SECTION 9 – VENDOR DOCUMENTATION

9.20.2 IOM

SECTION III

START-UP AND OPERATING PROCEDURES

ES-1-5 FIELD INSTALLATION NOTES – VERTICAL HEATERS

ES-1-7 RECOMMENDED PRACTICE FOR FIELD REPAIR OF REFRACTORY

ES-9-3 LIFTING REQUIREMENTS – HEATER COMPONENTS

MJ16-185-SHOep SUGGESTED SHO HEATER ERECTION PROCEDURE

MJ16-185-CHS START UP PROCEDURES FOR COLD AND HOT STARTS

COMPONENT DESCRIPTION

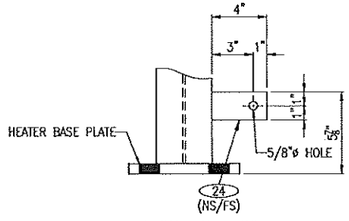
ITEM	QTY	DESCRIPTION	
1	1	UNIVERSAL COMBUSTION CORPORATION BURNER TYPE RGR-7-SP	1
2	2	3/16" PL COMBUSTION CHAMBER SIDE WALLS – A36	
3	1	3/16" PL COMBUSTION CHAMBER ROOF – A36	
4	1	3/16" PL COMBUSTION CHAMBER FLOOR – A36	
5	2	3/16" PL COMBUSTION CHAMBER END WALL – A36	
6	2	3/16" PL CONVECTION SIDE WALL – A36	
7	2	3/8" PL CONVECTION TUBE SHEETS – A36	
8	2	3/16" PL RETURN COVERS – A36	
9	1	3/16" PL TRANSITION – A36	
10	1	24" O.D. 3/16" PL STACK – CS	1
11	1	24" x 24" ACCESS DOOR w/ 1/8" x 2" DROP WARP GASKET	1
12		DROP WARP GASKET	
13		LIFTING LUGS (STRAIGHT UP LIFT ONLY) – A36	
14		NOT USED	
15		5/8" GALV. HIGH STRENGTH BOLT w/ HARDENED WASHER & HEAVY HEX NUT – A325	
16	1	3/4" – 3000# COUPLING & PLUG (CS) – FLOW METER	1
17A	1	1 1/2" – 150# RFWN FLG w/ BLIND (CS) 304SS SCH 40 PIPE SLEEVE & 304SS FLEXITALLIC GASKET – TEMPERATURE CONNECTION	2
17B	1	1 1/2" – 3000# COUPLING & PLUG (CS) w/ 304SS SCH 40 PIPE SLEEVE – SPARE	
18A	1	1 1/2" – 3000# COUPLING & PLUG (CS) w/ 304SS SCH 40 PIPE SLEEVE – SPARE	
18B	1	1 1/2" – 3000# COUPLING & PLUG (CS) w/ 304SS SCH 40 PIPE SLEEVE – SPARE	
19A	1	1 1/2" – 3000# COUPLING & PLUG (CS) w/ 304SS SCH 40 PIPE SLEEVE – SPARE	
19B	1	1 1/2" – 3000# COUPLING & PLUG (CS) w/ 304SS SCH 40 PIPE SLEEVE – FURNACE PRESSURE	2
20	1	3/16" PL AIR DUCT – A36	1
21	2	1 1/2" – 150# RFWN FLG w/ BLIND (CS) w/ CS SCH 40 PIPE SLEEVE & 304SS FLEXITALLIC GASKET – TEMPERATURE CONNECTIONS	2
22	1	1 1/2" – 3000# THR'D COUPLING w/ PLUG (C.S) – STACK TEMPERATURE	
23	1	4" – 150# RFWN FLG w/ BLIND (CS) w/ CS SCH 40 PIPE SLEEVE & 304SS FLEXITALLIC GASKET – SAMPLE PORT	2
24	2	GROUNDING LUGS 1/4" THK. PL. – C.S	
25		14 GA. FERRULES – 304SS (@ TUBE SHEET)	
26		10 GA. FERRULES – C.S. (@ RETURN COVERS)	
27	1	2" – 150# RFWN FLG w/ BLIND (CS) w/ CS SCH 40 PIPE SLEEVE & 304SS FLEXITALLIC GASKET – DRAIN CONNECTIONS	2
28	2	4" SITE PORT W/ (5 SCFM) AIR PURGE 1/2" COUPLING W/ 304SS SCH 40 PIPE SLEEVE (@ COMBUSTION CHAMBER END WALLS)	2
29	1	THM NAME PLATE (304SS)	
30	2	FLEXIBLE TUBE SEALS (SOCK & CLAMP) – SHOP INSTALLED	6
31		1/2" DIA. GALV MACHINE BOLT w/ FLAT WASHER & HEAVY HEX NUT – A307	
32		3/4" GALV. HIGH STRENGTH BOLT w/ HARDENED WASHER & HEAVY HEX NUT – A325	
33	1	EXPANSION JOINT	1
34	1	INLET SUPPORT – A36	
35	1	BLOWER SKID	1

DRAWING LIST

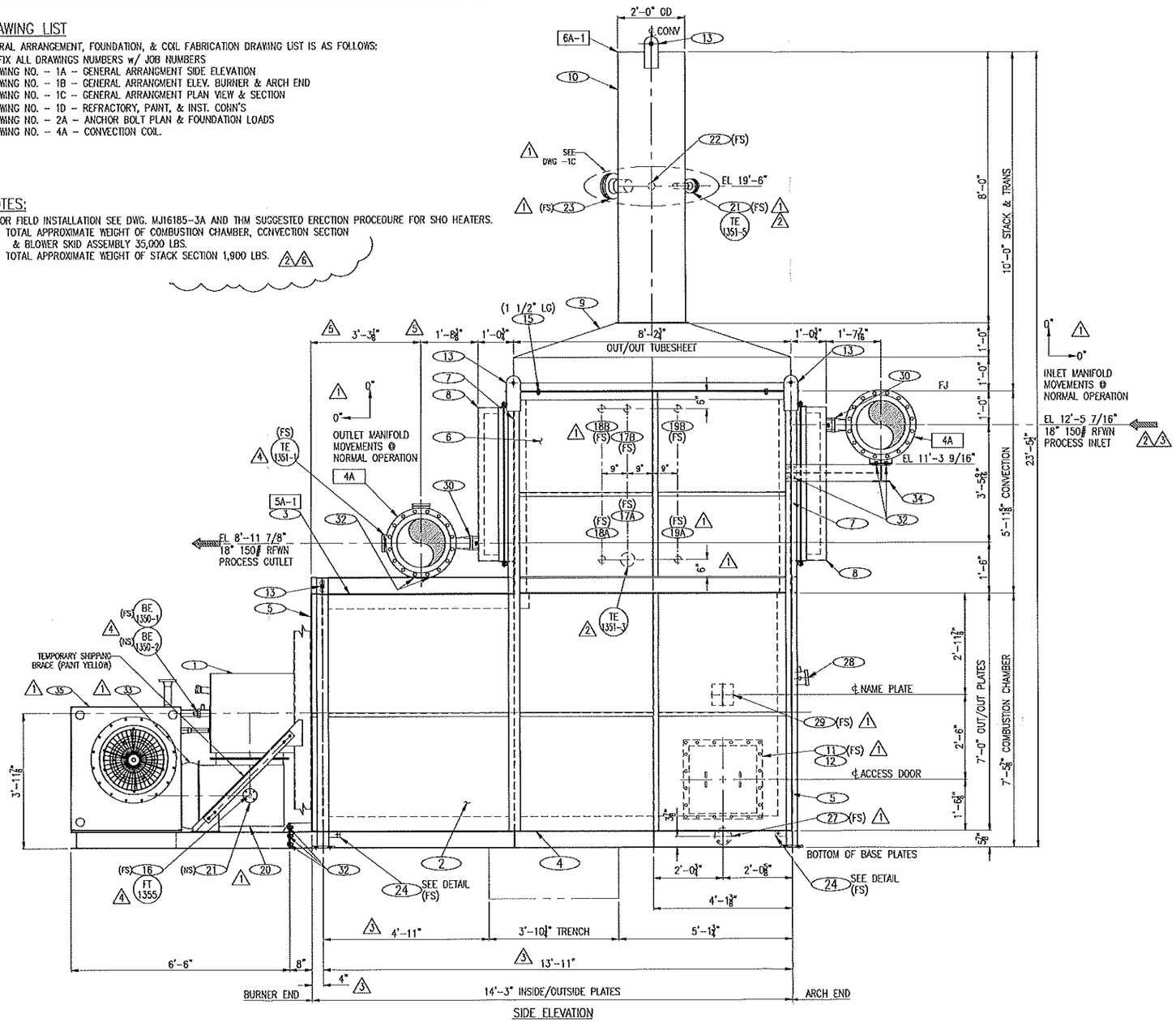
GENERAL ARRANGEMENT, FOUNDATION, & COIL FABRICATION DRAWING LIST IS AS FOLLOWS:
PREFIX ALL DRAWINGS NUMBERS w/ JOB NUMBERS
DRAWING NO. – 1A – GENERAL ARRANGMENT SIDE ELEVATION
DRAWING NO. – 1B – GENERAL ARRANGMENT ELEV. BURNER & ARCH END
DRAWING NO. – 1C – GENERAL ARRANGMENT PLAN VIEW & SECTION
DRAWING NO. – 1D – REFRACTORY, PAINT, & INST. CONN'S
DRAWING NO. – 2A – ANCHOR BOLT PLAN & FOUNDATION LOADS
DRAWING NO. – 4A – CONVECTION COIL.

NOTES:

1. FOR FIELD INSTALLATION SEE DWG. MJ16185-3A AND THM SUGGESTED ERECTION PROCEDURE FOR SHO HEATERS.
2. TOTAL APPROXIMATE WEIGHT OF COMBUSTION CHAMBER, CONVECTION SECTION & BLOWER SKID ASSEMBLY 35,000 LBS.
3. TOTAL APPROXIMATE WEIGHT OF STACK SECTION 1,900 LBS. 2 6



GROUNDING LUG DETAIL
(HEATER)



SIDE ELEVATION

Customer:
CALLIDUS TECHNOLOGIES
DYNO-NOBEL

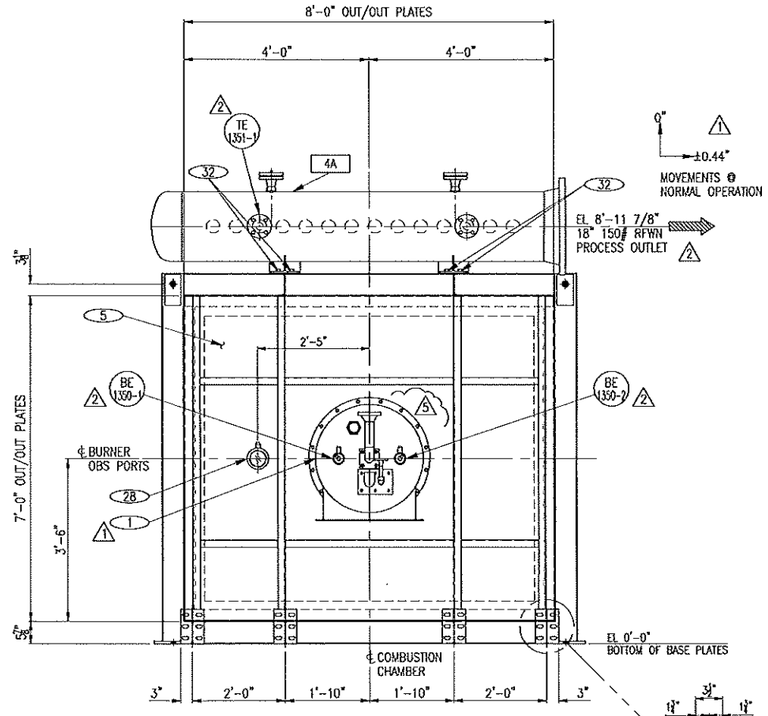
LOCATION : LOUISIANA, MO
UNIT : THERMAL OXIDIZER
SERVICE : INDIRECT FIRED AIR HEATER
EQUIPMENT No. : E-1351
P.O. No. : 4500700579

Rev.	Date	By	Revision Description
1	3/16	SDB	REV PER CUSTOMER COMMENTS
2	4/7	SDB	REV PER CUSTOMER COMMENTS
3	4/15	SDB	REV PER CUSTOMER COMMENTS
4	5/18	SDB	REV PER CUSTOMER COMMENTS
5	8/10	SDB	AS BUILT
6	8/22	SDB	REV PER CUSTOMER COMMENTS

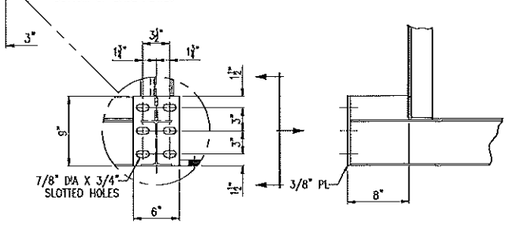
THM TULSA HEATERS MIDSTREAM

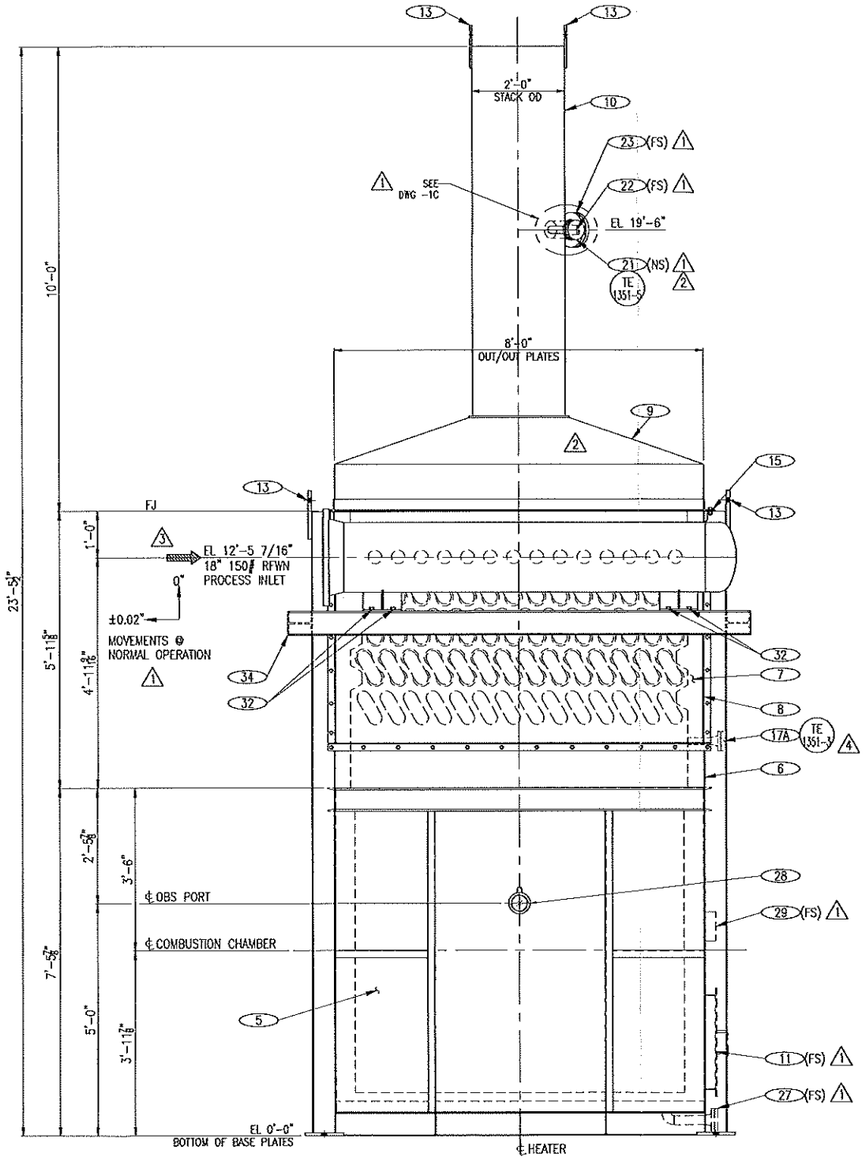
Title: GENERAL ARRANGEMENT SIDE ELEV

Drawn By: SDB	Date: 2/11/16	Job No.: MJ16-185	
Checked By: GP	Date: 2/23/16	Drawing No.: MJ16185-1A	Rev.: 6
Approved By:	Certified By:		



BURNER END VIEW
(SKID NOT SHOWN FOR CLARITY)





ARCH END VIEW

Customer:
CALLIDUS TECHNOLOGIES
DYNO-NOBEL

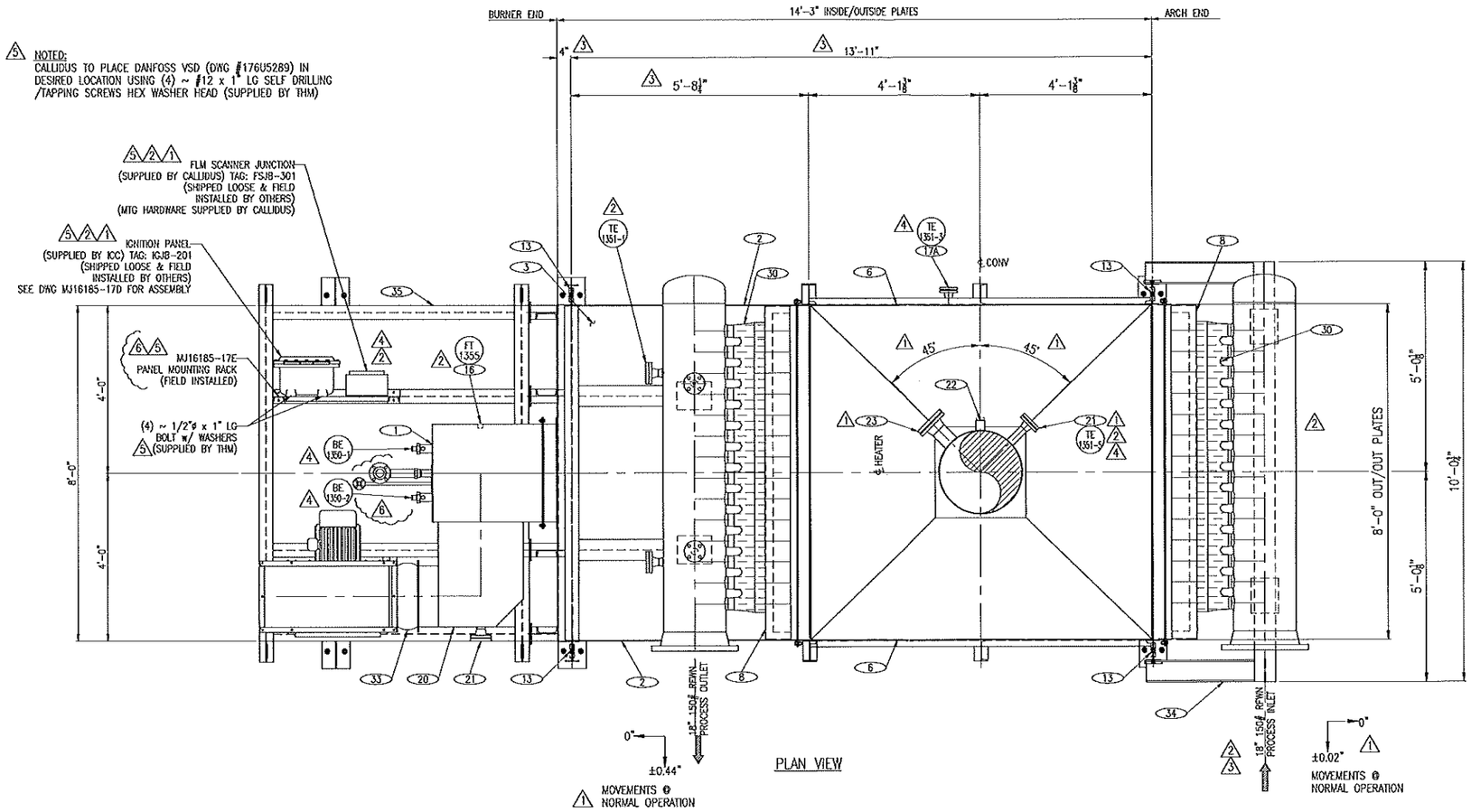
LOCATION : LOUISIANA, MO
UNIT : THERMAL OXIDIZER
SERVICE : INDIRECT FIRED AIR HEATER
EQUIPMENT No. : E-1351
P.O. No. : 4500700579

Rev.	Date	By	Revision Description
1	3/17	SDB	REV PER CUSTOMER COMMENTS
2	4/7	SDB	REV PER CUSTOMER COMMENTS
3	4/15	SDB	REV PER CUSTOMER COMMENTS
4	5/18	SDB	REV PER CUSTOMER COMMENTS
5	8/22	SDB	REV PER CUSTOMER COMMENTS

THM TULSA HEATERS MIDSTREAM

Title
GENERAL ARRANGEMENT ELEV. BURNER & ARCH END

Drawn By: SDB	Date: 2/15/16	Job No.: MJ16-185	
Checked By: GP	Date: 2/23/16	Drawing No.: MJ16185-1B	Rev.: 5
Approved By:	Certified By:		



PLAN VIEW

Customer:
CALLIDUS TECHNOLOGIES
DYNO-NOBEL

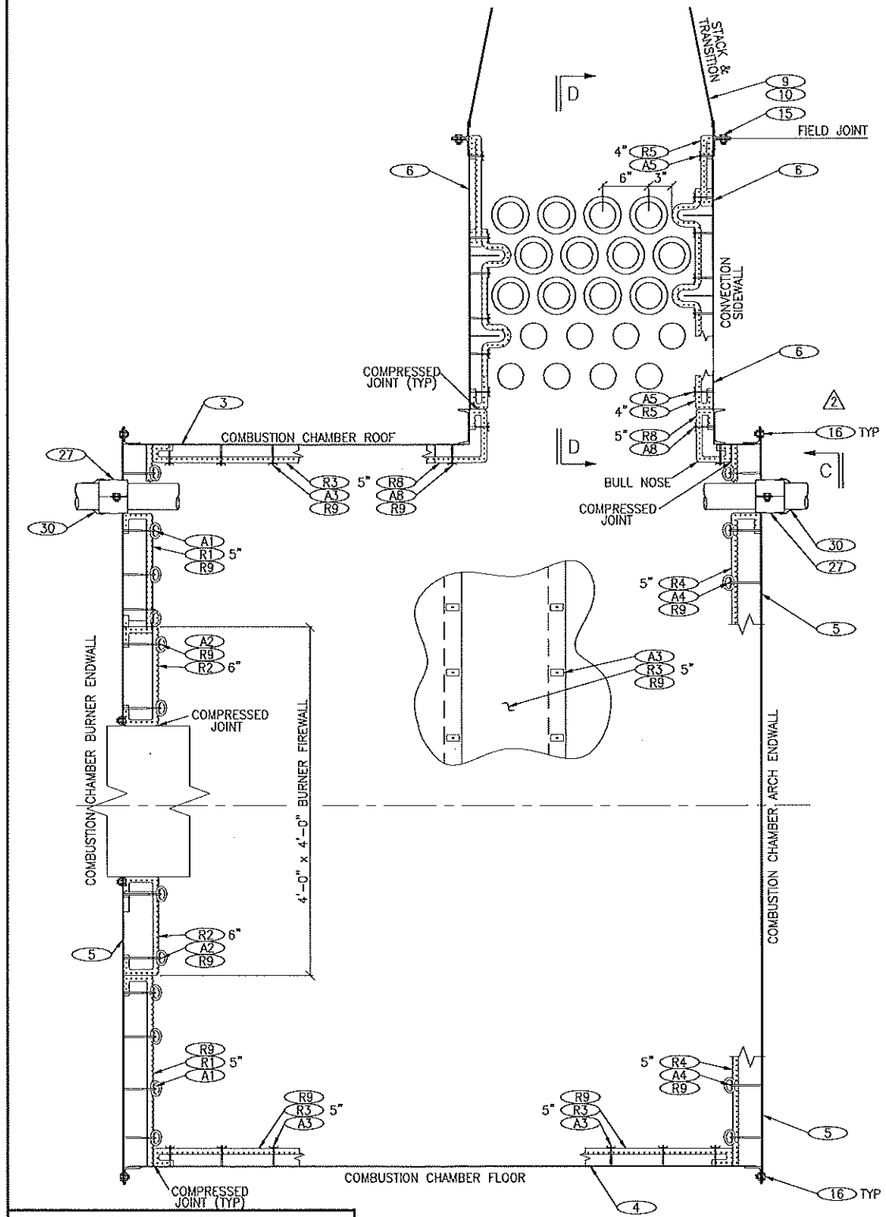
LOCATION : LOUISIANA, MO
UNIT : THERMAL OXIDIZER
SERVICE : INDIRECT FIRED AIR HEATER
EQUIPMENT No. : E-1351
P.O. No. : 4500700579

Rev.	Date	By	Revision Description
1	3/8	SDB	REV PER CUSTOMER COMMENTS
2	4/7	SDB	REV PER CUSTOMER COMMENTS
3	4/15	SDB	REV PER CUSTOMER COMMENTS
4	5/18	SDB	REV PER CUSTOMER COMMENTS
5	6/10	SDB	AS BUILT
6	8/22	SDB	REV PER CUSTOMER COMMENTS

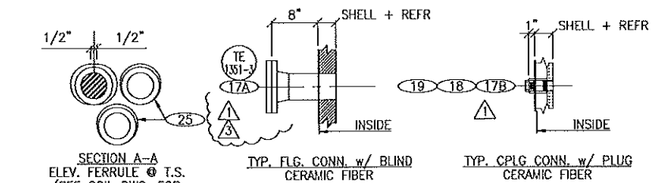
THM TULSA HEATERS MIDSTREAM

Title: GENERAL ARRANGEMENT PLAN VIEW & SECTION

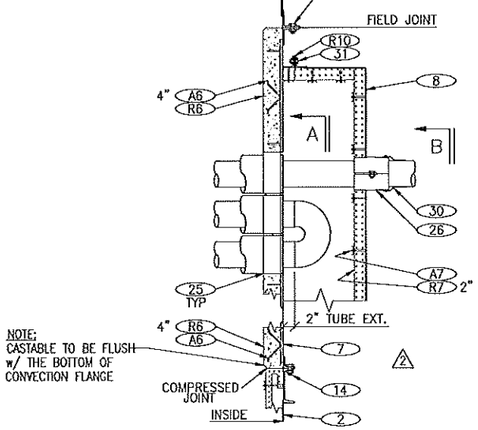
Drawn By: SDB	Date: 2/15/16	Job No.: MJ16-185	
Checked By: GP	Date: 2/29/16	Drawing No.: MJ16185-1C	Rev.: 6
Approved By:	Certified By:		



SCHEMATIC ELEV. CONVECTION SIDEWALL, COMBUSTION CHAMBER ROOF, SIDEWALLS, ENDWALL & FLOOR



⚠2 INSTRUMENT CONNECTIONS
(CONVECTION SECTION & STACK)
ALL FLANGE HOLES TO STRADDLE NATURAL CENTERLINES



SECTION D–D
SCHEMATIC ELEV. CONVECTION TUBE SHEET, STACK & RADIANT SIDEWALL

REFRACTORIES

ITEM	THICKNESS	DESCRIPTION	LOCATION	INSTALL
R1	5"	1" 8 LB C.F.B. OVER 1" 8 LB C.F.B. OVER 3" 6 LB C.F.B.	BURNER ENDWALL	SHOP
R2	6"	1" 8 LB CERACHEM OVER 2" 8 LB C.F.B. OVER 3" 6 LB C.F.B.	BURNER FIREWALL	SHOP
R3	5"	1" 8 LB C.F.B. OVER 1" 8 LB C.F.B. OVER 3" 6 LB C.F.B.	COMBUSTION CHAMBER SIDEWALL, ROOF, FLOOR	SHOP
R4	5"	1" 8 LB C.F.B. OVER 1" 8 LB C.F.B. OVER 3" 6 LB C.F.B.	COMBUSTION CHAMBER ARCH ENDWALL	SHOP
R5	4"	1" 8 LB C.F.B. OVER 1" 8 LB C.F.B. OVER 2" 6 LB C.F.B.	CONV. SIDES	SHOP
R6	4"	4" SPARLITE 55HS	TUBESHEETS	SHOP
R7	2"	1" 8 LB C.F.B. OVER 1" 8 LB C.F.B.	HEADER BOXES	SHOP
R8	5"	1" 8 LB C.F.B. OVER 1" 8 LB C.F.B. OVER 3" 6 LB C.F.B.	BULLNOSE	SHOP
R9	1"	1" 8 LB C.F.B.	DIAPER WRAPS	SHOP
R10	1/8"	1/8" X 2" DROP WARP GASKET	HEADER BOX /JOINTS	SHOP

NOTES:
1. INSULATION TO BE INSTALLED PER THI STANDARD ES-12
2. SEAMS TO BE LAPPED IN DIRECTION OF FLUE GAS FLOW
⚠2 3. THM TO PROVIDE FIELD CURE-OUT & START-UP PROCEDURES.

REFRACTORY ANCHORS

ITEM	DIA.	HEIGHT	C/C	DESCRIPTION	MATERIAL	LOCATION	INSTALL
A1	1/8" x 1/4"	6 1/2"	9"	PINS & CLIPS (w/ WRAP) HL 114-11	310SS	BURNER ENDWALL	SHOP
A2	1/8" x 1/4"	7 1/2"	9"	PINS & CLIPS (w/ WRAP) HL 114-13	310SS	BURNER FIREWALL	SHOP
A3	1/8" x 1/4"	6 1/2"	9"	PINS & CLIPS (w/ WRAP) HL 114-11	310SS	COMBUSTION CHAMBER SIDEWALL, ROOF, FLOOR	SHOP
A4	1/8" x 1/4"	6 1/2"	9"	PINS & CLIPS (w/ WRAP) HL 114-11	310SS	COMBUSTION CHAMBER ARCH ENDWALL	SHOP
A5	1/8" x 1/4"	6 1/2"	9"	PINS & CLIPS (w/ WRAP) HL 114-11	310SS	CONV. SIDES	SHOP
A6	3/16"	2 1/4"	8"	BULLHORN ANCHOR HL 208-B	304SS	TUBESHEETS	SHOP
A7	1/8" x 1/4"	2 1/2"	9"	PINS & CLIPS (NO/ WRAP) HL 114-3	304SS	HEADER BOXES	SHOP
A8	1/8" x 1/4"	6 1/2"	9"	PINS & CLIPS (w/ WRAP) HL 114-11	310SS	BULLNOSE	SHOP

COATINGS SPECIFICATIONS

EXTERIOR SURFACE PREPARATION:
SHELL: SANDBLAST PER SSPC-SP6
STACK: SANDBLAST PER SSPC-SP6

EXTERIOR COATING:
CASING:
1ST 1 COAT 2-3 MILS DFT: PPG'S DIMETCOTE 9 INORGANIC ZINC SILICATE PRIMER (COLOR: GRAY GREEN)
2ND NONE

⚠1 STACK:
1ST 1 COAT 2-3 MILS DFT: PPG'S DIMETCOTE 9 INORGANIC ZINC SILICATE PRIMER (COLOR: GRAY GREEN)
2ND 1 COAT 2-3 MILS DFT: HIGH TEMP ALUMINUM (SHERWIN WILLIAMS 100 A 518)

INTERIOR SURFACE PREPARATION:
NONE

INTERIOR COATING:
NONE

Customer:
CALLIDUS TECHNOLOGIES
DYNO-NOBEL

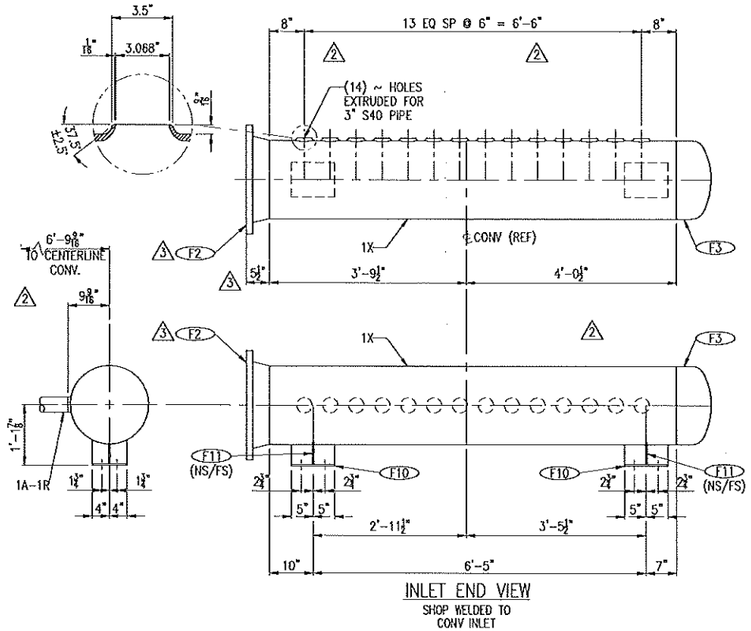
⚠1
LOCATION : LOUISIANA, MO
UNIT : THERMAL OXIDIZER
SERVICE : INDIRECT FIRED AIR HEATER
EQUIPMENT No. : E-1351
P.O. No. : 4500700579

Rev.	Date	By	Revision Description
1	3/18	SDB	REV PER CUSTOMER COMMENTS
2	4/7	SDB	REV PER CUSTOMER COMMENTS
3	5/18	SDB	REV PER CUSTOMER COMMENTS

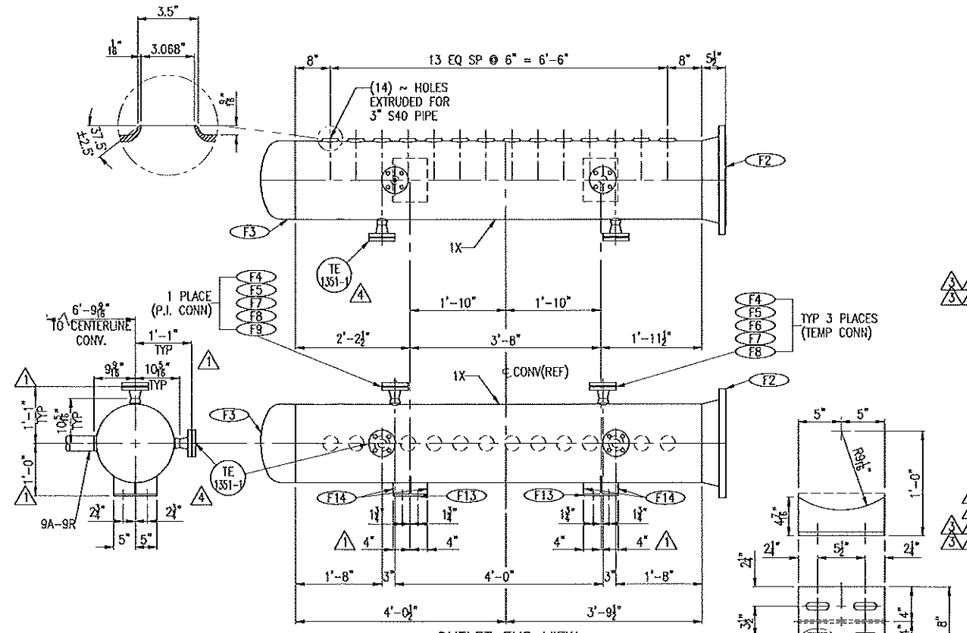
THM TULSA HEATERS MIDSTREAM

Title: REFRACTORY, PAINT & INST. CONN'S

Drawn By: SDB	Date: 2/16/16	Job No.: MJ16-185	
Checked By: GP	Date: 2/24/16	Drawing No.: MJ16185-1D	Rev.: 3
Approved By	Certified By		

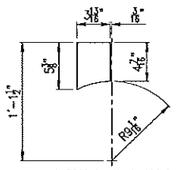


INLET END VIEW
SHOP WELDED TO CONV INLET

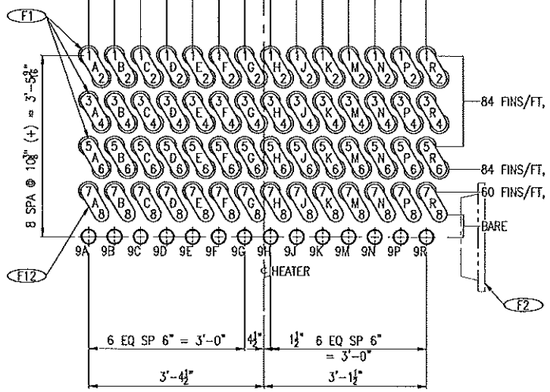


OUTLET END VIEW
SHOP WELDED TO CONV OUTLET

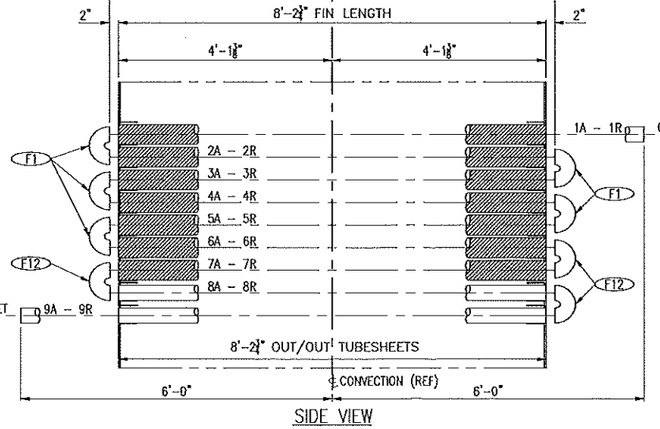
DETAIL OF F13 (FURNISHED BY THM) 1



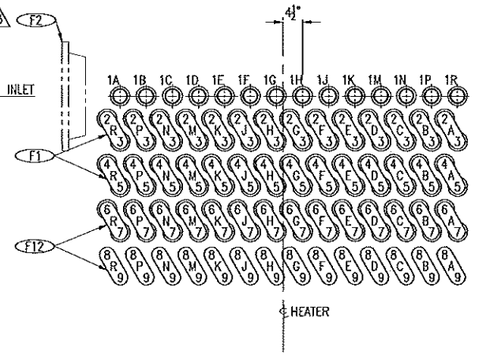
DETAIL OF F11 (FURNISHED BY THM)



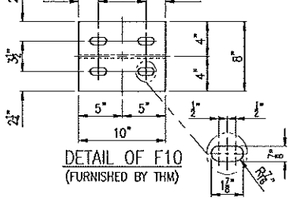
OUTLET END VIEW



SIDE VIEW



INLET END VIEW



DETAIL OF F10 (FURNISHED BY THM)

TUBE & PIPE BILL of MATERIAL

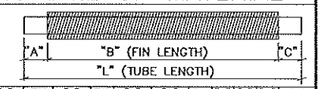
REV	MARK	QTY	FIN	DESCRIPTION SIZE X WALL	LENGTH FT	LENGTH IN	END PREP	MAT'L	LOCATION REMARK
	1A-1R	14	YES	3" SCH 40 PIPE	10	3 3/8	BEV BEV	SA106 GR. B	CONNECTION INLET
	2A-5R	56	YES	3" SCH 40 PIPE	8	6 3/4	BEV BEV	SA106 GR. B	
	6A-6R	14	YES	3" SCH 40 PIPE	8	6 3/4	BEV BEV	A335 P11	
	7A-7R	14	YES	3" SCH 40 PIPE	8	6 3/4	BEV BEV	A335 P11	
	8A-8R	14	NO	3" SCH 40 PIPE	8	6 3/4	BEV BEV	A335 P11	
	9A-9R	14	NO	3" SCH 40 PIPE	10	3 3/8	BEV BEV	A335 P11	CONNECTION OUTLET
	1X	2	NO	18" SCH 40 PIPE	7	10	BEV BEV	SA106 GR. B	MANIFOLD

FITTINGS BILL OF MATERIAL

REV	MARK	QTY	DESCRIPTION	MATERIAL	LOCATION REMARK
	F1	70	3" SCH 40 180° SR RETURN BEND (ID TO MATCH SCH 40)	SA234 WPB	
	F2	2	18" 150# RFWN FLG. (SCH 40 BORE)	SA105	
	F3	2	18" SCH 40 WELD CAP	SA234 WPB	
	F4	4	18" SCH. 40 RUN x 1 1/2" SCH. 80 OUTLET WELDOLET	SA105	
	F5	4	1 1/2" – 150# RFWN FLG. (SCH 80 BORE)	SA105	
	F6	3	1 1/2" – 150# RF BLIND FLG.	SA105	
	F7	16	1/2" DIA x 3" STUD w/ (2) HVY HEX NUTS	A193-B7/A194-2H	
	F8	4	1 1/2"–150# SPIRAL WOUND GASKET TYPE CGI FLEXICARB FILLER (OR EQUAL)	W/ 304SS	
	F9	1	1 1/2" – 150# RF BLIND FLG. – DRILL & TAP CENTER FOR 1/2" FNPT (W/ 1/2" NPT C.S. PLUG)	SA105	
	F10	2	WT5 x 16.5 x 0'-10" LG. (FURNISHED BY THM)	A992	
	F11	4	PL. 3/8" x 3 13/16" x 5 3/8" (FURNISHED BY THM)	CS	
	F12	42	3" SCH 40 180° SR RETURN BEND (ID TO MATCH SCH 40)	SA234 WP11	
	F13	2	WT5 x 16.5 x 0'-10" LG. (FURNISHED BY THM)	A992	
	F14	4	PL. 3/8" x 3 13/16" x 2 5/8" (FURNISHED BY THM)	CS	
	F15		DELETED ITEM		
	F16		DELETED ITEM		

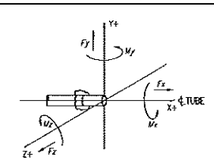
TUBE FINNING BILL OF MATERIAL

NOTES:
1. All fins helically wound, 7/16" Fins/foot, 1/4" High, and 1/16" Thick.
2. Fin types are as follows:
   SOL = Solid Fins &
   SER = Serrated Fins.
3. All fins to be continuous weld. High Frequency.



REV	MARK	QTY	TUBE MAT'L	TUBE OD	TUBE WALL	"L" FT	"L" IN	FIN TYPE	"A" FT	"A" IN	END PREP	"B" FT	"B" IN	"C" FT	"C" IN	END PREP	"N" /FT	"T" (IN)	"H" (IN)	FIN MAT'L
	1A-1R	14	SA106 GR. B	3 1/2	SCH 40	10	3 3/8	SER	0	2	BEV	8	2 3/4	1	10 3/4	BEV	84	0.035	1/2	CS
	2A-5R	56	SA106 GR. B	3 1/2	SCH 40	8	6 3/4	SER	0	2	BEV	8	2 3/4	0	2	BEV	84	0.035	1/2	CS
	6A-6R	14	A335 P11	3 1/2	SCH 40	8	6 3/4	SER	0	2	BEV	8	2 3/4	0	2	BEV	84	0.035	1/2	409SS
	7A-7R	14	A335 P11	3 1/2	SCH 40	8	6 3/4	SER	0	2	BEV	8	2 3/4	0	2	BEV	60	0.035	1/2	409SS

HORIZONTAL PIPE/TABLE 8 & 9 ANSI/API 560/ISO 13705



ALLOWABLE FORCES & MOMENTS FOR PIPE

PIPE SIZE (NPS)	Fx N	Fx Lbs	Fy N	Fy Lbs	Fz N	Fz Lbs	Mx Nm	Mx ft-lbs	My Nm	My ft-lbs	Mz Nm	Mz ft-lbs
18"	4893	1100	7562	1700	7562	1700	3282	2420	2441	1800	2441	1800

ALLOWABLE MOVEMENTS FOR TERMINAL @ CONNECTION (HORIZONTAL)

1	Dx		Dy		Dz	
	+1/2"	+13mm	0	0	+/-1/2"	+/-13mm

NOTES:
1. ALL WELD PROCEDURES ARE TO BE APPROVED PRIOR TO START OF WELDING.
2. CONVECTION COIL TO BE FABRICATED PER ASME CODE SECTION VIII DIV. 1 LATEST EDITION. CODE STAMP NOT REQUIRED.
3. FLANGE BOLT HOLES TO STRADDLE NATURAL CENTERLINES.
4. NOTE DELETED 6

NDE REQUIREMENTS	
RT:	100% OF 10%
UT:	N/A
MT:	N/A
PT:	100% BRANCH CONN & ATTACHMENT WELDS
PMI:	N/A
BHN:	N/A
PWHT:	N/A

DESIGN DATA	
PRESSURE:	100 PSIG
FLUID TEMPERATURE:	700° F
DESIGN TUBE WALL TEMPERATURE:	1050° F
CORROSION ALLOWANCE:	0.063"
SHOP HYDROTEST :	150 PSIG

Customer:
CALLIDUS TECHNOLOGIES
DYNO-NOBEL

LOCATION	:	LOUISIANA, MO
UNIT	:	THERMAL OXIDIZER
SERVICE	:	INDIRECT FIRED AIR HEATER
EQUIPMENT No.	:	R-1351
P.O. No.	:	4500700579 1

Rev.	Date	By	Revision Description
1	3/16	SDB	REV PER CUSTOMER COMMENTS
2	4/12	SDB	REV PER CUSTOMER COMMENTS
3	4/15	SDB	REV PER CUSTOMER COMMENTS
4	5/18	SDB	REV PER CUSTOMER COMMENTS
5	8/10	SDB	AS BUILT
6	8/22	SDB	REV PER CUSTOMER COMMENTS

THM TULSA HEATERS MIDSTREAM

Title: CONVECTION COIL DETAIL

Drawn By: SDB	Date: 2/10/16	Job No.: MJ16-185	
Checked By: GP	Date: 2/22/16	Drawing No.: MJ16185-4A	Rev.: 6
Approved By	Certified By		

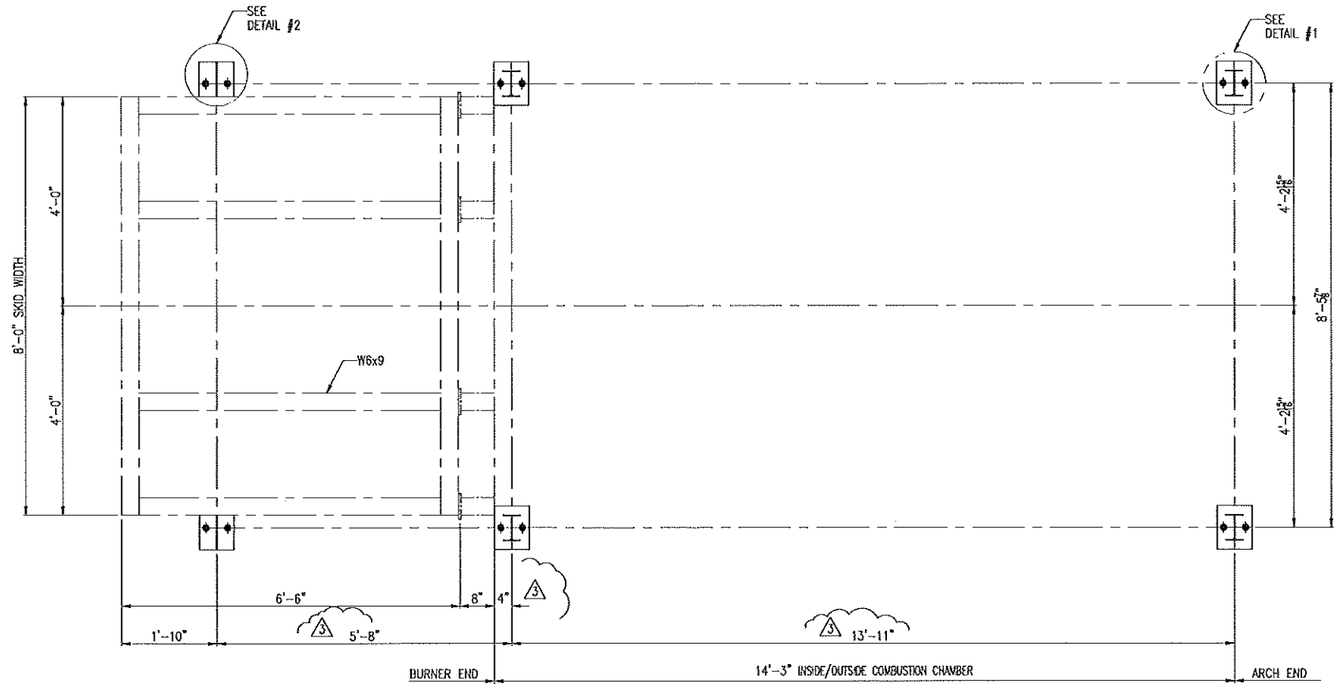
DESIGN PARAMETERS
WIND CODE: ASCE 7-05
Wind Velocity V: 90 MPH
Exposure Category: C
Importance Factor: 1.00

SEISMIC CODE: ASCE 7-05
Site Class: D
Factor Ss: 0.25
Factor S1: 0.15
Factor R: 3.00
Imp. Factor: 1.25
Factor V: 0.1111 W

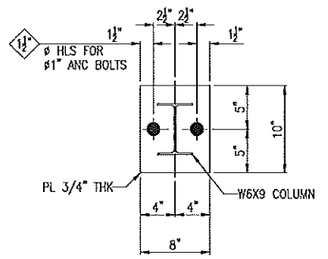
⚠2 FOUNDATION LOADS
UNITS: LBS

MAX DEAD LOAD	13,000 LBS
MAX UPLIFT	2,000 LBS
MAX SHEAR	6,000 LBS

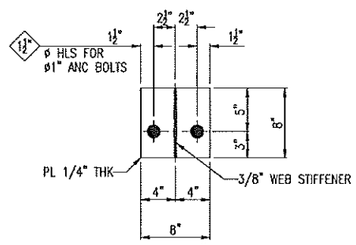
NOTE:
LOADS ARE SHOWN PER BASE PLATE
IF ADDITIONAL INFORMATION IS REQUIRED, PLEASE REFER TO
THE STRUCTURAL ANALYSIS DOCUMENT MJ16-185-28



ANCHOR BOLT PLAN



DETAIL #1
HEATER BASE PLATE
(TYP 4 PLACES)



DETAIL #2
SKID BASE PLATE
(TYP 2 PLACES)

Customer:
CALUDUS TECHNOLOGIES
DYNO-NOBEL

LOCATION : LOUISIANA, MO
UNIT : THERMAL OXIDIZER
SERVICE : INDIRECT FIRED AIR HEATER
⚠1 EQUIPMENT No. : E-1351
P.O. No. : 4500700579

Rev.	Date	By	Revision Description
1	3/18	SDB	REV PER CUSTOMER COMMENTS
2	4/12	SDB	REV PER CUSTOMER COMMENTS
3	4/15	SDB	REV PER CUSTOMER COMMENTS

THM TULSA HEATERS MIDSTREAM

Title: FOUNDATION LOADS & ANCHOR BOLT PLAN

Drawn By: SDB	Date: 2/16/16	Job No.: MJ16-185	
Checked By: GP	Date: 2/29/16	Drawing No.: MJ16185-2A	Rev.: 3
Approved By:	Certified By:		

ES-1-5

FIELD INSTALLATION NOTES – VERTICAL HEATERS

FIELD INSTALLATION NOTES - VERTICAL HEATERS

1.0 The following notes apply to the field installation of typical vertical heaters manufactured by THI. Some of the notes may not apply specifically to this particular heater, but a quick inspection of the attached General Arrangement Drawings will indicate where it does. These instructions should be used in conjunction with the Field Assembly and General Arrangement Drawings. This data is issued as a guide and specific details may vary from what is included herein. The erection contractor is invited to view the heaters in our shops prior to the shipment and discuss any details with THI at that time. THI has generated this data to aid in erection of the heater, but it remains the contractor's responsibility to determine the amount and type of work required to do so.

2.0 LIFTING

The procedure used in lifting this unit is left to the rigger handling the heater, but the following cautions MUST be observed:

2.1 The lift on the lifting lugs shall be straight up with no lateral or longitudinal thrust against the lugs permitted. all available lifting lugs shall be used.

2.2 Set the unit down in as level a position as possible.

2.3 Panels require special care to prevent a torque or twisting action.

2.4 For lifting purposes, weight of heater sections shall be the AS SHIPPED WEIGHT taken from the freight bill of lading for the particular section. All other weights are to be considered estimates only and not suitable for this purpose. Contact THI if this data is not available.

2.5 In general, the lifting lugs attached to a given component are designed for the lift of that component. If any combination of components is joined together prior to the lifting, then the lugs must be re-evaluated for the entire lift.

3.0 MAKING UP SHELL JOINTS

EACH SECTION MUST BE CHECKED FOR PLUMBNESS PRIOR TO SETTING ADDITIONAL SECTIONS.

When the unit has one or more major joints in the shell, the following procedure should be followed:

3.1 For joints between shell sections with castable refractory, lay a layer of 2" thick ceramic fiber strip to one side of the refractory joint using adhesive before setting adjacent section in place, or simply pack the joint with ceramic fiber after setting the shell sections. This joint should then be inspected to insure that a tight seal has been achieved. If the seal is not tight, then additional material shall be packed in place until the joint is air tight.

3.2 For joints between sections with ceramic fiber, the material at the joints shall be inspected to assure that the fiber projects beyond the joint approximately 1/2" on each piece so that a 1" compression is effected. When the sections are bolted together, the blanket at the joint should lightly pounded with a wooden block to help compress the blanket at the joint. If an adequate compression cannot be achieved, then additional fiber material shall be added.

3.3 When setting the convection box and stack transition, lay a layer of 2" thick ceramic fiber strip on top of the castable portion only of the lower section and set the upper section. Check the joint to insure that an air seal has been achieved. The level of each joint shall be checked. Shim as required to maintain level and correct elevation. Shims shall be provided by the erection contractor.

3.4 Be sure the bolt holes on the joint members angles or channels line up. This will require the use of a drift pin and occasionally relocating a few holes. Relocating holes up to five percent of the total number shall not be considered excessive.

3.5 Remove all shipping steel from sections prior to erection of each component.

3.6 The bolted joints between the header boxes on the upper and lower section, if any, may require ceramic fiber strips as in paragraph C and shall be made up with bolts supplied for this purpose.

3.7 When field joints are located in convection section, a review of the Field Assembly Drawing and the General Arrangement Drawing shall be made to insure all internal components, i.e., soot blower, intermediate supports, flue gas baffles, etc., are installed and that all shipping steel is removed prior to setting upper section.

4.0 INSTALLING CROSSOVERS

If this unit has crossovers connecting the upper and lower sections that must be field installed, they should be installed as follows:

4.1 BOLTED CROSSOVERS - Install and make up flanges with gaskets and bolts shipped with the heater.

4.2 WELDED CROSSOVERS - These should be lined up and the welds completed on both ends with full penetration welds. If desired, a welding procedure used in the shop fabrication of the heater will be forwarded for guidance in making these welds.

Whether bolted or welded, the crossovers may require cold springing so they will position correctly in the hot condition.

5.0 SETTING STACKS

5.1 If the stack is lined, the refractory joint on the top of the heater should be prepared per Section III. prior to setting the stack. The stacks shall be set in place and bolted with high strength bolts as called for on the General Arrangement Drawings. High strength bolts shall be torqued up properly to insure that the required minimum tension necessary to realize full bolt strength is achieved. Stacks shall be set plumb to within 2" per 100 feet of height. This may require the use of shims which shall be furnished by the erector as required.

5.2 Stack field joints should be per the detail on either the General Arrangement Drawing or the Field Assembly Drawing. Internal stack shipping braces should be removed after the joints are complete and the stack is set in place.

6.0 FLOOR BRICK AND REFRACTORY

The floor brick shall be laid in dry observing expansion joints of approximately 1/2" every 6'-0". Please note the appropriate detail for basic brick layout and direction wall. The high temperature castables shown on the Field Assembly Drawing should be poured in place around the burner as indicated. Follow the mixing instructions on the bags of refractory shipped with the heater for this purpose.

7.0 INSTALLATION OF BURNERS AND PLENUMS

The burner should be installed and positioned in accordance with the burner drawing attached. Install burner tiles, if required, after burners are in place per the detail on the Field Assembly Drawings. If plenums are included on this heater and shipped separate for field installation, see Field Assembly Drawings for details.

8.0 INSTALLATION OF SOOT BLOWERS

When soot blowers are required, they shall be installed per the soot blower manufacturer's drawings attached.

9.0 FIELD PROBLEMS

If erection problems arise that are beyond the scope of this document, call or write:

TULSA HEATERS, INC.
1215 S. Boulder, Suite 1200
TULSA, OKLA. 74119
Phone (918)582-9918
Fax (918) 582-9916
info@tulsaheaters.com

NOTE:

THI will assume reasonable responsibility for field repairs resulting in backcharges to THI only if THI is notified of the problem in advance of the repair and gives written approval of the method of correction. Invoices for backcharges must be supported by documentation with a description of the problem, time sheets, etc. Invoices for backcharges must be submitted to THI for payment within ninety days after approval by THI is given. Failure to follow this will relieve THI of any responsibility for that repair.

10.0 ERECTION CONSULTANTS

Rates are available upon request.

SPECIAL INSTRUCTIONS FOR TULSA HEATERS, INC. JOB

ES-1-7

RECOMMENDED PRACTICE FOR FIELD REPAIR OF REFRACTORY

RECOMMENDED PRACTICE FOR FIELD REPAIR OF REFRACTORY

The heater has been fabricated using a 1:2:4 LHV refractory. This refractory was shop mixed by volume, pneumatically placed and air cured prior to shipment. In the combustion zone or other selected areas, an additional layer of high temperature refractory may have been placed. The heater General Arrangement Drawings will show type and location of refractories. When it is necessary to replace refractory either 1:2:4 LHV or a good quality 2200° castable such as Kaiser IRC-22 should be purchased to replace the 1:2:4 LHV. The high temperature refractory should be replaced with a comparable material.

If damage has occurred during shipment and handling or when field installation is required at shipping braces and stack and duct field joints, the following guide may be used to place new refractory. It should be noted that if a premixed refractory is purchased the manufacturer's recommended procedure should be followed. This document is not intended to replace the recommended procedure, but rather to supplement it or serve when such is not available.

1.0 PREPARATION

1.1 In general, if the refractory is cracked but the crack density is not more than two or three cracks per square foot and the cracks are not opened up more than 1/8", then the refractory need not be repaired.

1.2 When the damage is more severe, then the damaged area should be removed, full depth. Care must be taken to insure that the edge of the existing refractory is perpendicular with the steel. Remove all debris and inspect the anchors and replace if necessary. If the steel was coated internally prior to refractory installation, the coating should be repaired, if damaged.

2.0 MIXING

2.1 Each bag of castable refractory requires the addition of a specific amount of water (to determine the appropriate amount to use with your castable, consult the appropriate product information sheet) to develop optimum properties.

2.2 This refractory material hardens rapidly, so water should not be added until job is ready for application. The mixing water should be potable

water and free from acid, alkali, oil or any other impurity. The temperature of this water should be between 50°F and 70°F (near 70°F is the most desirable). Avoid contamination of the mix. Do not add any foreign material of any kind. Some materials that cause contamination include: oil, salt, sugar, flour, borax, other castables, mortars, Portland cement and some plastic refractories.

2.3 *For best mixing results, use a clean, paddle-type mortar mixer. This type permits the closest control of water content, mixes rapidly and thoroughly and develops good workability with the minimum amount of water. It can be used for relatively thick mix and then be emptied completely. On a large job, two or more mixers may be required to reduce or eliminate time wasted waiting for one mixer to finish a batch.*

2.4 *You can also mix in a stationary or movable-type concrete mixer. However, with many concrete mixers, it's often necessary to add a large amount of water to help the material flow easily when discharged. This means that you often end up using more water than is really needed to provide maximum strength. Another problem is that some of the more sticky castables can stick to the sides of the drum, preventing proper mixing and/or the dumping of the entire batch each time. The third, and least desirable, mixing method is by hand. It is very difficult to achieve uniform mixing using this method. It also takes more time than other methods, which means a greater effort is required to control water content. Hand mixing is usually done in a mortar box, in a wheelbarrow or on a clean, flat surface. The dry castable should first be dry mixed and then water added. The dry mixing should be very thorough and the water added slowly and gradually. Finally, the material should be mixed sufficiently to obtain a uniform surface.*

2.5 *When using lightweight insulating castables, additional precautions must be taken. These must also be mixed long enough to insure a proper mix, but longer mixing will break down the lightweight aggregate, which, in turn, will mean a greater weight per cubic foot as installed and a loss of insulating value. While normal castables should be mixed for three to five minutes, these lightweight castables require considerably more water and thus a shorter mixing time of from one-half to one minute is permissible.*

2.6 *When mixing castables in a power mixer or a wet-mix pneumatic gun, a portion of the required water (not exceeding 50%) should be placed in the mixer for a few minutes before the dry material is added. Only clean, potable water should be used.*

2.7 *Mixing should be three to five minutes. (Longer mixing tends to speed up setting and reduce strength.) The size of the batch should be limited to a volume that will permit thorough placement within fifteen minutes from the time that mixing is started. If the weather is hot, the mixture should be placed in ten minutes. Do not add water and start mixing once you have stopped and the mixture has begun to set. Throw the batch away and start a new one. When machine mixing is done, mixing time should be kept to approximately three or four minutes.*

2.8 *Water should be added to the batch slowly to avoid a 'soupy' wet mixture, that weakens the strength of the castable and causes shrinkage. Lumps and balls can also form when a great deal of moisture is applied too quickly.*

2.9 *The amount of water required by castables can vary considerably from the recommended quantity shown in the product information sheet. A part of this variation occurs due to normal variations in the size of the particles in the castable. The ball in the hand test is the best way to determine water content and the recommended quantities can be increased or decreased to get a correct ball in the hand.*

2.10 *To test your batch, make a small ball of castable 2" to 3" in diameter, throw it about 2" to 3" in the air and catch it on your open hand. Do this several times quickly. If this ball breaks apart, the castable is too dry. If it flattens out, it is too wet for a dense castable, but can be used as an insulating castable. If it 'flows' between your fingers, it is too wet for either use. It should just ' slump' a little without cracking.*

2.11 *Remember, the strength of the cured castable can be reduced as much as twenty-five percent by too much water. This mistake must constantly be guarded against as a soupy castable is easy to pour and place. It is virtually impossible to use too little water. When in doubt, use less water. Some high temperature castables are too wet when the ball in the hand is correct. This demonstrates itself when vibrating or working it into the mold. It may flow too easily and fines may come to the surface. It so, cut back the water until the ball cracks in your hand.*

3.0 *INSTALLATION*

3.1 *If you are casting against a porous material, such as insulating firebrick or insulating block, it is necessary for you to first waterproof the surface or*

thoroughly wet it to prevent water being taken from the refractory mixture. For the actual installation, the molds or forms should be well filled out by vibration, rodding or shaking to obtain uniform density, remove air pockets and voids and to develop a homogeneous and strong structure. Most castables can be puddled with a trowel or spade. For some of the more lightweight castables, a 1" X 2" or 2" X 4" piece of wood is better. In the case of heavier castables, a 3/4" or 1" diameter concrete vibrator is quite effective. The vibrator makes it possible to set the particles of the fresh castable in motion, reducing friction and thus giving the mixture the mobile qualities of a thick fluid, which will flow easily into place.

3.2 *Inadequate puddling is most often the cause of trouble but too much puddling or vibration can be harmful as well. It can cause the binder to come to the surface or concentrate next to the form. Or it may concentrate around the vibrator if it has not moved continuously. You can also leave a hole in the castable if you withdraw the vibrator too quickly. In the case of lightweight castables, too much puddling can compress or break down the aggregate, producing a finished product that is too heavy and not as efficient an insulator. Use the vibrator very sparingly with an insulating castable. When several mix batches are required for large areas, a new batch should be mixed and ready when the previous batch has been used. Casting or troweling on partially-set material can cause lamination.*

3.3 *Surface finishing should be kept to a minimum, and no effort made to trowel the castable to a slick finish. The reason for this is that an excessively worked surface can cause fines to come to the surface, sealing it off, and thus slowing down drying after the curing period has been completed. This also promotes dusting of the surface when the furnace is put into operation. In extreme cases, it can even cause the surface layer to peel off and spall prior to heating the castable.*

3.4 *The secret of sound castings is to place small batches, use little water, work it into place, quickly and leave the surface rough. Proper locations of expansion joints will allow you to place proper size batches.*

3.5 *In addition to the use of an internal or external vibrator, castables can in installed using pneumatic methods. This technique is very popular because it offers unique advantages when it is necessary for you to handle large quantities of material through a small access area. For example, you can charge your material at the location most convenient to you - a hundred feet or more away from point of access - then carry it to*

placement through a hose.

3.6 Pneumatic guns are available in two types: dry guns and wet guns. In the case of a dry gun, water is added at the discharge nozzle. however, it is recommended that you pre-wet the castables to reduce rebound losses and dusting. On the other hand, wet guns mix the castable in the charging chamber; the wet mix is then forced through the hose by air pressure.

3.7 Castable refractories can also be rammed effectively . . . by use of pneumatic ramming tools or it can be slap-troweled in place. Slap-troweling has been found to be very effective for:

3.7.1 Small jobs where gunning equipment is not readily available.

3.7.2 Insulating irregular and difficult surfaces such as structural steel and sharply curved areas with many openings and obstructions.

3.7.3 Constrained areas where it is difficult to take the gun and nozzle.

3.7.4 Jobs where the utilities for the gun are not readily available.

3.8 Another factor affecting choice is the rebound or wastage associated with gunning which ranges from 15% to 35%. Gunning uses more material, but fewer man-hours are required to place the material. With slap-troweling, little material is wasted, but the man-hours used are high.

3.9 Refractory castables for slap-troweling are mixed to a stiff consistency just as they would be for any other placement method. In fact, water content as determined by the "ball-in-hand" is usually ideal for slap-troweling. Water content can then be varied as the job goes on to suit the requirements of the individual craftsman doing the job. Do not add new water to the mix if it becomes stiff. This 'retempering' causes a reduction in strength and the mix should be discarded if it becomes too stiff. Next time, mix a smaller batch.

3.10 A pointed trowel with 8 to 9 inch long blade and off-set handle is used. This is called a 'brick' trowel. A 'plaster's' trowel is to be avoided. A small portion of the castable is picked up on the top of the trowel and then thrown against the surface to be insulated with an upward sweeping motion of the arm and a flip of the wrist (see sketch on page nine). This imparts sufficient velocity to the wet mass of material so it will stick where

it is placed and it consolidates into a monolithic coating with the material previously placed. It will also penetrate wire mesh or lath which forms the anchoring system for the castable. Using this technique, a job best proceeds from bottom to top or from left to right (for a right-handed craftsman) or from bottom left to top right. Make sure that manageable amounts of castable are placed near the point of placement so the craftsman can work efficiently.

3.11 *Less desirable than the above technique is a 'pushing' approach. Castable is picked up on the bottom of the trowel and pushed through the anchoring so it sticks to the surface and consolidates with the previously pushed material. 'Pushing' may be necessary with anchoring containing small openings.*

3.12 *Do not apply the castable in thin multiple layers as it will peel and spall during curing and upon exposure to heat. A single thickness layer is preferred. On occasions, this is impossible because the required thickness is too much for a single layer. A too-thick layer may sag or fall off before it can cure. Craftsmen have developed a two-layer rhythm which is very effective. The first layer of 2-3 inches is started and continues until the area where you started is firm and stiffened and has good body. High spots on the first layer can be scraped upward onto the face of the trowel and slapped into low areas. This also leaves a rough surface ready for the next layer. Do not let it completely harden and do not finish it or smooth it in any way. Then go back and start the second layer. The job proceeds in a quickly, developed rhythm of first layer, second layer, first, second, etc. The size of each section is established by the peculiarities of the job. When the job must be halted for the day, or anytime before, the first layer is allowed to totally cure, score it deeply before leaving with the point of the trowel. The scores can be X's with the lines 2-4 inches apart and angled into the material. Upon re-starting the job, liberally saturate the scored areas with water and proceed as before.*

3.13 *The preferred finishing technique is "as little as possible'" Excessive working of the surface pulls water, fines, and the cement binder to the surface. This surface layer can cause cracking and spalling during curing and upon exposure to weather. It will certainly cause spalling upon the application of heat.*

3.14 *Trim the surface with the trowel edge or screed it with the edge of a board. Then finish it with minimum action of the trowel bottom. Do not add water to the surface. An attractive technique is to use a burlap cloth.*

After surface leveling, rub with the cloth in a consistent pattern to provide a textured surface.

4.0 CURING

4.1 Both high and low temperatures should be avoided while the castable is curing or developing it's hydraulic bond. What is most desirable is that both the mix and the water be in the range of 60°F to 70°F in temperature. Higher mix temperatures and higher ambient and curing temperatures (70°F to 90°F) are desirable for some very low castables and may be required to avoid excessive spalling during initial heating in some applications. You should also take special precautions if the atmospheric temperature is below 40°F or higher than 90°F.

4.2 Low temperatures tend to decrease the rate at which the castable sets up. In fact, at temperatures slightly above freezing, a castable will typically take twice as much time to cure . . . before the forms can be removed.

4.3 If your castable has been stored at temperatures below freezing, it is recommended that you use warm water for mixing or, even better, place it in a warm room for at least 24 hours. Otherwise, ice crystals may develop in the mix and result in poor workability. Castables should always be safely above freezing when installed.

4.4 Temperatures above 90°F can increase the rate at which castables set up. It is, therefore, not a good idea to store a castable beside a furnace or in bright sun. If the castable is too warm as it is mixed, it is suggested that you use chilled water to reduce the temperature of the mix so that you will have sufficient time for installation before it begins to set.

4.5 Castable refractory also needs moisture to develop optimum strength. The surface should be kept moist with a very fine spray of water. Another good method is to cover the fresh castable with wet cloth bags that completely seal the surface. Do not place the bags directly on the castable, but support them an inch or more above the surface. They should be kept wet continuously until the concrete is 24 hours old. Set will normally occur eight to ten hours after the concrete is mixed. To verify set, rub a small moistened area with a finger. If the finger is not soiled, the concrete may be considered to have set to the stage where the surface will not be washed by the curing water. A large volume of curing water is not required.

4.6 Curing can also be accomplished with a resin base membrane curing compound that is applied with a spray gun. Timing for this method is the same as for the water-curing routine. The curing compound seals the exposed surface of the castable, preventing evaporation of moisture within the mass for hydration of the binder. Where large areas are involved and lining thickness does not exceed 12 inches, this is the most economical curing method.

4.7 Molds or forms should not be removed until the castable has set. Following the curing, the castable may be exposed to heat immediately or it can be air dried indefinitely. Naturally, the longer it air dries before exposure to temperature, the more strength it will develop. However, the increase in strength becomes negligible after the first seventy-two hours.

5.0 HEAT-UP

5.1 All castable installations should be thoroughly heat dried before being placed in service, but not too quickly. There are two reasons for this: (1) They have a much lower permeability than comparable brick or plastic refractories, which makes it more difficult for water to pass through and escape as the castable is heated; and (2) rapid heating can cause cracks to develop on the cold face which extend part way through the lining to the hot face. Instead, it is recommended that temperatures be raised slowly. Prior to start-up, the refractory should be dried. This will give long setting life with a minimum of maintenance.

5.2 If the unit has pilots, light the pilots as soon as possible and allow them to burn for at least 24 hours before starting the drying out period. A low fire should be established with the secondary air doors on the burner wide open. With no process flow in the coil, raise the flue gas temperature by 50° F per hour to 300°F. Flue gas temperature should be held at 300°F for eight hours. Next raise the flue gas temperature 50°F per hour to 400°F and hold for eight hours. Finally raise the flue gas temperature by 50°F per hour to 500°F and hold for eight hours.

6.0 STORAGE

6.1 To avoid moisture absorption, castables should be stored in a cool, dry, well-ventilated atmosphere. Under these conditions, the material will lose strength at a rate of about ten percent over a year. However, if the castable is stored for prolonged periods, it should be tested for air-dried strength before using.

6.2 *Exposure to moisture will cause a hard gritty lump, which will have a reduced cementing effectiveness.*

6.3 *Bags should be stored indoors, under plastic. If it is necessary to store your castables outdoors, they should be placed on a ventilated platform off the ground and protected by some type of water-proof covering such as a tarpaulin. This tarpaulin should be arranged in such a way that no water can come in contact with any of your sacks. It should stop a short distance from the ground and effective ventilation must be provided. The storage area should also be covered with a heavy plastic sheet before the castable is stored to prevent ground moisture damage. This same precaution should be observed if your need is to store castable on concrete which is in contact with the ground.*

ES-9-3

LIFTING REQUIREMENTS – HEATER COMPONENTS

LIFTING REQUIREMENTS - HEATER COMPONENTS

1.0 SCOPE

This standard is written to set the minimum requirements for lifting of heater and waste heat recovery components as manufactured by or for Tulsa Heaters, Inc. It is not intended to advocate any specific rigging scheme but rather to insure that the basic design parameters that are essential for safe handling and lifting are not violated.

2.0 HORIZONTAL

Horizontal sections i.e. cabin type radiant sections, convection sections, horizontal ducts, sectional vertical heaters etc. shall be lifted using every lifting lug that is provided for that section. The loading on the lug shall be such that minimal lateral thrust is applied.

3.0 VERTICAL

Stacks, vertical ducts and single piece vertical radiant sections shall be lifted using either a combination of the lifting lugs at the top (final position) of the section and slings or slings only. Placement and number of the slings shall be such as to preserve structural integrity and minimize scuffing of the paint. Base plates on radiant shells may also be used for lifting when the shell is horizontal.

4.0 RESPONSIBILITY

The responsible party shall be that entity with whom Tulsa Heaters, Inc. has a contract. All subcontractors i.e. the lifting contractor et al shall be that vendors responsibility. All lifting beams, cables shackles etc. shall be supplied by the lifting contractor. If lifting lugs are bent or the section damaged by improper lifting, repairs will be made at the expense of the responsible party. It is strongly recommended that provisions be made for the lifting of major pieces early in the project so that any special considerations may be addressed. THI is available to work with any interested party to work out these special considerations to ensure the safe and timely completion of the project.

MJ16-185-SHOep

SUGGESTED SHO HEATER ERECTION PROCEDURE

SUGGESTED SHO HEATER ERECTION PROCEDURE

	Name	Reference Number	
Owner:	Dyno-Nobel	E-1351	
Customer:	Callidus Technologies		
Heater OEM:	***TULSA HEATERS MIDSTREAM, LLC***		MJ16-185
Burner OEM:	Universal Combustion	16-109	
FD Fan OEM:	New York Blower	2016-06170-001	
Jobsite:	Louisiana, MO.		
Unit:	Thermal Oxidizer		
Service:	Indirect Fired Air Heater		

Customer PO Number:	4500700579
THM Project Manager	Jeff Conner

Document Number	Date	By	Description
SHO SEP Rev01	20.Feb.13	BTE(TLC)	Expanded for Clarity
SHO SEP Rev02	10.Nov.15	JDC	Expanded on Multi-Piece Field Erection Sequence

SHO = Superior Quality, Flexibility, Dependability & Modularity

INDEX

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1. SCOPE

1.1 This **THM** Engineering Standard (THMES) provides the minimum recommended requirements for the receiving, short-term storage, preparations and field erection of **THM** SHO Heaters and their respective CMS Skids, as applicable.

1.2 This THMES is not intended to address the minimum field erection requirements of **THM**'s Std560 Fired Heater and WHRU product lines, which are addressed in separate Engineering Standards.

1.3 This THMES is not exhaustive or all-inclusive; it is the Field Erector's responsibility to build upon the foundation of this THMES to arrive at a sufficiently detailed Erection Procedure that will promote the safe and technically correct field erection of the subject modules and materials.

2. APPLICABLE DOCUMENTS

2.1 Applicable Industry Standards

The latest edition of the following Industry Standards and Codes (in effect at the time of Order placement) shall be considered an integral part of this procedure:

Standard	Rev	Description
API Standard 560		Fired Heaters for General Refinery Service
ASME Section V		Non-Destructive Examination Qualifications
ASME Section VIII -1		Boiler & Pressure Vessel Code
ASME Section IX		Welding and Brazing
ASME B31.3		Petroleum Refinery Piping
AWS D1.1		Structural Welding
AISC		Steel Construction
OSHA		Occupational Safety and Health Act
IBC		International Building Code
PIP		Process Industry Practices

2.2 Applicable **THI** (Tulsa Heaters, Inc.) Standards

THI Standard	Rev	Description
THI ES 1-5	0	Field Installation Notes – Vertical Cylindrical Heaters
THI ES 1-7	1	Recommended Practice for Field Repair of Refractory
THI ES 9-3	0	Lifting Requirements – Heater Components

2. APPLICABLE DOCUMENTS (continued)

2.3 Job Specific Documents

Document	Rev	Description
THM SHO Drawings **		
MJYR-SEQ- 1A		GA Side Elevation of SHO & CMS (incl. Component List)
MJYR-SEQ- 1B		GA Burner & Arch Elevations of SHO
MJYR-SEQ- 1C		GA Plan View of SHO
MJYR-SEQ- 1D		GA Refractory & Paint Systems of SHO
MJYR-SEQ- 2A		GA Foundation & Anchor Bolt Plan
MJYR-SEQ- 4A		Details of Convection Coil (incl. Bill of Material)
MJYR-SEQ- 4A		Details of Inlet / Outlet Manifolds & Crossovers (incl. Bill of Material)
MJYR-SEQ- 4B		Details of Radiant Coil
CMS OEM Drawings		
reference varies		P&ID (Process & Instrument Diagram) for CMS & SHO
reference varies		GA End Elevations of CMS Skid (incl. Bill of Material)
reference varies		GA Side Elevations of CMS Skid
reference varies		Wiring Diagrams/Schematics (typically 3 pgs)
reference varies		Field Wiring Diagram (w/ wiring designations)
reference varies		Layout for Local Control Panel (incl. Bill of Material)
reference varies		Layout for Skid Junction Box (incl. Bill of Material)
reference varies		Layout for Ign.Transformer Encl. (incl. Bill of Material)
Burner OEM Drawings		
reference varies		Assembly Drawing of Burner (incl. Bill of Material)
reference varies		Assembly Drawing of Pilot (incl. Bill of Material)
Shipping Documents		
MJYR-SEQ- SC1		SHO Shipping Clearance Drawing (incl. ship weights)
MJYR-SEQ- FSL		SHO Fabricated Steel Shipping List
MJYR-SEQ- ESL		SHO Engineering Shipping List
MJYR-SEQ- PSL		SHO Platforms Shipping List (as applicable)

** Note:
THM's GA Drawing (GAD) numbers are expressed as year-job-sequence number combination. A couple of examples follow to illustrate our numbering convention. In this document, GAD's are referenced as 1A, 1B, 4A, etc.
a. For job 200 sold in 1998, the 1A GA Drawing would be MJ98200-1A.
b. For job 757 sold in 2011, the 4A GA Drawing would be MJ11757-4A.

2. APPLICABLE DOCUMENTS (concluded)

2.4 Applicable OEM Installation, Operations and Maintenance Manuals are as follows:

OEM IO&M Manuals	Rev	Description
Primary Engineered Components		
reference varies		Burner IO&MM
reference varies		FD Fan/ Blower IO&MM
reference varies		HMI Panel IO&MM
reference varies		Ignition Transformer IO&MM
reference varies		Main Fuel Gas Flow Control Valve IO&MM
Primary Controllers (in LCP)		
reference varies		Flame Safeguard/ BMS Controller IO&MM
reference varies		Process Temperature/ Duty Controller IO&MM
reference varies		Flue Gas O2 Trim/ Excess Air Controller IO&MM
Primary Interlock Devices		
reference varies		Fuel Gas Supply PSLL Switch IO&MM
reference varies		Main Fuel Gas Header SDV (Block Valves) IO&MM
reference varies		Main Fuel Gas Header SVV (Vent Valves) IO&MM
reference varies		Fuel Gas to Burner PSHH Switch IO&MM
reference varies		Pilot Fuel Gas Header SDV (Block Valves) IO&MM
reference varies		Combustion Air to Burner PSLL Switch IO&MM
reference varies		Burner Element/ UV Detector IO&MM
reference varies		Radiant Flue Gas/ Firebox PSHH Switch IO&MM
reference varies		Stack Flue Gas TSHH Switch IO&MM
reference varies		Process Flow FSLL Switch
reference varies		Process Temperature TSHH Switch

3. GENERAL

3.1 Field Erector's Responsibilities

3.1.1 It is the Field Erector's responsibility to generate a job-specific Erection Procedure that incorporates the following industry standards, the Customer's / Owner's specifications and all applicable laws (local, state & federal, as appropriate). The Field Erector may wish to change the erection sequence suggested in this document and may do so to suit the local laws, local conditions, site conditions, customer specifications or the erection contractor's capacities.

3.1.2 It is recommended that the Field Erector advise **THM** before making any substantial deviations from these guidelines.

3.1.3 Specifically, it is the Field Erector's responsibility to understand the complexity of this effort and to develop an appropriate Field Erection Procedure (and supporting methods) to complete all field erection efforts in a safe and timely manner.

3.1.4 The Field Erector must be competent and capable of performing the industrial quality work that will be required to complete the erection.

3.1.5 The Field Erector should use the applicable industry standards and **THM** supplied documents (noted in Section 2) to further his understanding of the SHO heater and CMS skid design basis and their field erection requirements.

3.1.6 It is recommended that the Field Erector visit **THM**'s FabShop prior to shipment of the modules and materials to the job site. During this visit, the **THM** project team will be willing to meet with the contractor to discuss any issues pertaining to this project.

3.2 Corrections, Changes & Modifications

3.2.1 The Field Erector should be advised that unauthorized changes to a SHO heater and/or its CMS skid could void the Process, Mechanical, Combustion and/or Controls Warranties that **THM** has extended to the Purchaser and Owner. If field changes are appropriate and necessary, please communicate with **THM** via phone (918 392-8000), fax (918 582-9916) or email (info@tulsaheatersmidstream.com).

3.2.2 The Field Erector should be advised that strict adherence to the information and details given in **THM**'s contract drawings and documents provided by **THM** is mandatory and no deviation is accepted by **THM** without written consent from **THM**.

3.2.3 **THM** does not accept field backcharges without prior written notification and acceptance. The written notification must include a description of the problem, pictures if possible and the Field Erector's estimated time and costs to correct the issue or problem.

3.2.4 **THM** will review the Erector's notification and establish the appropriate revision, if any.

3.2.5 **THM** will either send personnel to correct the problem, or accept the Field Erector's backcharges, as defined by the written notification.

3.2.6 **THM** has an emergency number for "after hours" support. Please call **THM**'s main line at (918 392-8000) and be prepared to write down the emergency number from the voice message system.

3. GENERAL (concluded)

3.3 Receipt of Modules and Materials at the Jobsite

3.3.1 Field / receiving personnel should inspect all SHO heater modules for damage(s) immediately after unloading and prior to their acceptance of the shipment. Any and all damage(s) should be noted on the Bill of Lading and the immediately forwarded to the Transporter of record for his information and action. Again, any and all damage(s) must be recorded on the Bill of Lading before signing / accepting the shipment.

3.3.2 Any and all damage(s) identified after acceptance of a module will be considered handling & installation damage and will NOT be to the Transporter's account.

3.3.3 As a matter of corporate practice, **THM** does not typically provide shipping services to the jobsite. Nevertheless, even though **THM** will not typically provide shipping services, Field / Receiving personnel may contact **THM** for technical support of transportation damages by Others. Refer to the contact information noted above.

3.3.4 Inspect the burner tile to verify there was no damage to it during transportation.

3.4 Short-Term Storage

3.4.1 All SHO and CMS modules have short-term storage (time < 6 months) capability.

3.4.2 Modules may be stored outside, but the shipping covers and weatherproofing must remain intact - - as installed by **THM** at our FabShop.

3.4.3 Modules and materials must be cribbed up and are not meant to set on grade.

3.4.4 Modules and materials must not be stored in "standing water" (ie, do not store modules & materials in low areas at jobsite that could flood).

3.4.5 Crates, pallets and other materials must be protected from the elements and are not intended to be left unprotected. Components must be set / stored level.

3.4.6 Components must be set / stored level.

3.5 Long-Term Storage

3.10.1 **THM**'s sales basis was predicated on the timely assembly of the SHO heater and its CMS skid. No provisions were included in **THM**'s scope for the long-term storage of the SHO heater, the CMS skid and/or field erection materials.

3.10.2 Contact **THM** for support of long-term storage applications.

4. PREPARATIONS

4.1 Safety Plan

It is the Field Erector's responsibility to create and maintain a safe working environment for their personnel and if appropriate, to develop a safety plan for the subject effort.

4.2 Lift Plan

Lift Plans for all modules / major components must be provided to and approved by the Owner or the Owner's Representative prior to mobilization at the job site.

4.2.1 The lift forces acting on the lifting lugs (ie, eyes) shall be vertical / straight up; lateral or longitudinal thrusts against the lugs are NOT permitted. The lifting lugs are NOT designed to accept lateral or longitudinal loads.

4.2.2 For lifting purposes, the weights of the heater modules will be the AS SHIPPED WEIGHT taken from the freight bill of lading for the particular section being lifted. All other weights are to be considered estimates only and are not suitable for lifting purposes. Contact **THM** if this data is not available.

4.2.3 In general, the lifting lugs attached to a given module are designed for the lift forces of ONLY that module. If any combination of modules is joined prior to lifting creating a "super-module", then the lugs of the super-module must be reevaluated for the new lift.

4.2.4 If special lift combinations were identified during the SHO design, then those lift combination evaluations can be found in the structural analysis document, which is normally numbered with a suffix of 2B.

4.3 Foundations

Foundations (and anchor bolts) for the SHO+CMS module and for the Remote Control Panel shall be supplied by Others, in accordance with the **THM**'s GA Drawing "2A" and the structural calculations of "2B".

4.3.1 Foundations should be installed at least 30 days prior to setting the SHO modules.

4.3.2 The Field Erector should verify the following prior to start of erection:

a. Heater orientation.
b. Elevation of Foundation.
c. Location, orientation and size of anchor bolts.

4.3.3 It is suggested that a lower elevation reference point be set into the foundation, to enable the Field Erector to readily check the elevation of the base plate.

4.3.4 After the elevation mark is set, the column base plate elevation can be set by using shim plates with a smooth bearing surface set at the designated elevation.

4. PREPARATIONS (continued)

4.4 Process & Utilities Tie-Ins

The SHO + CMS will require the integration of the following into the plant's piping and utilities. It would be prudent for the Field Erector to take the appropriate preparatory steps to complete the tie-ins during the field erection phase.

4.4.1 Process Piping; Process Fluid TO SHO Heater,
4.4.2 Process Piping; Process Fluid FROM SHO Heater,

4.4.3 Fuel Piping; Gas TO CMS Skid,

4.4.4 Utility Piping; Gas Vented FROM CMS Skid (Optional, per Owner's Standards),
4.4.5 Utility Piping; Instrument Air TO CMS Skid,

4.4.6 Electric Power; 120 V/ 1 phase/ 60 Hz power to the Local Control Panel, and
4.4.7 Electric Power; 480 V/ 3 phase/ 3-60 Hz power (from VFD) to the FD Fan Motor.

Note that the above listing does NOT address the SHO's instrumentation tie-in requirements.

4.5 Materials and Modules Checks

To ensure the timely assembly of the SHO+CMS, it is recommended that prior to the start of the field erection activities (by some 2 -3 weeks), it would be prudent for the Field Erector to take inventory of the materials and modules at the jobsite relative to the following documents.

4.5.1 SHIPPING CLEARANCE Drawing; provides sizes & shipping weights of modules.

4.5.2 STEEL FABRICATION SHIPPING LIST; provides a comprehensive list of fabricated modules and materials.

4.5.3 ENGINEERING SHIPPING LIST; provides a comprehensive list of all engineered components that are NOT integrated into the heater modules, such as crossovers, pressure part bolts and gaskets and engineered components.

4.5.4 CMS SHIPPING LIST; provides a comprehensive list of Burner and CMS components.

4.5.5 PLATFORMS SHIPPING LIST; provides a comprehensive list of platforms, as applicable to the job scope.

4. PREPARATIONS (concluded)

4.6 SHO Heater Prep

4.6.1 Confirm that the Field Office has all of the latest copy of each GA Drawing (per the drawing list on GA Drawing 1A). Refer to section 2 for a listing of the relevant SHO documents.

Note: THM's GA Drawing numbers are expressed as year-job-drawing number sequence. A couple of examples follow. In this document, GAD's are simply referenced as 1A, 1B, 4A, etc.

a. For job 200 sold in 1998, the 1A GA Drawing would be MJ98200-1A.
b. For job 757 sold in 2011, the 4A GA Drawing would be MJ11757-4A.

4.6.2 Confirm that the Field Office has the latest SC1 - Ship Clearance Drawing (which provides the sizes and shipping weights of all major modules).

4.6.3 Confirm that the modules and materials noted in the SHIPPING LISTS of subsections 4.5.2 and 4.5.3 have been received and accepted by the Jobsite. If the project scope includes some ladders and platforms, confirm that the materials noted on the PLATFORMS SHIPPING LIST have been received at the Jobsite.

4.6.4 Erector should verify document revisions with owner before starting erection to ensure that the Field Office has the current revisions of same.

4.7 CMS Skid Prep

4.7.1 Confirm that the Field Office has all of the latest copy of each CMS Drawing Index. Refer to section 2 for a listing of the relevant CMS documents.

4.7.2 Confirm that the modules and materials noted in the SHIPPING LISTS of subsections 4.5.4 have been received and accepted by the Jobsite.

5. FIELD ERECTION SEQUENCE

SHO Mechanical

5.1 After the foundation / piers are found to be acceptable per section 4.3 and the GA Drawings, proceed with the following procedure:

5.2 Using **THM**'s GA Drawings 1A, 1B, 1C, 1D, 4A, 4B as references, lift / set the single piece radiant module onto the foundation piers in the proper orientation per the Approved Lift Plan (reference section 4.2).

Note 5.1: Lifting lugs are NOT designed to accept lateral or longitudinal loads; use spreader beams (as required) to obtain a vertical / straight-up lift.

Note 5.2: For a multi-piece radiant, individually set each module per the GA Drawings. Noting proper orientation, install the lower radiant section first. Ensure that the lower section is squared, leveled and plumbed. Remove the wooden cover and shipping steel from the lower section. Install the radiant coil onto the coil support rails in the lower section floor. Refer to the GA drawings for proper orientation and placement. The outlet coil flange will have an ASME code plate attached to it. This end of the coil should face the same end as the burner and the combustion management skid. Do not remove any of the coil shipping steel at this time. Noting proper orientation, remove the endwall plates from the upper radiant section. Lift this section onto the lower section. Install field joint bolts loosely prior to the re-installation of the endwall plates to the upper section. Before tightening field joint bolts make sure the upper section is squared, leveled and plumbed. Verify the radiant coil projections and install the radiant outlet manifold per the GA drawing. Install the manifold support between the manifold and the top of the radiant section.

Note 5.3: Whole sections must be squared, leveled and plumbed before placing any piece on top of it. Example: a multi-part radiant section must have all pieces, set (Lower, Radiant Coil and Upper) with bolts snugged first. Then, the whole radiant section is squared, leveled and plumbed before the next piece is set.

Note 5.4: When making field joints in multi-piece radiant sections (lower portion of heater), do not fully tighten the joint bolts until the entire radiant section has been leveled and plumbed. Tightening the bolts before the whole section is leveled and plumbed has been known to cause fit-up issues, rework and possible damage.

Note 5.5: Joint Refractory - where required - should be installed before bolting joints, so the joint refractory is compressed when the field joint bolts are installed. This joint refractory is to create a flue gas tight seal. Joint diagrams are located on the refractory drawing (1D).

Note 5.6: It is standard practice is to use drift pins to align bolt holes when setting modules.

Note 5.7: The top of each section should be checked for square, level, plumb and elevation before proceeding further. Shim as required to correct. Shims shall be provided by the erection contractor.

Note 5.8: Unless stated to the contrary, all A325 field joint bolts should be tightened per AISC's Turn-of-the-Nut Pre-Tensioning practice.

Note 5.9: Remove shipping bracing (painted yellow) as the erection sequence is completed.

5.3 Double-check / confirm the radiant module's proper orientation before proceeding.

5. FIELD ERECTION SEQUENCE (continued)

SHO Mechanical

5.4 After the elevation mark is set, the radiant module's base plate elevations can be set at the designated elevation by using shim plates (with a smooth bearing surface).

5.5 Square, level and plumb the radiant section.

5.6 Remove the wooden cover on the radiant roof casing flange (dispose of the wooden cover – it is no longer needed).

5.7 With the radiant roof opening and arch access door providing some flow through ventilation, remove the radiant coil's shipping steel (with yellow markings) in the center of radiant coil. Be careful to avoid damaging the radiant coil and radiant refractory.

Note 5.10: It is recommended that a suitable working / walking surface be laid on the radiant coil; shipping steel and floor materials should enter and exit the radiant module via the personnel access door on the arch endwall.

5.8 Install the appropriate refractory in the radiant / convection field joint and set the convection module on the bolting flange in the proper orientation.

5.9 Double-check / confirm the convection section's orientation for compliance with GA Drawings.

5.10 Square, level and plumb the convection section.

5.11 Bolt the convection section onto the radiant section with A325 Galvanized High-Strength Bolts (GHSB's), Galvanized Beveled Washers and A325 Galvanized Heavy Hexagonal Nuts (GHHN's) as shown within the GA Drawings.

Note 5.11: Bolting hardware quantity is defined by the ENGINEERING SHIPPING LIST.

5.12 Remove the wooden cover on the upper convection casing flanges (dispose of the cover).

5.13 Set the transition / stack assembly on the convection section (in the proper orientation).

5.14 Double-check / confirm the stack assembly's orientation for compliance with GA Drawings.

5.15 Square, level and plumb the transition / stack assembly on the convection section.

5.16 Bolt the transition / stack section to the convection section with A325 Galvanized High-Strength Bolts (GHSB's), Galvanized Flat Washers and A325 Galvanized Heavy Hexagonal Nuts (GHHN's) as shown within the GA Drawings.

5.17 If platforms are included in the job scope (reference the PLATFORMS SHIPPING LIST), it is recommended that the Field Erector install ladders and platforms as soon as possible and simultaneously with the erection of heater modules. Platforms, ladders and handrails create better accessibility. In the interest of personnel safety, however, platforms should not be used without proper railing and walking surfaces securely attached.

5.18 Using **THM**'s GA Drawings 1A, 1B, 1C, 1D, 4A, 4B as references, lift / set the ladders and platforms single piece radiant module onto the foundation piers in the proper orientation per the Approved Lift Plan (reference section 4.2). Some units are supplied with ladders and platforms

5.19 After the erection of the SHO Heater - - and a final check for level and plumb has been carried out - - the gaps between the bottom of the base plates and concrete foundations may be properly grouted.

5. FIELD ERECTION SEQUENCE (continued)

SHO Process Coil & Manifolds

5.20 GA Drawings 4A & 4B provide design specifics on the convection & radiant coils, respectively.

5.21 The radiant coil has been fully shop fabricated into its final form as a helical or serpentine coil.

Note 5.12: Helical coils are bottom supported by two supports aligned from endwall to endwall.
Note 5.13: Serpentine coils have intermediate supports on the roof, both walls and on the floor.
Note 5.14: Typically, radiant coils are shop installed, but larger sizes may be field installed to accommodate shipping restrictions / limits.

5.22 The convection coil has been fully shop fabricated into its final form in the convection section. Typically, the convection section provides counter-current operation, which places the inlets at the top and outlets at the bottom of the convection module, but co-current applications are provided in a minority of applications. SHO convection coils are supported by end tubesheets.

5.23 Crossovers connect the convection coil to the radiant coil and are shop fabricated into complete spools with flanged connections. There will always be one crossover per pass. Larger SHO Heaters and two-phase coils are often supplied with crossover supports to minimize the risks of excitation / vibration. Refer to **THM**'s GA Drawings to determine if supports have been provided.

5.24 Remove radiant and/or convection manifold shipping steel (if supplied by **THM**).

Note 5.15: per the task below, inspect the burner tile before re-installing the access door.

5.25 Position the radiant coil in the radiant section by using the dimension from outside of radiant section to face of flange as shown on the 1A GA Drawing.

5.26 Install the crossovers with the appropriate bolting and gaskets (per drawing 4A and 4B) and crossover supports (if supplied by **THM**).

5.27 Upon mechanical completion, the coil & manifolds may be hydrotested a second time; the coil and manifolds were hydrotested at **THM**'s FabShop. Refer to THM's Hydrotest calculations for more details on the coil's and manifolds' capabilities and limitations.

5.28 reserved for future use

5.29 reserved for future use

5. FIELD ERECTION SEQUENCE (continued)

SHO Refractory and Insulation

5.30 Refractories in both the radiant and convection sections have been shop installed per the GA Drawings, API Standard 560 and **THM** Standards. Prior to erection, it is recommended that the Field Erector confirm that the shop installed refractories are undamaged.

Note: 5.16: It is recommended that the Field Erector take reasonable precautions to keep the ceramic fiber refractory dry. Contact **THM** for support on drying water soaked blanket systems.

5.31 Install the tube seals at all radiant and convection terminals (including crossover terminals).

5.32 Install the Owner specified piping insulation & sheathing on the Inlet and Outlet Manifolds. It is NOT appropriate or necessary to insulate the coil terminals connecting to the Manifolds (ie, the coils between the casing and the manifolds). The tube seals provide some insulating characteristics and permit the coil to freely expand and contract; rigid insulation will interfere with the operation of the tube seals and potentially compromise the flue gas tight seal provided by the tube seals.

5.33 Install the Owner specified piping insulation & sheathing on the crossovers. It is NOT appropriate or necessary to insulate the coil terminals extending out of the convection and radiant casings. The tube seals provide some insulating characteristics and permit the coil to freely expand and contract; rigid insulation will interfere with the operation of the tube seals and potentially compromise the flue gas tight seal provided by the tube seals.

5.34 reserved for future use

5.35 reserved for future use

5.36 reserved for future use

5.37 reserved for future use

5.38 reserved for future use

5.39 reserved for future use

5. FIELD ERECTION SEQUENCE (continued)

Burner and Combustion Management System (CMS)

5.40 The CMS Skid and Panel wiring was completed and tested during the FAT.
5.41 The CMS Controllers were configured and tested during the FAT.
5.42 The CMS Burner and FD Fan were NOT tested during the FAT.

5.43 Use the CMS Documents noted in Sections 2.3 and 2.4 to facilitate the installation and wiring of the following local instruments. Of particular benefit will be the Field Wiring Diagram that summarizes all field wiring to be performed by the Field Erector.

5.43.1 Complete "Remote Heater Run" permissive wiring to Panel.
5.43.2 Complete "Remote ESD Shutdown" permissive wiring to Panel.
5.43.3 Complete power wiring to FD Fan Motor Starter.
5.43.4 Complete power wiring from FD Fan Starter to FD Fan VSD/VFD.
5.43.5 Complete power wiring from FD Fan VSD/VFD to FD Fan Motor.

5.43.6 Complete wiring of Motor Starter and VSD/VFD to Panel
5.43.7 Complete "ESD-100" permissive wiring to J/B.
5.43.8 Install Stack TE/TW assembly for TSHH and complete type JX wiring to Panel.
5.43.9 Install Process TE/TW assembly for TSHH and complete type JX wiring to Panel.
5.43.10 Install Process TE/TW assembly for Control and complete type JX wiring to Panel.

5.43.11 Complete "Process Low Flow" FSLL wiring to skid J/B.
5.43.12 Complete "Burner Element" BE wiring to Panel in separate conduit.
5.43.13 Complete "BMS Burner Status" wiring to Panel.
5.43.14 Complete "BMS Heater Alarm wiring to Panel.
5.43.15 Install O2 / Oxygen Probe and complete wiring to CMS Skid.

5.43.16 Complete control wiring for "Remote Temperature Setpoint" from DCS to Panel
5.43.17 Complete control wiring from fuel gas "Flow Control Valve" Operator to Panel.
5.43.18 Complete wiring between Panel and Ignition Junction Box.
5.43.19 Complete wiring between Panel and Skid J/Box for Main Train SDV1 interlock.
5.43.20 Complete wiring between Panel and Skid J/Box for Main Train SDV2 interlock.

5.43.21 Complete wiring between Panel and Skid J/Box for Low Gas Pressure interlock.
5.43.22 Complete wiring between Panel and Skid J/Box for High Gas Pressure interlock.
5.43.23 Install PSHH switch below convection tubes - on convection sidewall - and wire switch to Skid J/B for High Firebox Pressure interlock.
5.43.24 Complete wiring between Panel and Skid J/B for Low Combustion Air Flow interlock.
5.43.25 Complete wiring between Panel and Skid J/Box for Pilot Train SDV (all 3) Actuation.

5.43.26 Complete wiring between Panel and Skid J/Box for Main Train SDV1 Actuation.
5.43.27 Complete wiring between Panel and Skid J/Box for Main Train SDV2 Actuation.
5.43.28 Complete wiring between Panel and Skid J/Box for Main Train SVV Actuation.
5.43.29 Complete power wiring to Panel (120V/ 60 Hz/ 1 ph).
5.43.30 Install instrument air piping from local IA source to CMS Skid Instrument Air Header terminal flange.

5. FIELD ERECTION SEQUENCE (concluded)

Burner and Combustion Management System (CMS)

5.44 Confirm that the burner is installed in the burner endwall per the Burner OEM's drawings and installation manual.

5.45 Verify that the burner is mounted perpendicular to the endwall, such that the burner will horizontally fire into the center of the firebox. Adjust (ie, square, level and plumb) the burner mounting to obtain a perpendicular mounting.

5.46 Confirm that the burner tile wasn't damaged during installation.

5.47 Add any required refractory (eg, expansion gap) materials between burner tile and endwall refractory. Consult the Burner OEM's IO&M Manual for specific requirements.

5.48 Confirm that the pilot igniter electrode gap is approximately 1/8".

5.49 Confirm that the burner fuel gas and pilot gas piping connections are sufficiently tight (they could have loosened during shipping).

5.50 Confirm that the burner ignition wiring (enclosure to spark plug) is intact.

5.51 Confirm that the FD Fan Assembly is firmly mounted to the CMS Skid (its mounting bolts could have loosened during shipping).

5.52 Upon the proper completion of the above steps, the CMS is ready to be powered up (but not ready for operations).

5.53 For improved access to the burner endwall and local components, the control skid knee bracing may be removed once the CMS Skid is set into place (this step is optional).

5.54 reserved for future use.

5.55 reserved for future use.

6. CONCLUDING Q/A

6.1 Upon proper installation of the crossovers, the coil & manifolds may be hydrotested a second time; the coil and manifolds were hydrotested at **THM**'s FabShop. Refer to THM's Hydrotest calculations for more details on the coil's and manifolds' capabilities and limitations.

6.2 Prior to connecting the SHO manifolds to the plant piping, remove any and all debris in the process piping (to and from the heater) with a suitable flushing or pigging procedure.

6.3 Prior to connecting the CMS skid to the plant piping, remove any and all debris in the fuel gas and vent gas piping (to and from the CMS) with a suitable flushing or pigging procedure.

6.4

7. START-UP / COMMISSIONING

7.1 Refer to the **THM**'s Owner's Manual for commissioning and operating guidelines and tutorials.

MJ16-185-CHS

START UP PROCEDURES FOR COLD AND HOT STARTS

START UP PROCEDURES FOR COLD AND HOT STARTS

Cold Startup - The following sequence of operation is typical and recommended for the THM heater but should be verified by the BMS (Burner Management System) supplier. 1) Confirm that you have gas pressure to the system and all manual block valves to the pilot and main burner are opened. Confirm that there is process flow (compressed air) flowing through the heater coil. The automated shutdown valves for both the pilot and main gas trains should be closed (by the PLC) at this time. When the operator signals that they are ready to start the system the PLC will check that all the permissives and interlocks are in place to allow for a start of purge. 2) Start Purge. The purge is done with the combustion air blower set to maximum RPM and with all dampers in the wide open position. A timed purge should allow for a total of four volume changes in the heater and downstream system. Assuming the timing is not interrupted by an interlock activation, it will continue until complete. Once finished, it will notify the operator that "Purge Complete" has been accomplished. 3) Ignite Pilots. Once the purge is completed, the operator will be notified that the system is ready to start the pilots. The pilot header double block and bleed valves will energize and the ignition transformer will be energized. The pilot valves and the ignition transformers will only be energized for a maximum of 10 seconds. If the pilot flame is not detected within this time the individual pilot isolation valve will close and a purge sequence must be done again to attempt ignition again. 4) Prove Pilots. The pilot has its own dedicated flame detector, which in this case is a UV flame scanner sighted at the pilot flame. Once proven, the individual pilot valve will hold in and continue to burn. 5) Light Main Burner. Before the main burners are lit, the PLC will continue to check the permissives to ensure it is safe to light the main burner. Aside from the NFPA mandated permissives there should also be a permissive that indicates there is sufficient flow in the process coils. In other words, the process stream (in this case compressed air) must be flowing to light the main burner. The system then proceeds to energize the main header vent and shut-off valves. A five second trial for ignition should be provided from the time the individual isolation valve is opened until the detection of the flame from the main burner. The main burner is lit from the previously ignited pilot. If the main burner flame is not detected, the individual main burner isolation valves are de-energized. The main burner confirmation should be achieved through use of the second UV scanner which should be sighting the main flame and not be able to "see" the pilot flame. The main burner gun should light off at the minimum fire (1.9 MMBtu/hr) rate while the combustion air blower is also brought up to a flow that achieves

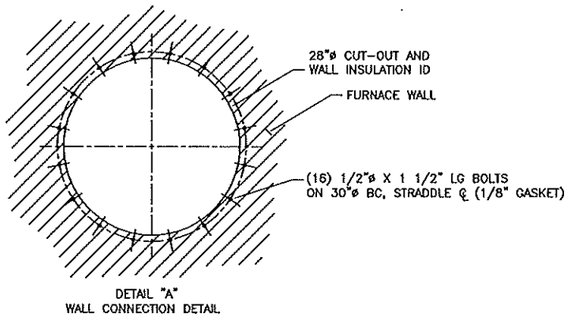
approximately 15% by volume O2 (dry). 6) Confirm Main Burner Status. Once this is achieved, the system is ready to be ramped up to operating conditions over time. This is usually performed manually or programmed within the PLC and the firing rate is increased in ratio with the fuel ensuring that approximately 15% O2 by volume is maintained in the flue gas. For a cold light off, this time should not be any faster than 10 minutes to the normal firing rate and should be done no more rapidly than linearly. For a hot light off (internal fire box temperatures greater than 500 F), it is permitted to shorten this ramp time to 5 minutes from minimum light off rate to normal firing rate. During both cold and hot starts, the process outlet temperatures should be monitored and maintained below the normal setpoint by adjusting (increasing) the process flowrate. It is permitted to operate the process flow rate at maximum during the ramp up period. When the normal firing rate is reached, the system can be switched to automatic temperature control providing that there is a small differential between the process outlet temperature and the setpoint temperature (within 5 F). Prior to start-up, all refractory installations should be thoroughly heat dried before being placed into normal operating service.

SECTION IV

BURNER

BURNER IOM
BURNER ASSEMBLY
PILOT ASSEMBLY
CAPACITY CURVE
MTR

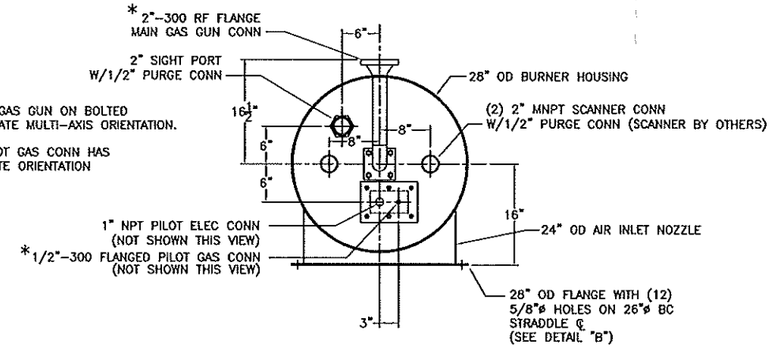
BURNER ASSEMBLY



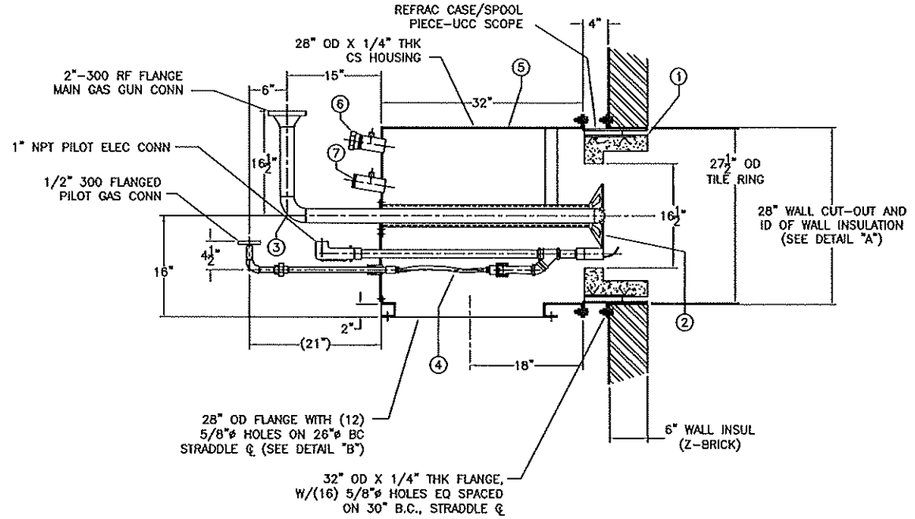
DETAIL "A"
WALL CONNECTION DETAIL

* NOTE:
2" 300# FLANGED MAIN GAS GUN ON BOLTED FLANGE CONN TO FACILITATE MULTI-AXIS ORIENTATION.

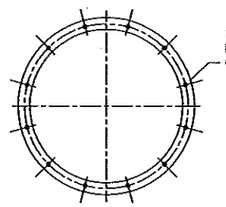
1/2" 300# FLANGED PILOT GAS CONN HAS UNION JOINT TO FACILITATE ORIENTATION IN ALL DIRECTIONS.



UCC RGR-7-SP BURNER
BACKPLATE VIEW
(TRUE ORIENTATION)



UCC RGR-7-SP BURNER
SECTION ELEVATION
(NOT SHOWN TRUE ORIENTATION)



1/4" THK X 28" OD X 24 1/4" ID
FLANGE WITH (12) 5/8"ø HOLES
ON 26"ø BC, STRADDLE ℄

DETAIL "B"
AIR INLET FLANGE

CUSTOMER: TULSA HEATERS MIDSTREAM
CUSTOMER PO NO.: 017841
ENDUSER: DYNO-NOBEL
JOBSITE: LOUISIANA, MO
TAG: B-1351
ELEV.: 500' ASL
UCC JOB NO.: 16-109

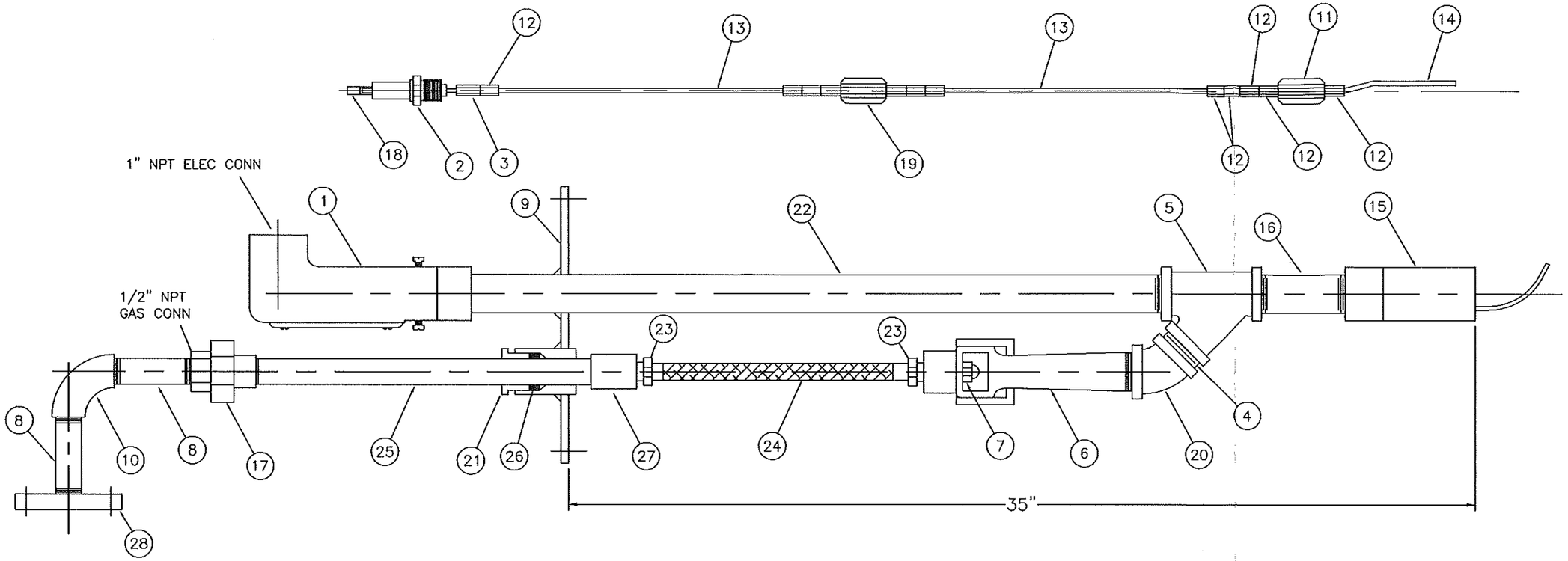
UNIVERSAL COMBUSTION CORPORATION
8312 SOUTH 75th EAST AVENUE
TULSA, OKLAHOMA 74133
PH. 918-254-1828 FAX. 918-459-3824 unicombust@aol.com

UCC TYPE RGR-7-SP BURNER
WITH INTERNAL MIX ELECTRIC IGNITION PILOT

DWN	CKD	APP	APP	DATE	SCALE	DWG. NO	REV
DM	LM			2/12/16	NTS	16-109-01	4

REV	DATE	DWN	CKD	APP	DESCRIPTION
4	6/30/16	DM	LM		AS BUILT
3	4/5/16	DM	LM		PER CUSTOMER REDLINE
2	3/17/16	DM	LM		PER CUSTOMER REDLINE
1	3/2/16	DM	LM		PER CUSTOMER REDLINE

PILOT ASSEMBLY



BILL OF MATERIAL			
MK.	QTY.	DESCRIPTION	DWG./PART NO.
(1)	ONE	WEATHERHEAD ASSEMBLY – NEMA 4	B-STD-0203
(2)	ONE	SPARK PLUG	UCC F-68
(3)	ONE	SPARK PLUG/IGNITION ROD CONN. 6-32 X 10-32	A-STD-0074
(4)	ONE	1", NPT CLOSE NIPPLE	–
(5)	ONE	1", 3000# PIPE LATERAL	–
(6)	ONE	PILOT MIXER ASSEMBLY	A-STD-0069
(7)	ONE	PILOT GAS ORIFICE – DRILLING = 19.5 GPH	A-STD-0063
(8)	2	1/2" NPT S40 PIPE X 3" LG, TBE	–
(9)	ONE	PILOT MOUNTING PLATE	16-109-04
(10)	1	1/2" NPT 90° ELBOW	–
(11)	ONE	CERAMIC INSULATOR	A-STD-0067
(12)	8	IGNITION ROD CONNECTOR – 10-32 X 10-32	A-STD-0073
(13)	2	IGNITION ROD EXT – 10-32 SS ALL THREAD X 13 1/4"	–
(14)	ONE	STD IGNITION ROD	A-STD-0151
(15)	ONE	P100X PILOT TIP W/DEFLECTOR	A-STD-0094-R1
(16)	ONE	PILOT INSULATOR GUIDE TUBE X 4" LG.	A-STD-0097
(17)	ONE	1/2" NPT 3000# UNION, CS	–
(18)	ONE	SPARK PLUG SNAP ON QUICK CONNECT	–
(19)	ONE	INTERMEDIATE INSULATOR ASSEMBLY	A-STD-0153
(20)	ONE	1" STD 45° ELBOW A105	–
(21)	ONE	1" NPT X 1/2" NPT BUSHING, MODIFIED, CS	––
(22)	ONE	1" S40 NIPPLE X 28" LONG, A105	–
(23)	2	1/4 NPT X 1/2 NPT REDUCER BUSHING	–
(24)	ONE	1/4" X 1/4" BRAIDED FLEX-I-HOSE X 12" LONG	–
(25)	ONE	1/2" S40 NIPPLE X 12" LONG, A105	–
(26)	ONE	3/32" DIA GRAPHITE PACKING STRING X 32" LG	–
(27)	ONE	1/2" 3000# FULL COUPLING, CS	–
(28)	ONE	1/2" 300 RFT FLANGE	–

REV	DATE	DWN	CKD	APP	DESCRIPTION
1	3/17/16	DM	LM		PER CUSTOMER REDLINE

CUSTOMER: TULSA HEATERS MIDSTREAM
CUSTOMER PO NO.: 017841
ENDUSER: DYNO-NOBEL
JOBSITE: LOUISIANA, MO
TAG.: B-1351
ELEV.: 500' ASL
UCC JOB NO.: 16-109

UNIVERSAL COMBUSTION CORPORATION
8312 SOUTH 75th EAST AVENUE
TULSA, OKLAHOMA 74133
PH. 918-254-1828 FAX. 918-459-3824 unicombust@aol.com

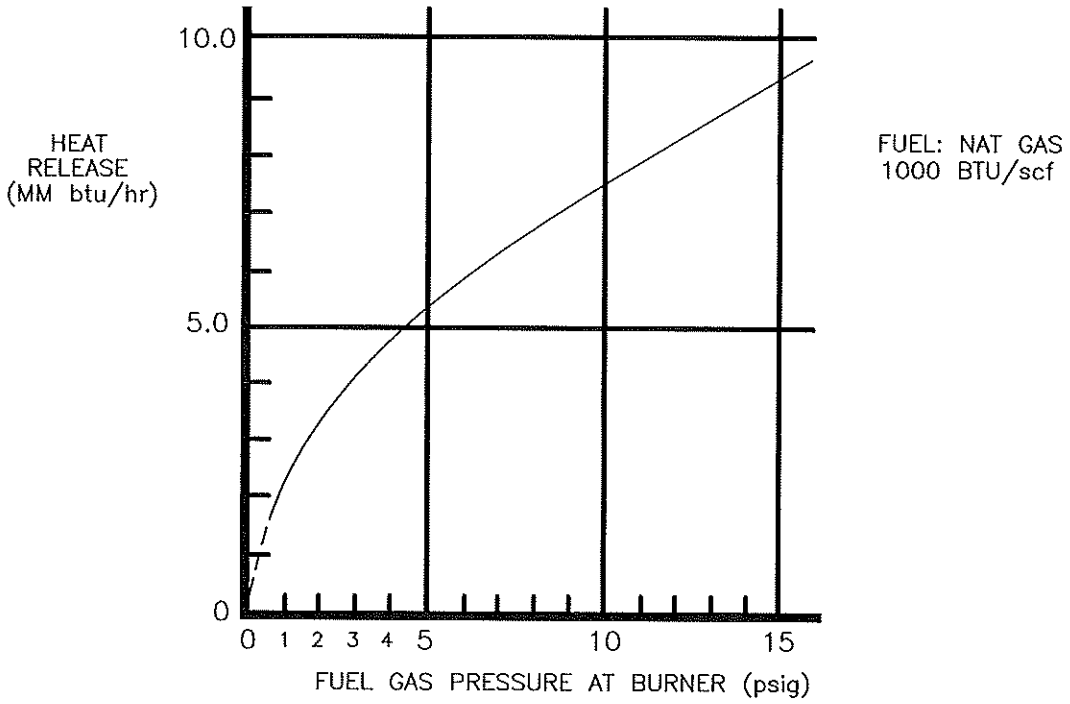
RGR-5 BURNER PILOT ASSEMBLY
ONE REQ'D

DWN	CKD	APP	APP	DATE	SCALE	DWG. NO	REV
DM	LM			2/15/16	NTS	16-109-03	1

CAPACITY CURVE

UNIVERSAL COMBUSTION CORPORATION

8312 SOUTH 75th EAST AVENUE
TULSA, OKLAHOMA 74133
PH. 918-254-1828 FAX. 918-459-3824 unicombust@aol.com



UCC CAPACITY CURVE NO. 16-109-CC
REFERENCE DRAWING NO. 16-109-01
JOB NO. 16-109
DATE: 2/12/16
CUSTOMER NAME: TULSA HEATERS MIDSTREAM
PO: 017841
END USER NAME: DYNO-NOBEL
UNIT: H100 AIR HEATER
JOBSITE: LOUISIANA, MO ELEV: 500' ASL

BURNER TYPE AND SIZE: RGR-7-SP (1 REQ'D)
FUEL TYPE(S): MAIN GAS - INLET GAS - 1000 BTU/scf (LHV)
PILOT - SAME
PILOT ORIFICE DRILLING: #55 MTD DIA
MAX HEAT RELEASE: 9.38 MM BTU/hr @ 15 psig
NORMAL HEAT RELEASE: 7.97 MM BTU/hr. @ 11 psig
MIN. HEAT RELEASE: 1.88 MM BTU/hr. @ 0.6 psig
PILOT GAS PRESSURE REQ'D: 10 psig CONSTANT
PILOT HEAT CAPACITY: 60,000 Btu/hr

THE NEW YORK BLOWER COMPANY
7660 Quincy Street
Willowbrook, IL 60527-5530
Visit us on the Web: http://www.nyb.com
Phone: (800) 208-7918 Email: nyb@nyb.com

INSTALLATION MAINTENANCE, OPERATING INSTRUCTIONS

IM-250

SQUARE FANS

⚠ WARNING

THIS FAN HAS MOVING PARTS THAT CAN CAUSE SERIOUS BODILY INJURY. BEFORE OPERATING OR STARTING MAINTENANCE READ THE INSTALLATION AND MAINTENANCE INSTRUCTIONS AND THE AMCA SAFETY PRACTICES MANUAL PROVIDED WITH THIS FAN.

DURING OPERATION

1. KEEP BODY, HANDS, AND FOREIGN OBJECTS AWAY FROM THE INLET, THE OUTLET, AND THE OTHER MOVING PARTS OF THE FAN SUCH AS SHAFTS, BELTS, AND PULLEYS.

2. DO NOT OPERATE AT EXCESSIVE SPEEDS OR TEMPERATURES.

BEFORE STARTING MAINTENANCE WORK:

LOCK POWER SUPPLY IN OFF POSITION AND IMMOBILIZE FAN WHEEL.

98-0250

A WORD ABOUT SAFETY

The above **WARNING** decal appears on all **nyb** fans. Air moving equipment involves electrical wiring, moving parts, sound, and air velocity or pressure which can create safety hazards if the equipment is not properly installed, operated and maintained. To minimize this danger, follow these instructions as well as the additional instructions and warnings on the equipment itself.
All installers, operators and maintenance personnel should study AMCA Publication 410, "Recommended Safety Practices for Air Moving Devices", which is included as part of every shipment. Additional copies can be obtained by writing to New York Blower Company, 7660 Quincy St., Willowbrook, IL 60527.

ELECTRICAL DISCONNECTS

Every motor driven fan should have an independent disconnect switch to isolate the unit from the electrical supply. It should be near the fan and must be capable of being locked by maintenance personnel while servicing the unit, in accordance with OSHA procedures.

MOVING PARTS

All moving parts must have guards to protect personnel. Safety requirements vary, so the number and type of guards needed to meet company, local and OSHA standards must be determined and specified by the user. Never start a fan without having all safety guards installed. Check regularly for damaged or missing guards and do not operate any fan with guards removed. Fans can also become dangerous because of potential "windmilling", even though all electrical power is disconnected. Always block the rotating assembly before working on any moving parts.

SOUND

Some fans can generate sound that could be hazardous to exposed personnel. It is the responsibility of the system designer and user to determine sound levels of the system, the degree of personnel exposure, and to comply with applicable safety requirements to protect personnel from excessive noise. Consult **nyb** for fan sound power level ratings.

AIR PRESSURE AND SUCTION

In addition to the normal dangers of rotating machinery, fans present another hazard from the suction created at the fan inlet. This suction can draw materials into the fan where they become high velocity projectiles at the outlet. It can also be extremely dangerous to persons in close proximity to the inlet, as the forces involved can overcome the strength of most individuals. Inlets and outlets that are not ducted should be screened to prevent entry and discharge of solid objects.

⚠ DANGER

DO NOT OPEN UNTIL THE POWER SUPPLY HAS BEEN LOCKED OFF AND THE SHAFT HAS STOPPED ROTATING.
FAILURE TO DO THIS CAN RESULT IN SERIOUS BODILY INJURY. 98-0249

ACCESS DOORS

The above DANGER decal is placed on all **nyb** cleanout doors. These doors, as well as access doors to the duct system, should never be opened while the fan is in operation. Serious injury could result from the effects of air pressure or suction.
Quick-opening doors must have the door handle bolts securely tightened to prevent accidental or unauthorized opening. Bolted doors must be tightened for the same reason.

RECEIVING AND INSPECTION

The fan and accessories should be inspected on receipt for any shipping damage. Turn the wheel by hand to see that it rotates freely and does not bind.
F.O.B. factory shipping terms require that the receiver be responsible for inspecting the equipment upon arrival. Note damage or shortages on the Bill of Lading and file any claims for damage or loss in transit. **nyb** will assist the customer as much as possible; however, claims must be originated at the point of delivery.

HANDLING AND STORAGE

Holes are provided in the housing sides for lifting. Never lift a fan by the wheel, shaft, motor, motor bracket, or any fan part not designed for lifting. A spreader should be used to avoid damage.

Whenever possible, fans and accessories should be stored in a clean, dry location to prevent rust and corrosion of steel components. If outdoor storage is necessary, protection should be provided. Cover the entire fan to prevent the accumulation of dirt and moisture in the housing. Cover motors with waterproof material. Check dampers for free operation and lubricate moving parts prior to storage. Inspect the stored unit periodically. **Rotate the wheel by hand every two weeks to redistribute grease on motor bearings.**

FAN INSTALLATION

nyb wheels are dynamically balanced when fabricated. Fully assembled fans are test run at operating speeds to check the entire assembly for conformance to **nyb** vibration limits. Nevertheless, all units must be adequately supported for smooth operation. **Ductwork or stacks should be independently supported as excess weight may distort the fan housing and cause contact between moving parts.** Where vibration isolators are used, consult the **nyb** certified drawing for proper location and adjustment.

Slab-Mounted Units

A correctly designed and level concrete foundation provides the best means of installing floor-mounted fans. The mass of the base must maintain the fan/driver alignment, absorb normal vibration, and resist lateral loads. The overall dimensions of the concrete base should extend at least six inches beyond the base of the fan. The weight of the slab should be two to three times the weight of the rotating assembly, including the motor. The foundation requires firmly anchored fasteners such as the anchor bolts shown in Figure 1. Hammer-drilled expansion fasteners can be used in less demanding applications.

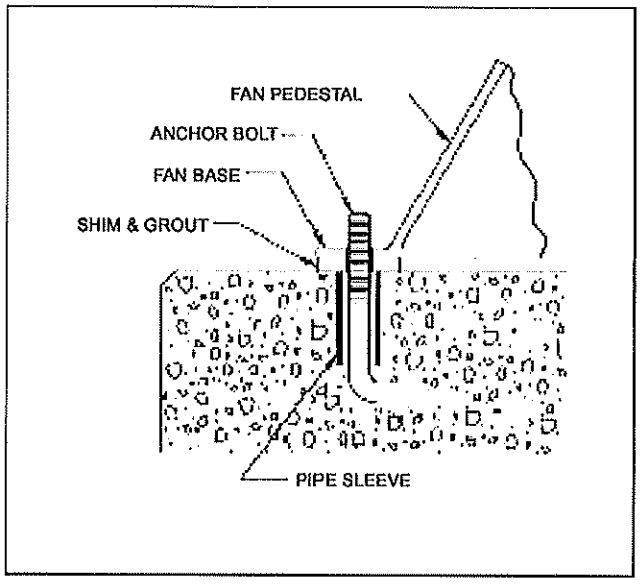


Figure 1

Move the fan to the mounting location and lower it over the anchor bolts, leveling the fan with shims around the bolts. Fasten the fan securely. When grout is used, shim the fan at least 3/4-inch from the concrete base (see Figure 1). When isolation is used, check the **nyb** certified drawing for installation instructions.

Elevated Units

When an elevated or suspended structural steel platform is used, it must have sufficient bracing to support the unit load and prevent side sway. The platform should be of welded construction to maintain permanent alignment of all members.

START-UP

Safe operation and maintenance includes the selection and use of appropriate safety accessories for the specific installation. This is the responsibility of the system designer and requires consideration of equipment location and accessibility as well as adjacent components. All safety accessories must be installed properly prior to start-up.

Safe operating speed is a function of system temperature and wheel design. Do not under any circumstances exceed the maximum safe fan speed published in the **nyb** bulletin, which is available from your **nyb** field sales representative.

Procedure

1. If the drive components are not supplied by **nyb,** verify with the manufacturer that the starting torque is adequate for the speed and inertia of the fan.
2. Inspect the installation prior to starting the fan. Check for any loose items or debris that could be drawn into the fan or dislodged by the fan discharge. Check the interior of the fan as well. Turn the wheel by hand to check for binding.
3. Check drive installation.
4. Check the tightness of all setscrews, nuts and bolts. When furnished, tighten hub setscrews with the wheel oriented so that the setscrew is positioned underneath the shaft.
5. Install all remaining safety devices and guards. Verify that the supply voltage is correct and wire the motor. "Bump" the starter to check for proper wheel rotation.

6. Use extreme caution when testing the fan with plenum ducting disconnected. Apply power and check for unusual sounds or excessive vibration. If either exists, see the section on Common Fan Problems. To avoid motor overload, do not run the fan for more than a few seconds if plenum is not fully installed. Without plenum ductwork, normal operating speed may not be obtained without motor overload. Once plenum ductwork is complete, check for correct fan speed and complete installation. Plenum ductwork and guards must be fully installed for safety.
7. Setscrews should be rechecked after a few minutes, eight hours and two weeks of operation (see Tables 1 for correct tightening torques).

NOTE: Shut the fan down immediately if there is any sudden increase in fan vibration.

Table 1 - WHEEL SETSCREW TORQUES

Setscrew Size Diameter (in.)	Carbon Steel Setscrew Torque*	
	lb.-in.	lb.-ft.
1/4	75	6.2
5/16	144	12
3/8	252	21
7/16	396	33
1/2	600	50
5/8	1164	97

*** Stainless Steel setscrews are not hardened and should not be tightened to more than 1/2 the values shown.**

FAN MAINTENANCE

nyb fans are manufactured to high standards with quality materials and components. Proper maintenance will ensure a long and trouble-free service life.

Do not attempt any maintenance on a fan unless the electrical supply has been completely disconnected and locked. In many cases, a fan can windmill despite removal of all electrical power. The rotating assembly should be blocked securely before attempting maintenance of any kind.

The key to good fan maintenance is regular and systematic inspection of all fan parts. Inspection frequency is determined by the severity of the application and local conditions. Strict adherence to an inspection schedule is essential.

Regular fan maintenance should include the following:

1. Check the fan wheel for any wear or corrosion, as either can cause catastrophic failures. Check also for the build-up of material which can cause unbalance resulting in vibration and serious safety hazards. Clean or replace the wheel as required.
2. During any routine maintenance, all setscrews and bolts should be checked for tightness. See table for torques.
3. When installing a new wheel or cone, the proper wheel-to-inlet cone clearance must be maintained (see Figure 2).

WARNING: Do not remove or loosen the fan hub from the fan wheel. Removing or loosening the fan hub from the fan wheel will cause imbalance and void the warranty.

FULL-WIDTH WHEEL-CONE CLEARANCES
(contact nyb for partial-width dimensions)

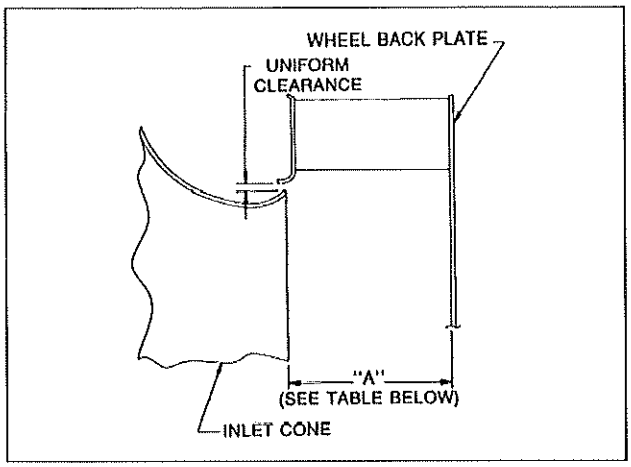


Figure 2

Fan Model	"A" Dimension	Fan Model	"A" Dimension
10	4 1/2	20	7 5/16
12	5	22	8 1/8
13	5 1/2	24	8 7/8
15	6 7/16	27	9 7/8
16	6	30	10 11/16
18	6 5/8		

WHEEL BALANCE

Airstreams containing particulate or chemicals can cause abrasion or corrosion of the fan parts. This wear is often uneven and can lead to significant wheel unbalance over time. When such wear is discovered, a decision must be made as to whether to rebalance or replace the wheel.

The soundness of all parts should be determined if the original thickness of components is reduced. Be sure there is no hidden structural damage. The airstream components should also be cleaned to remove any build-up of foreign material. Specialized equipment can be used to rebalance a cleaned wheel that is considered structurally sound.

Balance weights should be rigidly attached at a point that will not interfere with the housing nor disrupt airflow. Remember that centrifugal forces can be extremely high at the outer radius of a fan wheel. Welding is the preferred method of balance weight attachment. Be sure to ground the welder directly to the fan wheel.

COMMON FAN PROBLEMS

Excessive Vibration

A common complaint regarding industrial fans is "excessive vibration". **nyb** is careful to ensure that each unit is precisely balanced prior to shipment; however, there are many other causes of vibration including:

1. Loose mounting bolts or setscrews.
2. Misaligned or unbalanced motor.
3. Bent shaft due to mishandling or material impact.
4. Accumulation of foreign material on the wheel.
5. Excessive wear or erosion of the wheel.
6. Excessive system pressure or restriction of airflow due to closed dampers.
7. Inadequate structural support, mounting procedures or materials.
8. Externally transmitted vibration.

Inadequate Performance

1. Incorrect testing procedures or calculations.
2. Fan running too slowly.
3. Fan wheel rotating in wrong direction.
4. Wheel not properly centered relative to inlet cone.
5. Poor system design, closed dampers, air leaks, clogged filters, or coils.
6. Obstructions or sharp elbows near inlets.
7. Sharp deflection of airstream at fan outlet.

Excessive Noise

1. Fan operating near "stall" due to incorrect system design or installation.
2. Vibration originating elsewhere in the system.
3. System resonance or pulsation.
4. Improper location or orientation of fan intake and discharge.
5. Inadequate or faulty design of supporting structures.
6. Nearby sound reflecting surfaces.
7. Loose accessories or components.

Premature Component Failure

1. Prolonged or major vibration.
2. Inadequate or improper maintenance.
3. Abrasive or corrosive elements in the airstream or surrounding environment.
4. Misalignment or physical damage to rotating components.
5. Excessive fan speed.
6. Extreme ambient or airstream temperatures.
7. Improper tightening of wheel setscrews.

REPLACEMENT PARTS

It is recommended that only factory-supplied replacement parts be used. **nyb** fan parts are built to be fully compatible with the original fan, using specific alloys and tolerances. These parts carry a standard **nyb** warranty.

When ordering replacement parts, specify the part name, **nyb** shop and control number, fan size, type, rotation (viewed from drive end) and arrangement. Most of this information is on the metal nameplate attached to the fan base.

For assistance in selecting replacement parts, contact your local **nyb** representative or visit: http://www.nyb.com.

Example: Part required: AcF Wheel
Shop/control number: A-10106-100
Fan description: Model 18 SQ Fan
Clockwise rotation
Arrangement: 4

Suggested replacement parts include:

Wheel	Component parts: Damper
Inlet Cone	Motor

LIMITED PRODUCT WARRANTY

All products are warranted by **nyb** to be free from defects in materials and workmanship for a period of one (1) year after shipment from its plant, provided buyer demonstrates to satisfaction of **nyb** that the product was properly installed and maintained in accordance with **nyb**'s instructions and recommendations and that it was used under normal operating conditions.

This warranty is limited to the replacing and/or repairing by **nyb** of any part or parts which have been returned to **nyb** with **nyb**'s written authorization and which in **nyb**'s opinion are defective. Parts not manufactured by **nyb** but installed by **nyb** in equipment sold to the buyer shall carry the original manufacturer's warranty only. All transportation charges and any and all sales and use taxes, duties, imports or excises for such part or parts shall be paid for by the buyer. **nyb** shall have the sole right to determine whether defective parts shall be repaired or replaced.

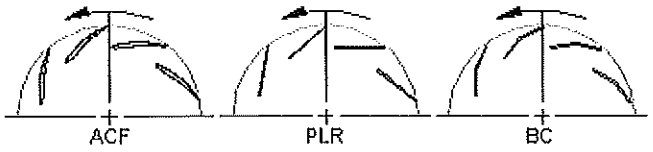
This warranty does not cover any customer labor charges for replacement of parts, adjustments or repairs, or any other work unless such charges shall be assumed or authorized in advance, in writing, by **nyb.**

This warranty does not cover any product which, in the judgement of **nyb,** has been subject to misuse or neglect, or which has been repaired or altered outside **nyb**'s plant in any way which may have impaired its safety, operation or efficiency, or any product which has been subject to accident.

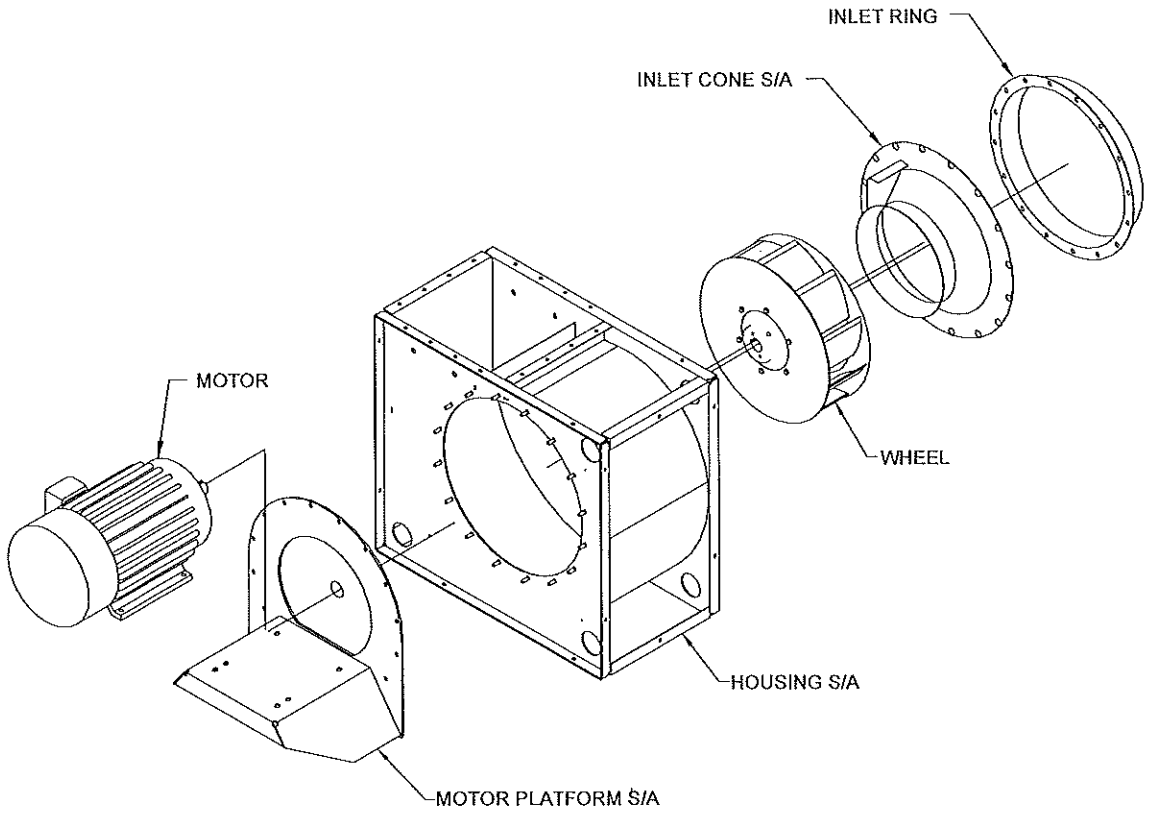
This warranty shall be null and void if any part not manufactured or supplied by **nyb** for use in any of its products shall have been substituted and used in place of a part manufactured or supplied by **nyb** for such use.

There are no warranties, other than those appearing on the acknowledgement form **INCLUDING NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE,** given in connection with the sale of the goods sold hereunder. The buyer agrees that his sole and exclusive remedy, and the limit of **nyb**'s liability for loss from any cause whatsoever, shall be the purchase price of the goods sold hereunder for which a claim is made.

SPECIFY ROTATION AS VIEWED FROM DRIVE SIDE



ARROW INDICATES COUNTERCLOCKWISE ROTATION



Parts List	
1. Inlet Ring	4. Housing
2. Inlet Cone	5. Motor Platform
3. Wheel	6. Motor

* Order for parts must specify rotation.

THE NEW YORK BLOWER COMPANY 7660 Quincy Street Willowbrook, IL 60527-5530 Visit us on the Web: http://www.nyb.com Phone: (800) 208-7918 Email: nyb@nyb.com	INSTALLATION MAINTENANCE, OPERATING INSTRUCTIONS	**IM Insert - All**

INFORMATION AND WARNINGS ON ALL NYB FANS

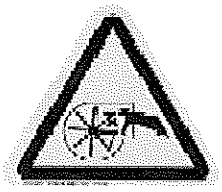
Beginning in June 2012, warning signage has been placed on all nyb fans in the form of readily understandable symbols or pictograms, as specified by ISO and recommended by the European Union. The following is a brief description of each pictogram:

General Hazard

Hand Crush from above

Electrical Hazard due to motor

Entanglement of Hand/Rotating Shaft



Danger of having hands or fingers cut

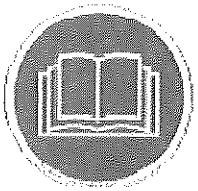
Do Not Enter/Confined Space

Mandatory Instructions:

Hand Crush / Pinch Point

Lock Power Supply in Off Position and wait for shaft to stop rotating prior to opening or servicing

Possibility of entanglement of hand or fingers



Read Installation, Operation, Maintenance Manual

Hot Surfaces

Lift Here

SECTION 9 – VENDOR DOCUMENTATION

9.20.3 Data Sheets

ITEM IDENTIFICATION

Purchaser	Callidus Technologies	Owner	Dyno-Nobel	
Location	Louisiana, MO	Manufacturer	Tulsa Heaters Midstream LLC	
Unit No	Thermal Oxidizer	Item No.	E-1351	1
Service	Indirect Fired Air Heater	Reference	MJ16-185	
Number	One	Type	Convective Design	

Total Absorbed Duty, MMBTU / hr 7.00

Maximum/Minimum Fired Duty, MMBTU/hr 9.4/1.0

PROCESS DESIGN CONDITIONS

	SHELL	COIL			REV
Operating Case	DESIGN				
Service	Indirect Fired	Air Heater			
Heat Absorption, MM Btu / hr	(7.00)	7.00			
Fluid	Flue Gas	Air			
Flow Rate, Lb / hr	26,457	49,850			
Flow Rate, BPD					
Pressure Drop, in H2O & psi (Allowable, Clean)	1.0	10.0			
Pressure Drop, in H2O & psi (Calculated, Clean)	0.3	8.8			
Avg. Radiant Flux Density, Btu / hr * ft2 (Calculated)					
Avg. Convection Flux Density, Btu / hr * ft2 (Calculated)		8,084			
Maximum Radiant Flux Density, Btu / hr * ft2					
Maximum Convection Flux Density, Btu / hr * ft2					
Velocity Limitation, ft / sec					
Mass Velocity, Flue Gas & Process Fluid, Lb / ft2 * sec	0.336	19			
Maximum Allowable Inside Film Temperature, deg F		675			
Maximum Calculated Inside Film Temperature, deg F		1091			
Fouling Factor, hr * ft2 * deg F / BTU	0.001	0.001			
Inlet Conditions:					
Temperature, deg F	1400	80			
Pressure, in H2O & psig	0.3	10.3			
Liquid Flow, Lb / hr	0	0			
Vapor Flow, Lb / hr	26,457	49,850			
Density, Vapor, Lb / ft3		0.12			
Molecular Weight, Vapor	28.48	29.00			
Viscosity, Liquid, cp					
Viscosity, Vapor, cp		0.019			
Specific Heat, Liquid, Btu / Lb * deg F					
Specific Heat, Vapor, Btu / Lb * deg F		0.240			
Thermal Conductivity, Liquid, Btu / hr * ft * deg F					
Thermal Conductivity, Vapor, Btu / hr * ft * deg F		0.015			
Outlet Conditions:					
Temperature, deg F	430	650			
Pressure, in H2O & psig	amb	1.5			
Liquid Flow, Lb / hr	0	0			
Vapor Flow, Lb / hr	26,457	49,850			
Density, Vapor Lb / ft3		0.04			
Molecular Weight, Vapor	28.48	29.00			
Viscosity, Liquid, cp					
Viscosity, Vapor, cp		0.031			
Specific Heat, Liquid, Btu / Lb * deg F					
Specific Heat, Vapor, Btu / Lb * deg F		0.252			
Thermal Conductivity, Liquid, Btu / hr * ft * deg F					
Thermal Conductivity, Vapor, Btu / hr * ft * deg F		0.028			

Burner:

Heat Release, MMBtu/hr	9.37	
Flue Gas Oxygen %(dry)	15%	

Filename: MJ16-185

MECHANICAL DESIGN CONDITIONS

Coil Design:	COIL			
Design Pressure, psig	100			
Design Fluid Temperature, Deg F	700	for A106	1000 for P11	
Corrosion Allowance.....Tubes & Fittings, in.	0.063			
Hydrostatic Test Pressure, psig	150			
Stress Relieve	NO			
Weld Inspection Requirements, Radiography or Other	N/A			
Maximum Tube Wall Temperature, Deg F (Calculated)	1000			
Inside Film Coefficient (Calculated)	38			
Maximum Tube Wall Temperature, Deg F (Design)	1050			
Design Basis for Tube Wall Thickness	API-530/ASME Section VIII but no stamp			
Coil Arrangement				
Vertical or Horizontal	HORIZONTAL			
Tube Material (ASTM Specification and Grade)	A106GrB	A335 P11- 1st 4 rows		
Outside Diameter, In	3.500			
Wall Thickness, (Average), In	0.216			
Number of Passes	14			
Overall Tube Length, Ft	8.92			
Effective Tube Length, Ft	7.50			
Bare Tubes: Number	28			
Total Exposed Surface, Sq Ft	192			
Extended Surface Tubes: Number	98			
Total Exposed Surface, Sq Ft	5,886			
Tube Spacing, Center to Center, In. (Staggered) (In Line)	6			
Tube Center to Furnace Wall, In. Min	3			
Description of Extended Surface:	Row 1	Row 2-7		
Type	Serrated	Serrated		
Fin or Stud Material	SS 10.5Cr (40	Carbon		
Fin or Stud Dimensions Height (in.) x Thickness (in.)	0.5 x 0.035	0.5 x 0.035		
Fin or Stud Spacing	5 FPI	7 FPI		
Maximum Fin or Stud Temperature (°F)	997	718		
Extension Ratio	6.76	9.07		
Return Bends &/or Plug Type Fittings				
Manufacturer and Type	SR U Bends			
Material (ASTM Specification and Grade)	A234WPB			
Nominal Rating or Schedule	sch 40			
Location	Header Box			
Welded or Rolled	welded			
Manifolds				
Manufacturer and Type	Flanged			
Material (ASTM Specification and Grade)	A106GrB			
Nominal Rating	Std			
Location				
Welded or Rolled				
Flange: Size and Rating	18" / 150#	inlet	18"/150#	outlet
Location				
Tube Supports				
Ends, Top, Bottom	ENDS	INTERMEDIATE		
Material	CS	N/A		
Thickness	3/8"			
Type and Thickness of Insulation	Castable 4"			

Filename: MJ16-185

MECHANICAL DESIGN CONDITIONS (continued)

REV

Refractory Design Basis:

Casing Temperature, °F	150	Wind Velocity, MPH	5	Ambient Temperature, °F		85

Combustion Chamber

Thickness	5.0	Hot-Face Temperature: Material		1,500	Calculated	1,400
Wall Construction	5" blanket					
Anchor Material & Type	310 SS pins/clips			Anchor Attachment		Welded
Casing Material	CS	Casing Thickness	3/16"	Outside Temperature		150

Floor:

Thickness	5.0	Hot-Face Temperature: Material			Calculated	1,400
Wall Construction	5" of Ceramic Fiber					
Anchor Material & Type	310 pins/clips			Anchor Attachment		Stud Gun
Casing Material	CS	Casing Thickness	3/16"	Outside Temperature		

Sidewalls:

Thickness	5.0	Hot-Face Temperature: Material		1,500	Calculated	1,400
Construction	5" of Ceramic Fiber					
Anchor Material & Type	310 pins/clips			Anchor Attachment		Stud Gun
Casing Material	CS	Casing Thickness	3/16"	Outside Temperature		150

Roof:

Thickness	NONE	Hot-Face Temperature: Material			Calculated	
Roof Construction						
Casing Material		Casing Thickness		Anchor Attachment Outside Temperature		

Outlet Transition:

Thickness	3/16"	Hot-Face Temperature: Material		1000°F	Calculated	430
Wall Construction	3/16" CS					
Anchor Material & Type				Anchor Attachment		
Casing Material		Casing Thickness	3/16"	Outside Temperature		

Header Boxes

Location	BOTH ENDS	Hinged Door / Bolted Panel		BOLTED		
Thickness	2"					
Wall Construction	2" Ceramic Fiber Blanket					
Anchor Material & Type	CS Pins					
Casing Material	CS	Casing Thickness	3/16"			

Exhaust Gas Ducts

Location	N/A		N/A	N/A
Material & Thickness	N/A		N/A	N/A
Lining (internal or external)	N/A		N/A	N/A
Insulation Material	N/A		N/A	N/A
Liner Thickness & Material	N/A		N/A	N/A
Design Temperatures, Hot Face / Cold Face, deg F	N/A		N/A	N/A

Internal & External Coatings

Int. Prep & Coating(s)	NONE	
Ext. Prep & Coating(s)	Per THM Standard	SP-6 Blast and 2-3 mils IZ for heater casing, high temp aluminum for transition/stack

Special Equipment

Combustion air blower/VFD in NEMA 12 enclosure(loose)