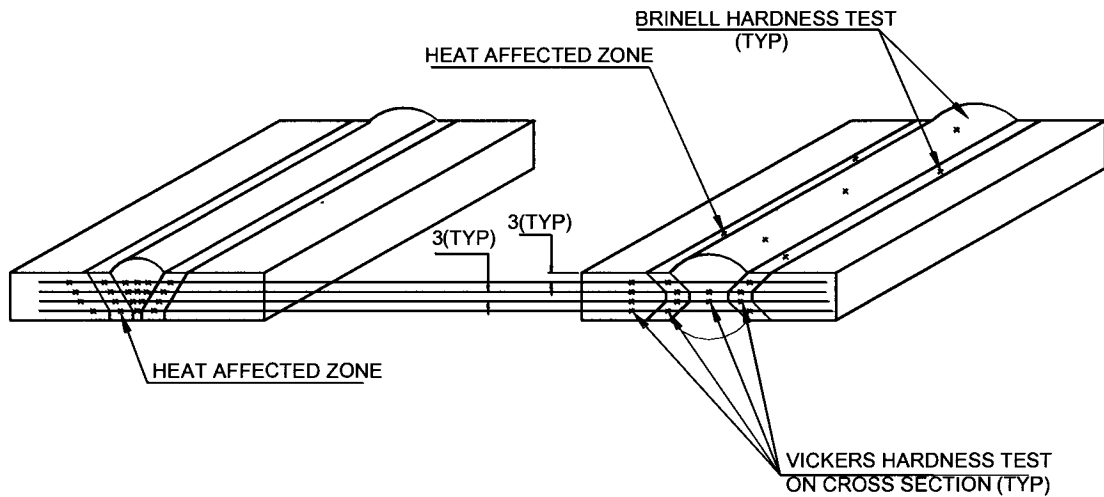


FIG.1- HARDNESS REQUIREMENT ON TEST COUPONS

अग्निरोधक नियंत्रण स्टेशन
के लिए
विनिर्देश

SPECIFICATION
FOR
FLAMEPROOF CONTROL STATIONS

6	29.9.20	REVISED AND ISSUED AS STANDARD SPECIFICATION	NNB/ RKS	ANPS	SA	SM
5	24.02.16	REVISED AND ISSUED AS STANDARD SPECIFICATION	NNB/AK	ANPS	BRB	SC
4	11.04.11	REVISED AND ISSUED AS STANDARD SPECIFICATION	PS	ANPS	UAP	DM
3	24.08.07	REVISED AND ISSUED AS STANDARD SPECIFICATION	ANPS	UAP	JMS	VC
2	30.01.02	REVISED AND ISSUED AS STANDARD SPECIFICATION	UAP	AAN	VPS	GRR
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
Approved by						

Abbreviations:

AC	Alternating Current
BIS	Bureau of Indian Standards
CEA	Central Electricity Authority
CT	Current Transformer
DC	Direct Current
FRLS	Flame Retardant Low Smoke
FRP	Fibre Reinforced Plastic
GI	Galvanised Iron
IEC	International Electro-technical Commission
IP	Ingress Protection
IS	Indian Standards
LED	Light Emitting Diodes
LV	Low Voltage
MR	Material Requisition
NABL	National Accreditation Board for Testing and Calibration Laboratories
PB	Push Button
PESO	Petroleum and Explosives Safety Organisation
PVC	Poly Vinyl Chloride
SMD	Surface Mounted Device
SWG	Standard Wire Gauge
XLPE	Cross Linked Poly Ethylene

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Mr. Rajesh Sinha (Inspection)

CONTENTS

1.0	SCOPE.....	4
2.0	CODES AND STANDARDS.....	4
3.0	GENERAL REQUIREMENTS.....	4
4.0	SITE CONDITIONS.....	4
5.0	CERTIFICATION	4
6.0	TECHNICAL REQUIREMENTS.....	5
7.0	INSPECTION, TESTING AND ACCEPTANCE.....	6
8.0	PACKING AND DESPATCH	7

1.0 SCOPE

This specification covers the requirements of design, manufacture, testing, packing and supply of flameproof control stations and accessories suitable for installation in locations handling flammable liquids and gases/ vapors.

2.0 CODES AND STANDARDS

2.1 The equipment shall comply with the requirements of latest revision of the following standards issued by BIS:

IS-5	: Colours for ready mixed paints and enamels.
IS-1248	: Direct acting indicating analogue measuring instruments and their accessories.
IS / IEC 60079-0	: Electrical apparatus for explosive gas atmospheres (General Requirements).
IS / IEC 60079-1	: Electrical apparatus for explosive gas atmospheres (Equipment Protection by Flameproof Enclosures "d").
IS / IEC 60529	: Degree of protection provided by enclosures (IP Code).
IS / IEC 60947	: LV switchgear and control gear.

2.2 In case of imported equipment, only IECEx (or equivalent, if more stringent than the applicable IEC) certified equipment shall be used.

2.3 The equipment shall also conform to the provisions of CEA Regulations with latest amendments and other statutory regulations currently in force in the country.

2.4 In case Indian standards are not available for any equipment, standards issued by IEC or equivalent agency (if more stringent than IEC) shall be applicable.

2.5 In case of any conflict between requirements specified in various applicable documents for the project, the most stringent requirement shall govern. However, Owner/ EIL's decision in this regard will be final and binding.

3.0 GENERAL REQUIREMENTS

3.1 The offered equipment shall be brand new with state of art technology and having proven field track record. No prototype equipment shall be offered.

3.2 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment for at least 10 years from the date of supply.

4.0 SITE CONDITIONS

The equipment shall be suitable for installation and satisfactory operation in classified hazardous locations in tropical, humid and corrosive atmosphere as prevalent in refineries, petrochemical and fertilizer plants. Unless otherwise specified, a design ambient temperature of 40° C and an altitude not exceeding 1000 m above mean sea level shall be considered.

5.0 CERTIFICATION

The equipment shall have test certificates issued by NABL-approved/ Central Government labs in India/ IECEx-approved/ equivalent labs). All equipment (indigenous & imported) shall also have valid statutory approvals as applicable for the specified location and marking as per IS/ IEC 60079 or IEC 60079 and as required by statutory authorities. All indigenous flameproof equipment shall have valid BIS license.

6.0 TECHNICAL REQUIREMENTS

6.1 Construction

- 6.1.1 The enclosures of the control stations shall be made of cast light metal alloy, unless otherwise specified. The enclosures of the control stations intended for use in units handling sulphuric acid/ other corrosive materials shall be made of stainless steel grade SS-316L, if specified in MR/ tender.
- 6.1.2 The control stations shall be suitable for use in outdoor open locations and shall have minimum IP-55 degree of protection. They shall preferably be provided with integral canopy. However, where the enclosure has been certified without integral canopy, a separate canopy can be accepted. The separate canopy shall be made of at least 1.6 mm (16 gauge) galvanised sheet steel/ FRP/ stainless steel minimum SS-304 (as specified in purchase specifications). The canopy shall be suitable for providing protection against rain from top, back and two sides.
- 6.1.3 The control station enclosure shall be provided with gaskets for IP, if required by equipment certification. Gaskets, wherever provided, shall be made of non-inflammable and self-extinguishing material.
- 6.1.4 All metal surfaces shall undergo manufacturer's standard cleaning/ painting/ powder coating cycle. After surface preparation, the equipment shall be painted with two coats of epoxy based final paint or epoxy powder coated with minimum coating thickness of 80 microns, with colour shade as below:
- Flame proof (Gas group IIA/ IIB) : Dark admiralty grey shade 632 of IS-5/
RAL 7031
 - Flame proof (Gas group IIC) : Light yellow shade 355 of IS-5/ RAL 1012
- All unpainted parts shall be suitably treated to prevent rust formation/ corrosion. If these parts are moving then these shall be greased. Grease, which does not solidify, shall be applied to flamepath. However, in case of Stainless Steel control stations, finish shall be Electropolish/ Buffed/ equivalent finish.
- 6.1.5 Equipment shall be marked as per IS/IEC 60079.
- 6.1.6 All accessories like nuts, bolts, washers etc. and operating shaft of push buttons, switches etc. shall be made of stainless steel SS-304. Alternatively, Nickel-plated brass material may be used for the operating shafts of push buttons, switches etc.
- 6.1.7 The control stations shall be provided with two earthing studs (minimum M10 bolt, nut with spring and plain washer) with lugs on the external surface of the enclosures suitable for termination of 8 SWG GI wire. No screw type fixing arrangement shall be allowed.
- 6.1.8 The control station shall be provided with two cable entries at bottom, and one entry to be blocked with flameproof nickel plated brass sealing plug, unless otherwise specified. Required number of flameproof double compression nickel plated brass cable glands shall be provided. The cable termination chamber of the control station shall be large enough to provide a minimum space of 100mm between top of the cable gland and bottom of the terminal block.
- 6.1.9 The control stations shall have external fixing lugs for mounting on wall or column. The holes provided on these lugs shall be of oblong type.
- 6.1.10 A tag plate indicating Tag Number shall be provided on each control station. A nameplate shall be provided to indicate the Name of Manufacturer, test certificate number, serial number, BIS license number, applicable gas group etc. as per IS/IEC 60079 and any additional marking required by statutory authority like approval no. etc. The nameplates shall be engraved type or laser-marked and permanently fixed on the equipment. In case the standard details given above are embossed on the enclosures, the same need not be repeated on the name plate. All

tag plates shall be engraved, 3 ply laminate fixed with screws and name plate shall be Al anodized or SS-304 engraved or laser-marked and fixed with rivets.

- 6.1.11 All flameproof control stations shall be suitable for 240V AC as well as 110V/ 220V DC control supply.

6.2 Component Specification

- 6.2.1 Push buttons for START/ OPEN and STOP/ CLOSE shall be of GREEN and RED colour respectively. The STOP push button shall be mushroom type with stay put feature and lockable in pressed position. Refer Sketch 1 for wiring and other details for various types of local control stations.
- 6.2.2 All selector switches shall have minimum two poles for each position. Each position of switch shall be indelibly marked on the control station. Exact configuration of selector switch (e.g. LOCAL-OFF-REMOTE) shall be as per datasheet/ MR requirement.
- 6.2.3 All ammeters shall be of moving iron type having an accuracy class of 1.5 and suitable for 1 Ampere CT secondary. Minimum size of ammeter shall be either 72mm x 72 mm or 65 mm diameter. 80% of the scale length shall cover 100% of the CT primary current uniformly and the balance 20% of the scale shall cover 100-800% of the CT primary. A red mark corresponding to the full load current of the motor shall be provided on the ammeter dial. The ammeter front glass shall be toughened.
- 6.2.4 Indicating lamp(s) wherever provided shall be clustered LED type or SMD chip type LED with colour lens of minimum 25mm diameter.

6.3 Terminals & Wiring

- 6.3.1 The control stations shall be provided with sufficient number of terminals. More than 2 wires per terminal shall not be permitted. If required, additional terminal with shorting link may be used. Each terminal for external cable connection shall be suitable for termination of 2.5 mm² (unless otherwise specified) stranded copper conductor. Tinned copper lugs shall be provided for cable termination wherever applicable.
- 6.3.2 All internal wiring shall employ 1.5 mm², 660V/ 1100V grade, FRLS type, XLPE/ PVC insulated copper conductor wires. All termination shall be with suitable lugs.

7.0 INSPECTION, TESTING AND ACCEPTANCE

- 7.1 During fabrication, the equipment shall be subjected to inspection by EIL/ Owner or by an agency authorized by the Owner, as per agreed Inspection Test Plan. Manufacturer shall furnish all necessary information concerning the supply to EIL/ Owner's inspector. All routine/acceptance tests shall be carried out at manufacturer's works under his care & expense.
- 7.2 Type test certificates from NABL-approved/ Central Government Labs in India/ IECEx-certified/ equivalent Labs, Manufacturer's works test reports, applicable PESO approval and BIS license shall be shown to the inspection agency on demand during inspection. The certificates, BIS license and PESO approval must be valid at the time of despatch.
- 7.3 Test certificates of bought out components shall be submitted to the inspection agency, as per Inspection and Test Plan no. 6-81-1006.
- 7.4 All equipments shall be subjected to various routine / acceptance tests as per Inspection and Test Plan no. 6-81-1006.

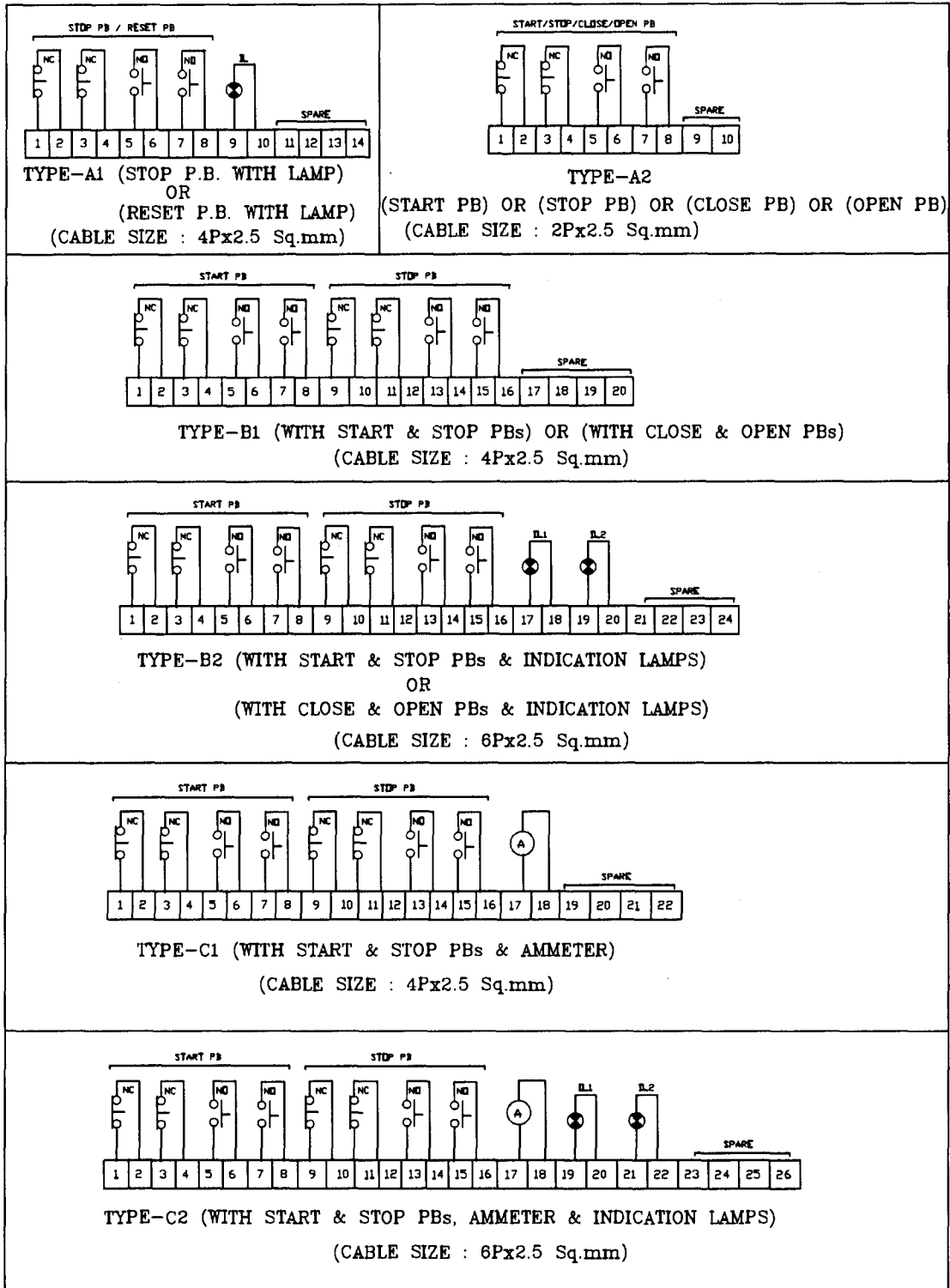
8.0 PACKING AND DESPATCH

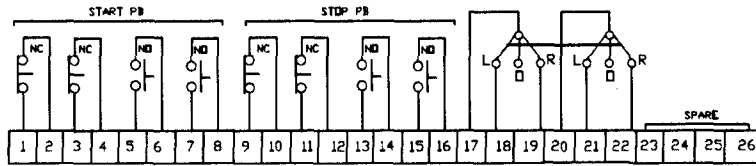
All the equipment shall be divided into several sections for protection and ease of handling during transportation. The equipment shall be properly packed for the selected mode of transportation, i.e. by ship/ rail or trailer, and shall be wrapped in polythene sheets before being placed in crates/ cases to prevent damage to finish. The crates/ cases shall have skid bottom for handling. Special notations such as 'Fragile', 'This side up', 'Center of gravity', 'Weight', 'Owner's particulars', 'PO no.' etc., shall be clearly marked on the packages together with other details as per purchase order.

The equipment may be stored outdoors for long periods before installation. The packing should be suitable for outdoor storage in areas with heavy rains and high ambient temperature unless otherwise agreed. A set of instruction manuals for installation, testing and commissioning, a set of operation & maintenance manuals and a set of final drawing shall be enclosed in a waterproof cover along with the shipment.

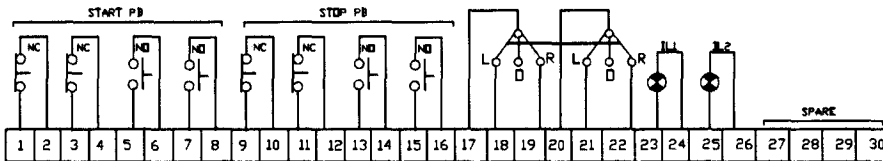
SKETCH-1

WIRING DETAILS OF LOCAL CONTROL STATIONS

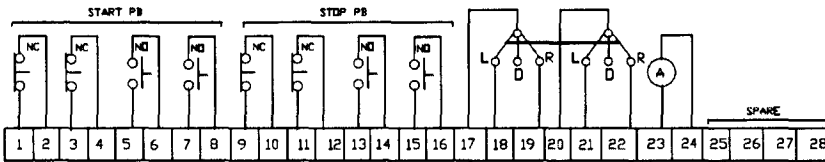




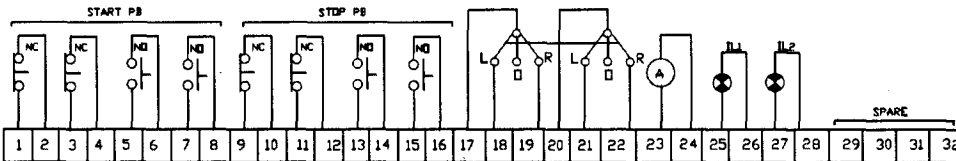
TYPE-D1 (WITH START & STOP PBs & L-O-R SELECTOR SWITCH)
(CABLE SIZE : 6P \times 2.5 Sq.mm) (REFER NOTE-11)



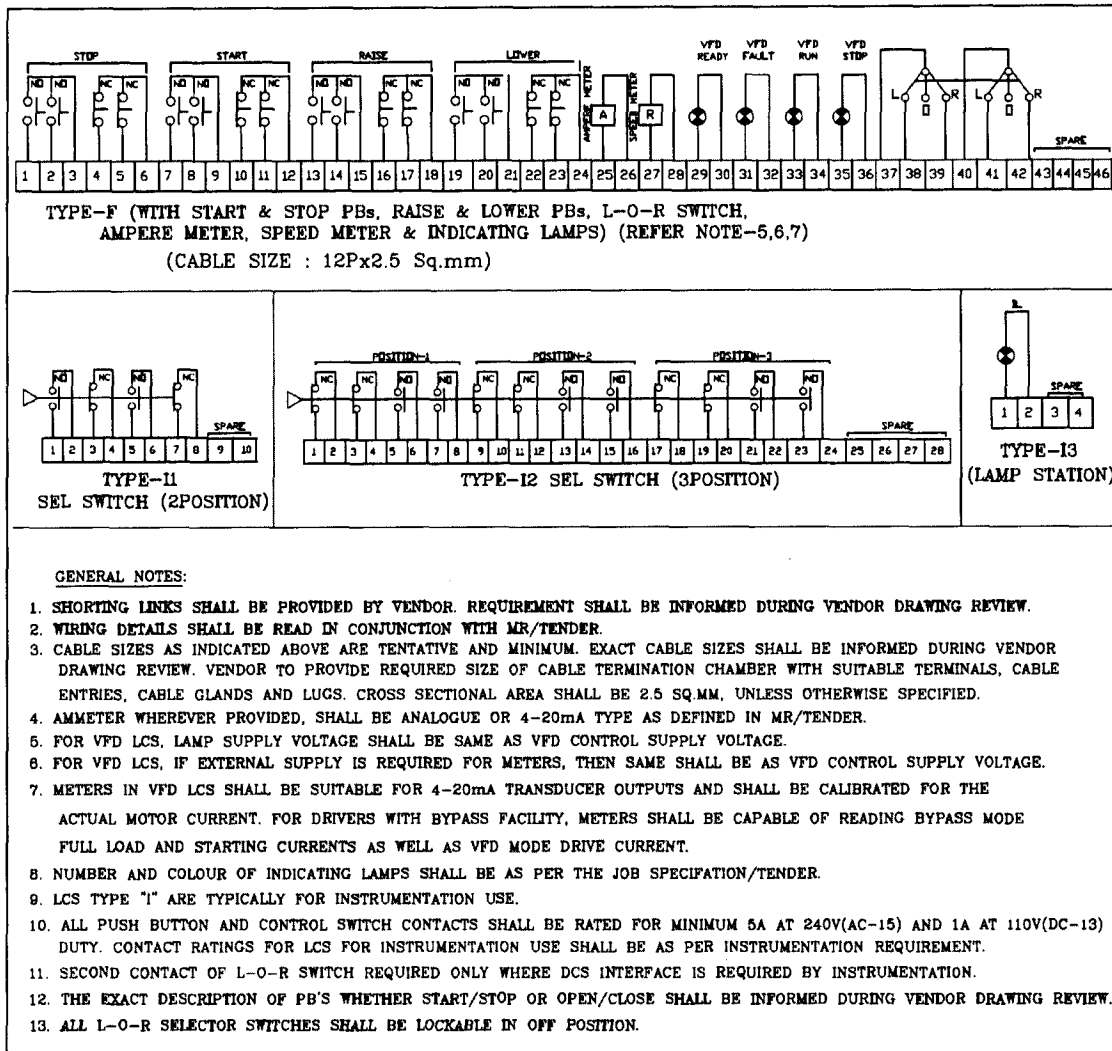
TYPE-D2 (WITH START & STOP PBs, L-O-R SELECTOR SWITCH & INDICATION LAMPS)
(CABLE SIZE : 12P \times 2.5 Sq.mm) (REFER NOTE-11)



TYPE-E1 (WITH START & STOP PBs, AMMETER & L-O-R SELECTOR SWITCH)
(CABLE SIZE : 6P \times 2.5 Sq.mm) (REFER NOTE-11)



TYPE-E2 (WITH START & STOP PBs, AMMETER, L-O-R SELECTOR SWITCH & INDICATION LAMPS)
(CABLE SIZE : 12P \times 2.5 Sq.mm) (REFER NOTE-11)



औद्योगिक किस्म के नियंत्रण स्टेशन
के लिए विनिर्देश

**SPECIFICATION
FOR
INDUSTRIAL TYPE CONTROL
STATIONS**

6	18.01.21	REVISED AND ISSUED AS STANDARD SPECIFICATION	<i>Puneet</i> PS	<i>Rashid</i> RSR	<i>Lij palag</i> PG	<i>S.M.</i> SM
5	11.03.16	REVISED AND ISSUED AS STANDARD SPECIFICATION	SV	ANPS	BRB	SC
4	11.04.11	REVISED AND ISSUED AS STANDARD SPECIFICATION	JM	ANPS	UAP	DM
3	24.08.07	REVISED AND ISSUED AS STANDARD SPECIFICATION	ANPS	UAP	JMS	VC
2	30.01.02	REVISED AND ISSUED AS STANDARD SPECIFICATION	UAP	AAN	VPS	GRR
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
						Approved by

Abbreviations:

AC	Alternating Current
BIS	Bureau of Indian standards
CEA	Central Electricity Authority
CT	Current Transformer
DC	Direct Current
EIL	Engineers India Limited
FRLS	Flame Retardant Low Smoke
GI	Galvanised Iron
IEC	International Electrotechnical Commission
IP	Ingress Protection
IS	Indian Standards
LED	Light Emitting Diode
LV	Low Voltage
NC	Normally Closed
NO	Normally Open
PB	Push Button
PO	Purchase Order
PVC	Poly Vinyl Chloride
SMD	Surface Mount Device
SS	Stainless Steel
SWG	Standard Wire Gauge
VFD	Variable Frequency Drive
XLPE	Cross Linked Poly Ethylene

Electrical Standards Committee

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CONTENTS

1.0	SCOPE.....	4
2.0	CODES AND STANDARDS.....	4
3.0	GENERAL REQUIREMENTS.....	4
4.0	SITE CONDITIONS.....	4
5.0	TECHNICAL REQUIREMENTS.....	4
6.0	INSPECTION, TESTING AND ACCEPTANCE.....	6
7.0	PACKING AND DESPATCH.....	6

1.0 SCOPE

This specification covers the requirements of design, manufacture, testing, packing and supply of industrial type control stations and accessories suitable for installation in non-hazardous/safe outdoor areas.

2.0 CODES AND STANDARDS

2.1 The equipment shall comply with the requirements of latest revision of following standards issued by BIS:

IS: 5 : Colours for ready mixed paints and enamels.

IS: 1248 : Direct acting indicating analogue measuring instruments and their accessories.

IS / IEC: 60529 : Degrees of protection provided by enclosures (IP code).

IS / IEC: 60947 : LV switchgear and control gear.

2.2 In case of imported equipment, IEC standards or equivalent standards shall be applicable, if these standards are equivalent or more stringent than the applicable Indian Standards.

2.3 The equipment shall also conform to the provisions of CEA Regulations with latest amendments and other statutory regulations currently in force in the country.

2.4 In case Indian standards are not available for any equipment, standards issued by IEC or equivalent agency (if more stringent than IEC) shall be applicable.

2.5 In case of any conflict between requirements specified in various applicable documents for the project, the most stringent requirement shall govern. However, Owner's/EIL's decision in this regard will be final and binding.

3.0 GENERAL REQUIREMENTS

3.1 The offered equipment shall be brand new with state of art technology and having proven field track record. No prototype equipment shall be offered.

3.2 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment for at least 10 years from the date of supply.

4.0 SITE CONDITIONS

The equipment shall be suitable for installation and satisfactory operation in tropical, humid and corrosive atmosphere as prevalent in refineries, petrochemical and fertilizer plants. Unless otherwise specified, a design ambient temperature of 40° C and an altitude not exceeding 1000 m above mean sea level shall be considered.

5.0 TECHNICAL REQUIREMENTS

5.1 Construction

5.1.1 The enclosures of the control stations shall be made of either sheet steel or cast light metal alloy, unless otherwise specified.

5.1.2 The control stations shall be suitable for use in outdoor open locations and shall have minimum IP-55 degree of protection. Suitable canopy shall be provided for protection against rain from top, back and two sides. The separate canopy shall be made of at least 1.6 mm (16 gauge) galvanized sheet steel/ stainless steel minimum SS-304 (as specified in purchase specifications).

- 5.1.3 All control stations shall be suitable for 240V AC as well as for 110V/220V DC control supply.
- 5.1.4 The control stations shall be provided with gaskets made of non-inflammable and self-extinguishing material.
- 5.1.5 All metal surfaces shall undergo manufacturer's standard cleaning/ painting/ powder coating cycle. After surface preparation, the equipment shall be painted with two coats of epoxy based final paint or epoxy powder coated with minimum coating thickness of 80 microns, with colour shade as dark admiralty grey, shade 632 of IS-5/ RAL 7031. All unpainted parts shall be suitably treated to prevent rust formation/ corrosion. If these parts are moving, then these shall be greased with grease which does not solidify.
- 5.1.6 All accessories like nuts, bolts, washers etc. and operating shaft of push buttons, switches etc. shall be made of stainless steel SS-304. Alternatively, nickel-plated brass material may be used for the operating shafts of push buttons, switches etc.
- 5.1.7 The control stations shall be provided with two earthing studs (minimum M10 bolt, nut with spring and plain washer) with lugs on the external surface of the enclosures suitable for termination of 8 SWG GI wire. No screw type fixing arrangement shall be allowed.
- 5.1.8 The control stations shall be provided with undrilled gland plate. However, double compression nickel-plated brass cable glands shall be supplied loose to suit the specified cable sizes. The cable termination chamber of the control station shall be large enough to provide a minimum space of 100 mm between top of the cable gland and bottom of the terminal block.
- 5.1.9 The control stations shall have external fixing lugs for mounting on wall or column. The holes provided on these lugs shall be of oblong type.
- 5.1.10 A tag plate indicating Tag Number shall be provided on each control station. The tag plate shall be engraved, 3 ply laminate fixed with screws.

5.2 Component Specification

- 5.2.1 Push buttons for START/ OPEN and STOP/ CLOSE shall be of GREEN and RED colour respectively. Each push button shall have two NO and two NC contacts. The STOP push button shall be mushroom type with stay put feature and lockable in pressed position. Refer Sketch 1 for wiring and other details for various types of control stations
- 5.2.2 All selector switches shall have minimum two poles for each position. Each position of switch shall be indelibly marked on the control station. The configuration of selector switch shall be LOCAL-OFF-REMOTE.
- 5.2.3 All ammeters shall be of moving iron type having an accuracy class of 1.5 and suitable for 1 Ampere CT secondary. Minimum size of ammeter shall be either 72 mm x 72 mm or 65 mm diameter. 80% of the scale length shall cover 100% of the CT primary current uniformly and the balance 20% of the scale shall cover 100-800% of the CT primary. A red mark corresponding to the full load current of the motor shall be provided on the ammeter dial. The ammeter front glass shall be toughened.
- 5.2.4 Indicating lamp(s), wherever provided, shall be clustered LED type or SMD chip type LED with colour lens of minimum 25 mm diameter.

5.3 Terminals & Wiring

- 5.3.1 The control stations shall be provided with sufficient number of terminals. More than 2 wires per terminal shall not be permitted. If required, additional terminal with shorting link may be used. Each terminal for external cable connection shall be suitable for termination of 2.5 mm² (unless otherwise specified) stranded copper conductor. Tinned copper lugs shall be provided for cable termination wherever applicable.

5.3.2 All internal wiring shall employ 1.5 mm², 660V/ 1100V grade, FRLS type, XLPE/ PVC insulated copper conductor wires. All termination shall be with suitable lugs.

6.0 INSPECTION, TESTING AND ACCEPTANCE

6.1 During fabrication, the equipment shall be subjected to inspection by EIL/ Owner or by an agency authorised by the Owner, as per agreed Inspection Test Plan. Manufacturer shall furnish all necessary information concerning the supply to EIL/ Owner's inspector. All routine/ acceptance tests shall be carried out at manufacturer's works under his care and expense.

6.2 Test certificates of bought out components shall be submitted to the inspection agency, as per Inspection and Test Plan no. 6-81-1014.

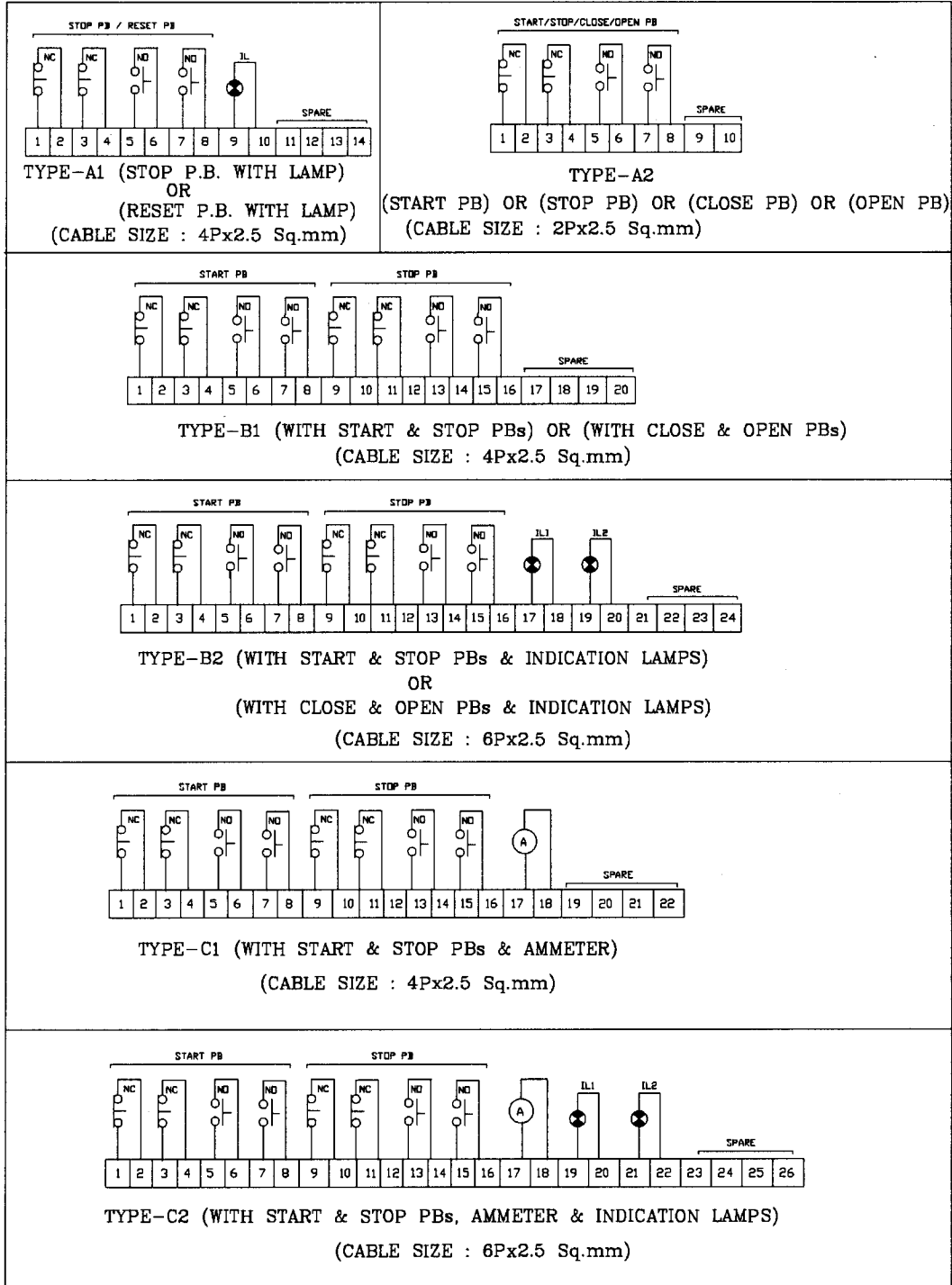
6.3 All equipment shall be subjected to various routine / acceptance tests as per Inspection and Test Plan no. 6-81-1014.

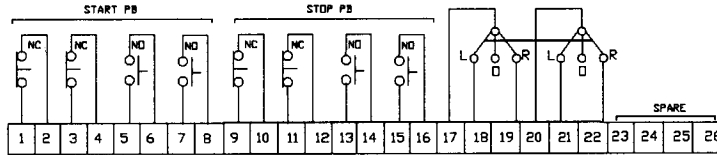
7.0 PACKING AND DESPATCH

All the equipment shall be divided into several sections for protection and ease of handling during transportation. The equipment shall be properly packed for the selected mode of transportation, i.e. by ship/ rail or trailer, and shall be wrapped in polythene sheets before being placed in crates/ cases to prevent damage to finish. The crates/ cases shall have skid bottom for handling. Special notations such as 'Fragile', 'This side up', 'Center of gravity', 'Weight', 'Owner's particulars', 'PO no.' etc., shall be clearly marked on the packages together with other details as per purchase order.

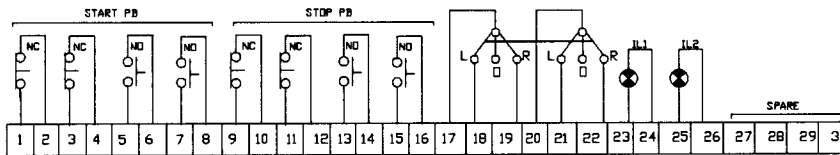
The equipment may be stored outdoors for long periods before installation. The packing shall be suitable for outdoor storage in areas with heavy rains and high ambient temperature unless otherwise agreed. A set of instruction manuals for installation, testing and commissioning, a set of operation & maintenance manuals and a set of final drawing shall be enclosed in a waterproof cover along with the shipment.

SKETCH-1
 WIRING DETAILS OF CONTROL STATIONS

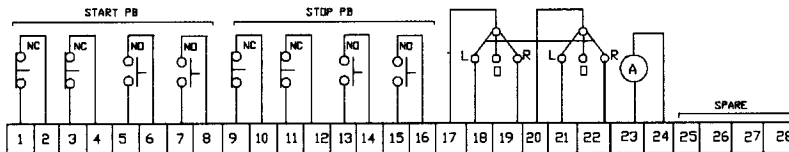




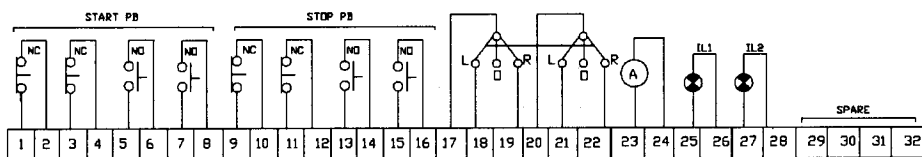
TYPE-D1 (WITH START & STOP PBs & L-O-R SELECTOR SWITCH)
(CABLE SIZE : 6Px2.5 Sq.mm)



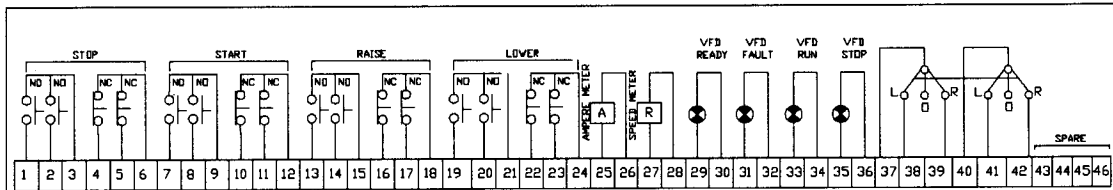
TYPE-D2 (WITH START & STOP PBs, L-O-R SELECTOR SWITCH & INDICATION LAMPS)
(CABLE SIZE : 12Px2.5 Sq.mm)



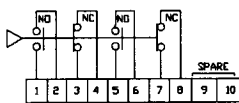
TYPE-E1 (WITH START & STOP PBs, AMMETER & L-O-R SELECTOR SWITCH)
(CABLE SIZE : 6Px2.5 Sq.mm)



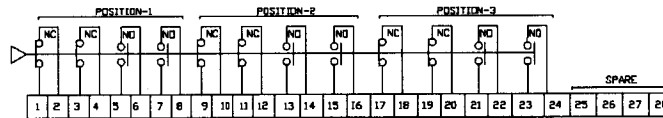
TYPE-E2 (WITH START & STOP PBs, AMMETER, L-O-R SELECTOR SWITCH & INDICATION LAMPS)
(CABLE SIZE : 12Px2.5 Sq.mm)



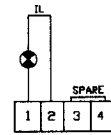
TYPE-F (WITH START & STOP PBs, RAISE & LOWER PBs, L-O-R SWITCH,
AMPERE METER, SPEED METER & INDICATING LAMPS) (REFER NOTE-5,8,7)
(CABLE SIZE : 12P x 2.5 Sq.mm)



TYPE-I1
SEL SWITCH (2 POSITION)



TYPE-I2 SEL SWITCH (3 POSITION)



TYPE-I3
(LAMP STATION)

GENERAL NOTES:

- SHORTING LINKS SHALL BE PROVIDED BY VENDOR. REQUIREMENT SHALL BE INFORMED DURING VENDOR DRAWING REVIEW.
- WIRING DETAILS SHALL BE READ IN CONJUNCTION WITH MR/TENDER.
- CABLE SIZES AS INDICATED ABOVE ARE TENTATIVE AND MINIMUM. EXACT CABLE SIZES SHALL BE INFORMED DURING VENDOR DRAWING REVIEW. VENDOR TO PROVIDE REQUIRED SIZE OF CABLE TERMINATION CHAMBER WITH SUITABLE TERMINALS, CABLE ENTRIES, CABLE GLANDS AND LUGS. CONDUCTOR SIZE SHALL BE 2.5 SQ.MM, UNLESS OTHERWISE SPECIFIED.
- AMMETER WHEREVER PROVIDED, SHALL BE ANALOGUE TYPE UNLESS OTHERWISE SPECIFIED. 4-20 MA TYPE SHALL BE PROVIDED IF DEFINED IN MR/TENDER.
- FOR VFD CONTROL STATIONS, LAMP SUPPLY VOLTAGE SHALL BE SAME AS VFD CONTROL SUPPLY VOLTAGE.
- FOR VFD CONTROL STATIONS, IF EXTERNAL SUPPLY IS REQUIRED FOR METERS, THEN SAME SHALL BE AS VFD CONTROL SUPPLY VOLTAGE.
- METERS IN VFD CONTROL STATIONS SHALL BE SUITABLE FOR 4-20mA TRANSDUCER OUTPUTS AND SHALL BE CALIBRATED FOR THE ACTUAL MOTOR CURRENT. FOR VFD HAVING BYPASS FACILITY, METERS SHALL BE CAPABLE OF READING BYPASS MODE FULL LOAD AND STARTING CURRENTS AS WELL AS VFD MODE DRIVE CURRENT.
- NUMBER AND COLOUR OF INDICATING LAMPS SHALL BE AS PER THE JOB SPECIFICATION/TENDER.
- CONTROL STATIONS TYPE "I" ARE TYPICALLY FOR INSTRUMENTATION USE.
- ALL PUSH BUTTON AND CONTROL SWITCH CONTACTS SHALL BE RATED FOR MINIMUM 5A AT 240V(AC-15) AND 1A AT 220V/110V(DC-13) DUTY. CONTACT RATINGS FOR CONTROL STATIONS FOR INSTRUMENTATION USE SHALL BE AS PER INSTRUMENTATION REQUIREMENT.
- THE EXACT DESCRIPTION OF PB'S WHETHER START/STOP OR OPEN/CLOSE SHALL BE INFORMED DURING VENDOR DRAWING REVIEW.
- ALL L-O-R SELECTOR SWITCHES SHALL BE LOCKABLE IN OFF POSITION.

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इंडक्शन मोटरों
के लिए विनिर्देश

SPECIFICATION
FOR
ENERGY EFFICIENT
MEDIUM VOLTAGE
INDUCTION MOTORS

2	11 10 19	REVISED & ISSUED AS STANDARD SPECIFICATION	RKR	VKJ	SA	RKT
1	12 08 14	REVISED & ISSUED AS STANDARD SPECIFICATION	SS/SHIRALI	VKJ	BRB	SC
0	20 04 09	ISSUED AS STANDARD SPECIFICATION	SD	BRB	JMS	ND
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
						Approved by