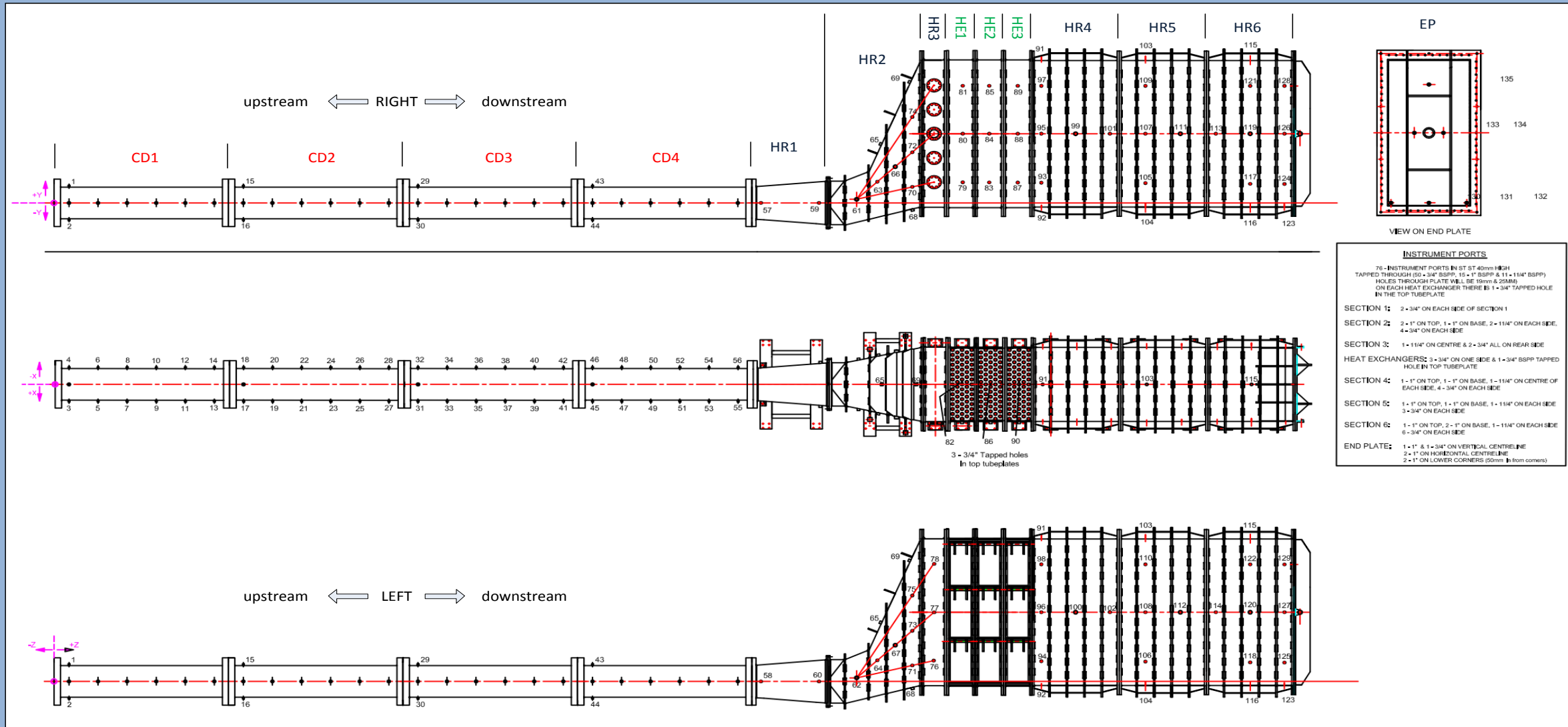


Date	27 February 2016	General Comments: (weather, rig configuration) Weather: Cold and sunny with a light North Westerly breeze. Rig configuration: 4 x 3m circular duct; expansion section and HRSG attached. End open - end plate not attached igniter 258mm from beginning of 2nd circular duct section Engine Speed: 40%; 11,800 rpm 2nd of HRSG tests with composition of 60% H2 and 40% CH4 at an EQR of 0.60 The test gave a moderate combustion event and all sensor provided a good response. Flame speed, on both IP and OP's, showed an increase through the HE section as did the pressure and temperature profiles. Good correlation between flame speeds from both wall IPs and OPs at around 350 m/s.
Time	15:43:55	
Test Number	4	
Mixture Composition	60% H2 40% CH4	
Ambient Temperature	6°C	
Ambient Pressure	970	
Wind Speed	5 m/s	
Wind direction	NW	
Relative Humidity	80.00%	
Mass Flow	10.049 kg/s	
Equivalence Ratio	0.62	

		Ionisation Probes		Ionisation Rakes		Optical Probes	
Max overpressure		Max. temperature		Max. flame speed		Max. flame speed	
742 mbar		1087 °C		357 m/s		278 m/s	
		Initial Temperature				Max. flame speed	
		508 °C				440 m/s	
Location of Max. Overpressure		Location of Max. Temperature		Location of Max. Flame Speed		Location of Max. Flame Speed	
sensor	KU7	sensor	TC3	sensor	IP14	sensor	OP6
label	CD4-R2	label	CD1-R5	label	HR4-R5M	label	HR4-T1
distance	9758 mm	distance	2258 mm	distance	18165 mm	distance	16985 mm



Naming Convention

Section Identifier
i.e. HE, HR, CD or EP

Section Number (1-6)
Numbered from downstream to upstream

Vertical position in section (sides only) i.e. U, M or L.
Absence of letter denotes centreline

Longitudinal position in section (numbered from 1)

Side
i.e. R, L, T or B

Key

CD	Circular duct	U	Upper
HR	HRSG	M	Middle
HE	Heat Exchanger	L	Lower
EP	End Plate	R	Right Side (when viewed downstream from engine)
		L	Left Side
		T	Top
		B	Bottom

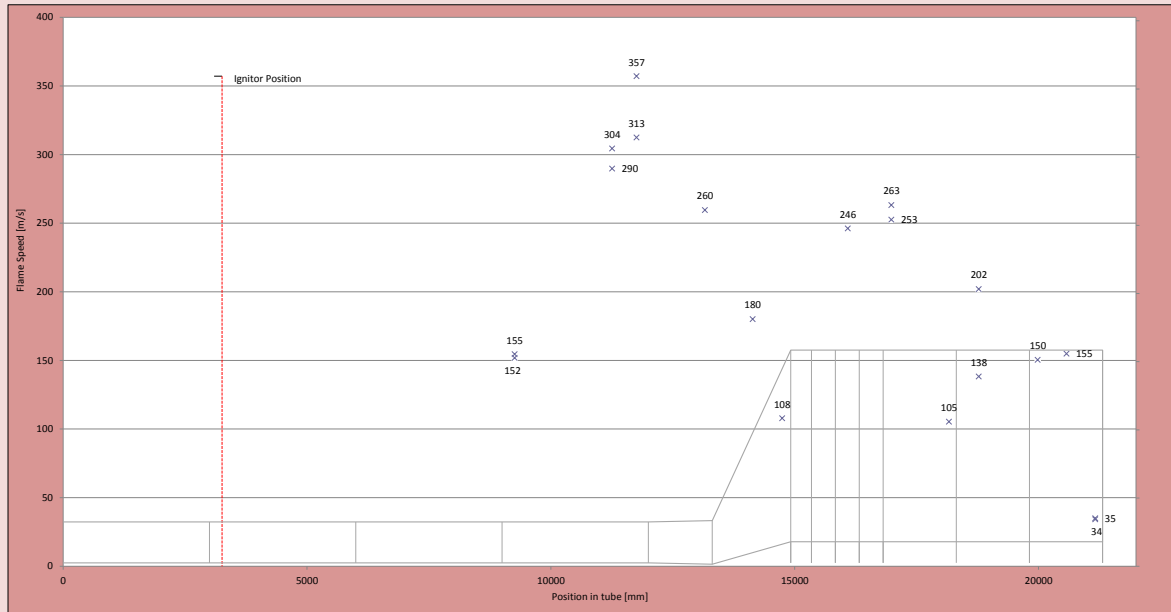
There are 13 sections on the rig

- 4 circular duct sections (CD1 to CD4)
- 6 HRSG sections (HR1 to HR6)
- 3 heat exchanger sections (HE1 to HE3) located between HR3 and HR4

0	3000	6000	9000	12000	13310	14920	15345	15835	16325	16815	18315	19815	21315	21315	19815	16815	16325	15835	15345	14920	13310	12000	9000	6000	3000	0	
600	600	600	600	600	620	3120	3120	3120	3120	3120	3120	3120	3120	310	310	310	310	310	310	310	310	-20	0	0	0	0	0

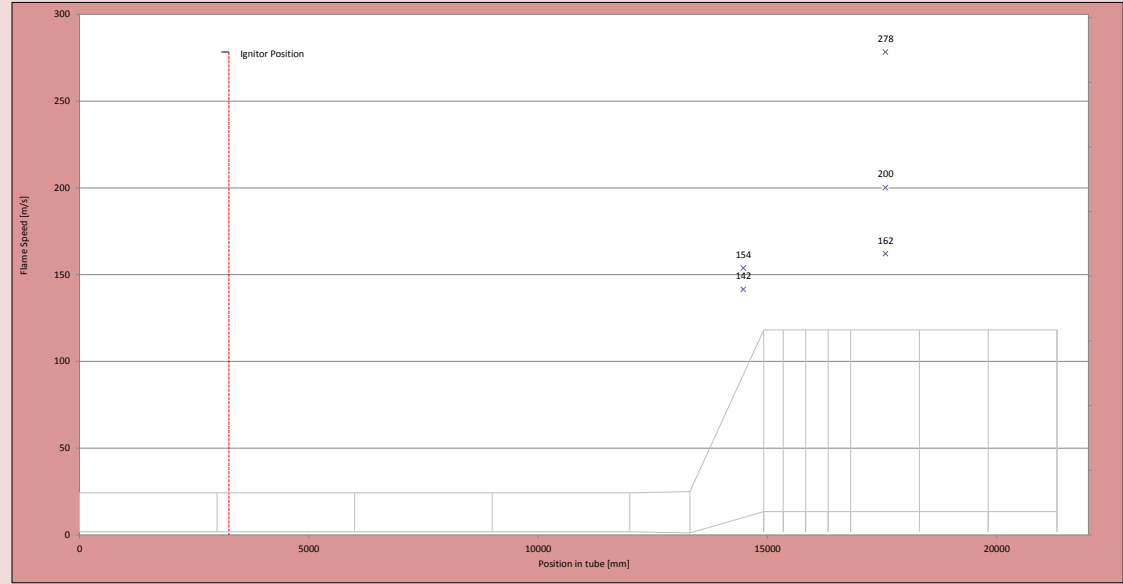
Location of igniter mm Time of ignition seconds

IP Number	Location label	Data Name	Position in tube (mm)	Flame arrival time (s)	Avg Flame speed from last sensor (m/s)
IP4	CD4-L1	Flameion_4	9258	16.7820	155
IP5	CD4-R1	Flameion_5	9258	16.7827	152
IP2	CD4-L5	Flameion_2	11258	16.7886	304
IP3	CD4-R5	Flameion_3	11258	16.7896	290
IP0	CD4-L6	Flameion_0	11758	16.7902	313
IP1	CD4-R6	Flameion_1	11758	16.7910	357
IP6	HR1-R2	Flameion_6	13160	16.7964	260
IP7	HR2-R3M	Flameion_7	14140	16.8018	180
IP8	HR2-R5M	Flameion_8	14745	16.8075	108
IP10	HE2-R1M	Flameion_10	16090	16.8098	246
IP12	HR4-R1M	Flameion_12	16985	16.8132	263
IP13	HR4-L1L	Flameion_13	16985	16.8109	253
IP15	HR5-R2M	Flameion_15	18775	16.8261	138
IP16	HR5-L2L	Flameion_16	18775	16.8198	202
IP17	HR6-R1M	Flameion_17	19985	16.8341	150
IP19	HR6-L3L	Flameion_19	20575	16.8314	155
IP18	HR6-R5M	Flameion_18	21165	16.8678	35
IP20	HR6-L5L	Flameion_20	21165	16.8486	34
IP9	#N/A	Flameion_9	#N/A		
IP11	#N/A	Flameion_11	#N/A		
IP14	HR4-R5M	Flameion_14	18165	16.8201	105
IP21	#N/A	Flameion_21	#N/A		
IP22	#N/A	Flameion_22	#N/A		
IP23	#N/A	Flameion_23	#N/A		



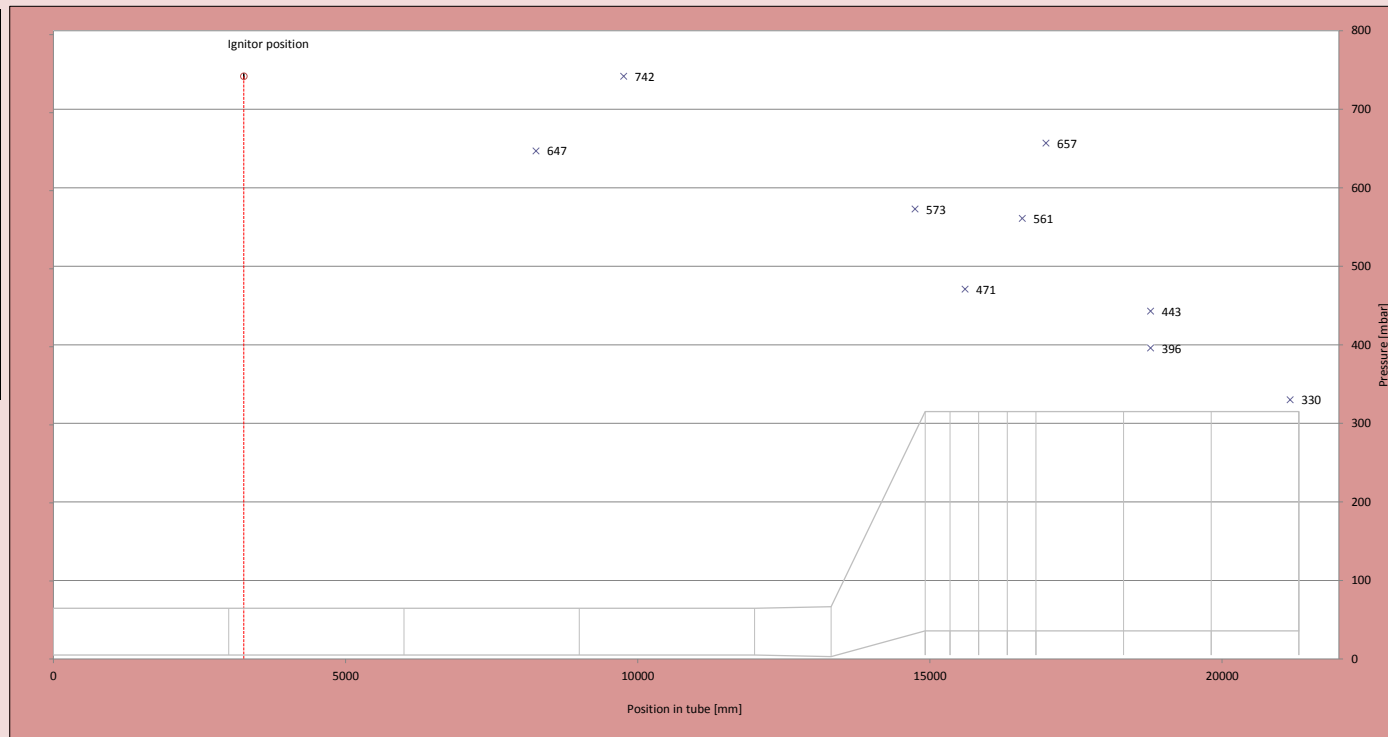
Location of igniter mm Time of ignition seconds

Rake Number	IP Number	Location label	Data Name	Position in tube (mm)	Flame arrival time (s)	Avg Flame speed from last sensor (m/s)
RA1	IP24	HR2-R2M	Flameion_0	13785		
RA1	IP25	HR2-R2M	Flameion_1	13785		
RA1	IP26	HR2-R2M	Flameion_2	13785		
RA2	IP27	HR2-R4M	Flameion_3	14475	16.8225	142
RA2	IP28	HR2-R4M	Flameion_4	14475		
RA2	IP29	HR2-R4M	Flameion_5	14475	16.8161	154
RA3	IP30	HR4-R3M	Flameion_6	17575	16.8153	278
RA3	IP31	HR4-R3M	Flameion_7	17575	16.8147	200
RA3	IP32	HR4-R3M	Flameion_8	17575	16.8145	162
RA4	IP33	HR5-R4M	Flameion_9	19375		
RA4	IP34	HR5-R4M	Flameion_10	19375		
RA4	IP35	HR5-R4M	Flameion_11	19375		



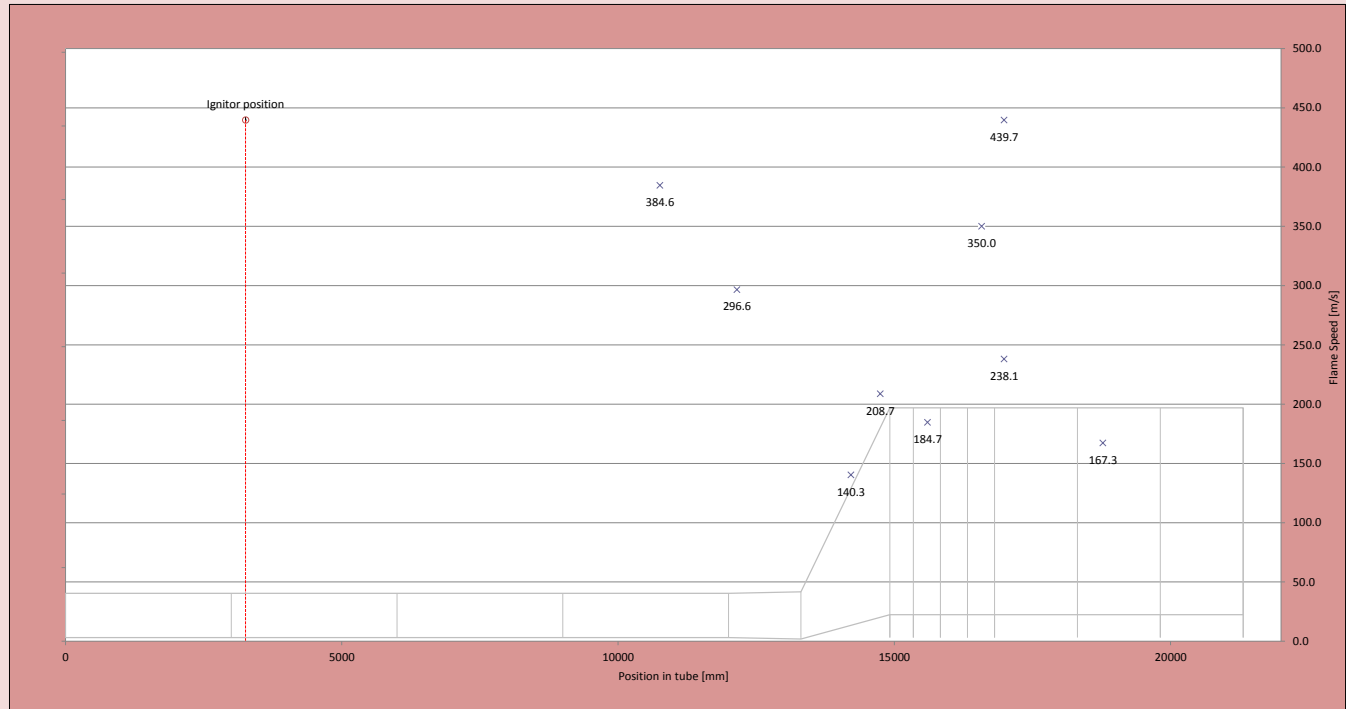
Location of igniter mm

Transducer number	Location	Position in tube [mm]	ΔP_{max} [mbar]	Time ΔP_{max} [mbar]
KU0	HE1-R1U	15600	471	16.8105
KU1	HE3-R1L	16580	561	16.8120
KU2	HR4-R1U	16985	657	16.8138
KU3	HR5-R2L	18775	443	16.8139
KU4	HR5-L2M	18775	396	16.8150
KU5	HR6-LSM	21165	330	16.8172
KU6	CD3-R5	8258	647	16.8160
KU7	CD4-R2	9758	742	16.8198
KU8	HR2-T5	14745	573	16.8130
KU9	HR3-L1L	15140	406	16.8148
KU10	#N/A	#N/A		
KU11	#N/A	#N/A		
PCB	#N/A	#N/A		



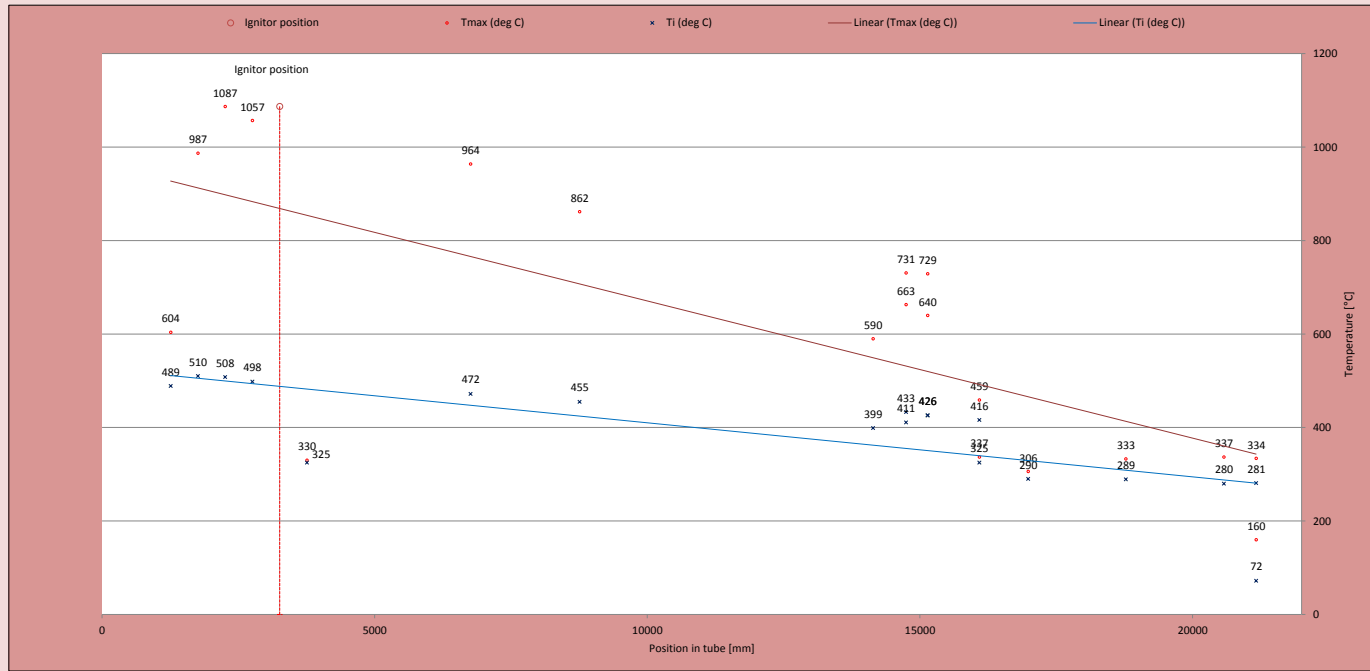
Location of igniter mm Time of ignition seconds

OP Number	Location label	Position in tube (mm)	Flame arrival time (s)	Average flame speed (m/s)
OP11	CD4-L3	10258	16.7876	
OP10	CD4-R4	10758	16.7889	384.6
OP0	HR1-R1	12152	16.7936	296.6
OP1	HR2-T3	14215	16.8083	140.3
OP2	HR2-L5M	14745	16.8091	208.7
OP3	HE1-T1	15600	16.8158	184.7
OP4	HE3-T1	16580	16.8186	350.0
OP5	HR4-R1L	16985	16.8139	238.1
OP6	HR4-T1	16985	16.8146	439.7
OP7	HR5-T2	18775	16.8253	167.3
OP8	HR6-T3	20575		
OP9	HR6-R5U	21165		
OP12	#N/A	#N/A		
OP13	#N/A	#N/A		
OP14	#N/A	#N/A		
OP15	#N/A	#N/A		



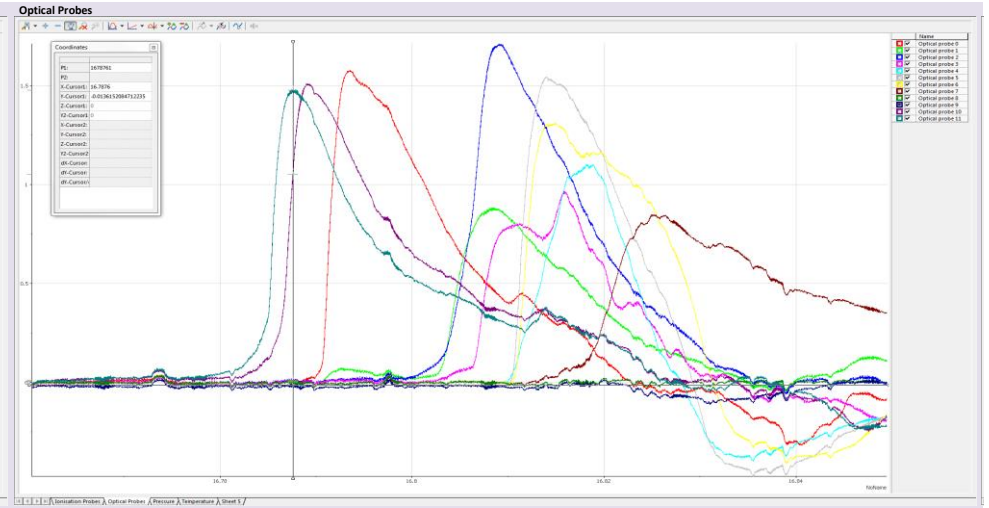
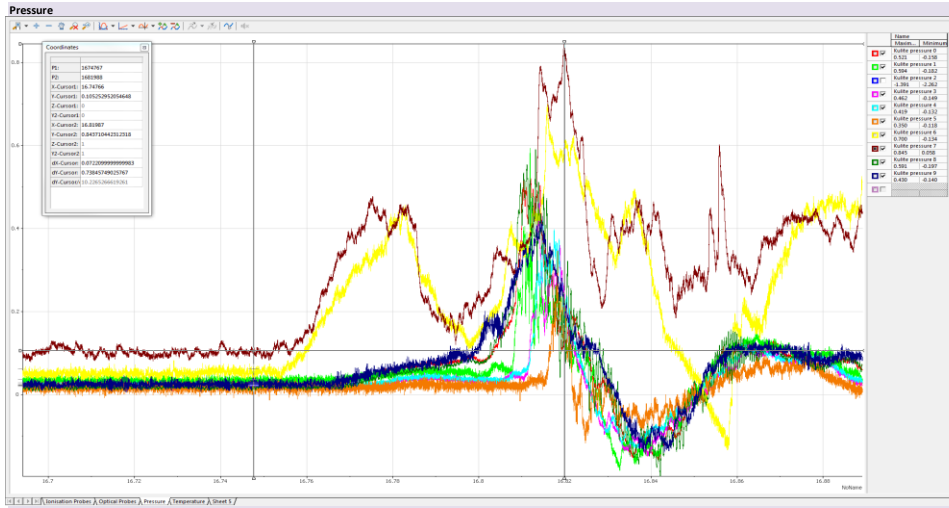
Location of igniter 3258 mm

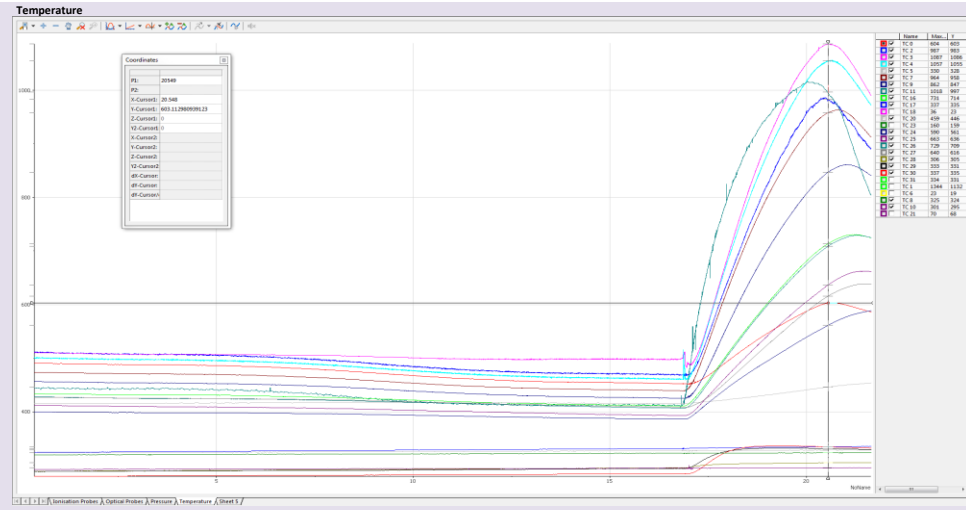
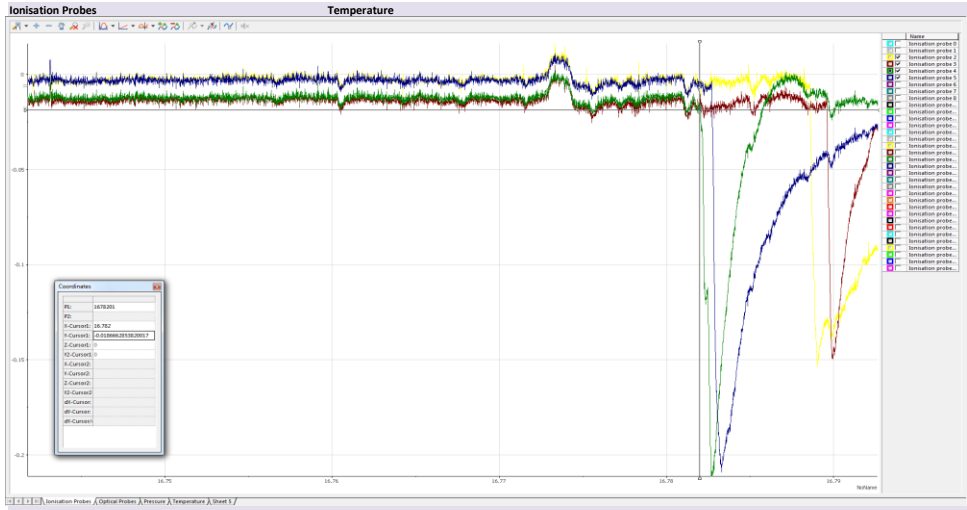
Thermocouple number	Location	Position in tube (mm)	T _{max} (deg C)	T _i (deg C)
TC0	CD1-R3	1258	604	489
TC2	CD1-R4	1758	987	510
TC3	CD1-R5	2258	1087	508
TC4	CD1-R6	2758	1057	498
TC5	CD2-R2	3758	330	325
TC7	CD3-R2	6758	964	472
TC9	CD3-R6	8758	862	455
TC11	#N/A	#N/A	1018	442
TC12	#N/A	#N/A		
TC13	#N/A	#N/A		
TC14	#N/A	#N/A		
TC15	#N/A	#N/A		
TC16	HR2-R5L	14745	731	433
TC17	HE2-R1U	16090	337	325
TC18	HR6-R3L	20575		
TC19	#N/A	#N/A		
TC20	HE2-R1L	16090	459	416
TC22	#N/A	#N/A		
TC23	HR6-R5L	21165	160	72
TC24	HR2-L3M	14140	590	399
TC25	HR2-L5L	14745	663	411
TC26	HR3-L1M	15140	729	426
TC27	HR3-L1U	15140	640	426
TC28	HR4-L1M	16985	306	290
TC29	HR5-L2U	18775	333	289
TC30	HR6-L3U	20575	337	280
TC31	HR6-L5U	21165	334	281



surface thermocouples [not plotted]

TC1	CD1-T2	1508		
TC6	CD2-T2	4508	23	20
TC8	CD3-T2	7508	325	320
TC10	CD4-T2	10508	301	293
TC21	HR5-R1M	18455	70	68





Sensor	OLD DESIGNATION	NEW DESIGNATION	Section	Section Number	Side	Horizontal Location	Vertical Location	PORT REF	SIZE	"X"	"Y"	"Z"
-		CD1-T1	CD	1	T	1		1	1" BSPP	0	298	258
TC1	TS1-1	CD1-T2	CD	1	T	2		NA	SURFACE	0	298	1508
-		CD1-B1	CD	1	B	1		2	1" BSPP	0	-298	258
-	NS1-1	CD1-R1	CD	1	R	1		3	3/4" BSPP	298	0	258
-	FS1-1	CD1-L1	CD	1	L	1		4	3/4" BSPP	-298	0	258
-	NS1-2	CD1-R2	CD	1	R	2		5	3/4" BSPP	298	0	758
-	FS1-2	CD1-L2	CD	1	L	2		6	3/4" BSPP	-298	0	758
TC0	NS1-3	CD1-R3	CD	1	R	3		7	3/4" BSPP	298	0	1258
-	FS1-3	CD1-L3	CD	1	L	3		8	3/4" BSPP	-298	0	1258
TC2	NS1-4	CD1-R4	CD	1	R	4		9	3/4" BSPP	298	0	1758
-	FS1-4	CD1-L4	CD	1	L	4		10	3/4" BSPP	-298	0	1758
TC3	NS1-5	CD1-R5	CD	1	R	5		11	3/4" BSPP	298	0	2258
-	FS1-5	CD1-L5	CD	1	L	5		12	3/4" BSPP	-298	0	2258
TC4	NS1-6	CD1-R6	CD	1	R	6		13	3/4" BSPP	298	0	2758
-	FS1-6	CD1-L6	CD	1	L	6		14	3/4" BSPP	-298	0	2758
IGN		CD2-T1	CD	2	T	1		15	1" BSPP	0	298	3258
TC6	TS2-1	CD2-T2	CD	2	T	2		NA	SURFACE	0	298	4508
-		CD2-B1	CD	2	B	1		16	1" BSPP	0	-298	2358
-	NS2-1	CD2-R1	CD	2	R	1		17	3/4" BSPP	298	0	3258
-	FS2-1	CD2-L1	CD	2	L	1		18	3/4" BSPP	-298	0	3258
TC5	NS2-2	CD2-R2	CD	2	R	2		19	3/4" BSPP	298	0	3758
-	FS2-2	CD2-L2	CD	2	L	2		20	3/4" BSPP	-298	0	3758
-	NS2-3	CD2-R3	CD	2	R	3		21	3/4" BSPP	298	0	4258
-	FS2-3	CD2-L3	CD	2	L	3		22	3/4" BSPP	-298	0	4258
-	NS2-4	CD2-R4	CD	2	R	4		23	3/4" BSPP	298	0	4758
-	FS2-4	CD2-L4	CD	2	L	4		24	3/4" BSPP	-298	0	4758
-	NS2-5	CD2-R5	CD	2	R	5		25	3/4" BSPP	298	0	5258
-	FS2-5	CD2-L5	CD	2	L	5		26	3/4" BSPP	-298	0	5258
-	NS2-6	CD2-R6	CD	2	R	6		27	3/4" BSPP	298	0	5758
-	FS2-6	CD2-L6	CD	3	L	6		28	3/4" BSPP	-298	0	5758
-		CD3-T1	CD	3	T	1		29	1" BSPP	0	298	6258
TC8	TS1-1	CD3-T2	CD	3	T	2		NA	SURFACE	0	298	7508
-		CD3-B1	CD	3	B	1		30	1" BSPP	0	-298	6258
-	NS3-1	CD3-R1	CD	3	R	1		31	3/4" BSPP	298	0	6258
-	FS3-1	CD3-L1	CD	3	L	1		32	3/4" BSPP	-298	0	6258
TC7	NS3-2	CD3-R2	CD	3	R	2		33	3/4" BSPP	298	0	6758
-	FS3-2	CD3-L2	CD	3	L	2		34	3/4" BSPP	-298	0	6758
-	NS3-3	CD3-R3	CD	3	R	3		35	3/4" BSPP	298	0	7258
-	FS3-3	CD3-L3	CD	3	L	3		36	3/4" BSPP	-298	0	7258
-	NS3-4	CD3-R4	CD	3	R	4		37	3/4" BSPP	298	0	7758
-	FS3-4	CD3-L4	CD	3	L	4		38	3/4" BSPP	-298	0	7758
KU6	NS3-5	CD3-R5	CD	3	R	5		39	3/4" BSPP	298	0	8258
-	FS3-5	CD3-L5	CD	3	L	5		40	3/4" BSPP	-298	0	8258
TC9	NS3-6	CD3-R6	CD	3	R	6		41	3/4" BSPP	298	0	8758
-	FS3-6	CD3-L6	CD	3	L	6		42	3/4" BSPP	-298	0	8758
-		CD4-T1	CD	4	T	1		43	1" BSPP	0	298	9258
TC10	TS1-1	CD4-T2	CD	4	T	2		NA	SURFACE	0	298	10508
-		CD4-B1	CD	4	B	1		44	1" BSPP	0	-298	9258
IP5	NS4-1	CD4-R1	CD	4	R	1		45	3/4" BSPP	298	0	9258
IP4	FS4-1	CD4-L1	CD	4	L	1		46	3/4" BSPP	-298	0	9258
KU7	NS4-2	CD4-R2	CD	4	R	2		47	3/4" BSPP	298	0	9758
-	FS4-2	CD4-L2	CD	4	L	2		48	3/4" BSPP	-298	0	9758
-	NS4-3	CD4-R3	CD	4	R	3		49	3/4" BSPP	298	0	10258
OP11	FS4-3	CD4-L3	CD	4	L	3		50	3/4" BSPP	-298	0	10258
OP10	NS4-4	CD4-R4	CD	4	R	4		51	3/4" BSPP	298	0	10758
-	FS4-4	CD4-L4	CD	4	L	4		52	3/4" BSPP	-298	0	10758
IP3	NS4-5	CD4-R5	CD	4	R	5		53	3/4" BSPP	298	0	11258
IP2	FS4-5	CD4-L5	CD	4	L	5		54	3/4" BSPP	-298	0	11258
IP1	NS4-6	CD4-R6	CD	4	R	6		55	3/4" BSPP	298	0	11758

Sensor	OLD DESIGNATION	NEW DESIGNATION	Section	Section Number	Side	Horizontal Location	Vertical Location	PORT REF	SIZE	"X"	"Y"	"Z"
IP0	FS4-6	CD4-L6	CD	4	L	6		56	3/4" BSPP	-298	0	11758
OP0		HR1-R1	HR	1	R	1		57	3/4" BSPP	308	0	12152
-		HR1-L1	HR	1	L	1		58	3/4" BSPP	-308	0	12152
IP6		HR1-R2	HR	1	R	2		59	3/4" BSPP	393	0	13160
-		HR1-L2	HR	1	L	2		60	3/4" BSPP	-393	0	13160
RA1		HR2-R2M	HR	2	R	2	M	61	11/4" BSPP	448	70	13785
RA1		HR2-L2M	HR	2	L	2	M	62	11/4" BSPP	-448	70	13785
IP7		HR2-R3M	HR	2	R	3	M	63	3/4" BSPP	528	410	14140
TC24		HR2-L3M	HR	2	L	3	M	64	3/4" BSPP	-528	410	14140
OP1		HR2-T3	HR	2	T	3		65	1" BSPP	0	1122	14215
RA2		HR2-R4M	HR	2	R	4	M	66	11/4" BSPP	598	700	14475
RA2		HR2-L4M	HR	2	L	4	M	67	11/4" BSPP	-598	700	14475
-		HR2-B5	HR	2	B	5		68	1" BSPP	0	-100	14745
KU8		HR2-T5	HR	2	T	5		69	1" BSPP	0	2315	14745
TC16		HR2-R5L	HR	2	R	5	L	70	3/4" BSPP	662	310	14745
TC25		HR2-L5L	HR	2	L	5	L	71	3/4" BSPP	-662	310	14745
IP8		HR2-R5M	HR	2	R	5	M	72	3/4" BSPP	662	975	14745
OP2		HR2-L5M	HR	2	L	5	M	73	3/4" BSPP	-662	975	14745
-		HR2-R5U	HR	2	R	5	U	74	3/4" BSPP	662	1660	14745
-		HR2-L5U	HR	2	L	5	U	75	3/4" BSPP	-662	1660	14745
KU9		HR3-L1L	HR	3	L	1	L	76	3/4" BSPP	-700	400	15140
TC26		HR3-L1M	HR	3	L	1	M	77	11/4" BSPP	-700	1335	15140
TC27		HR3-L1U	HR	3	L	1	U	78	3/4" BSPP	-700	2270	15140
-		HE1-R1L	HE	1	R	1	L	79	3/4" BSPP	700	400	15600
-		HE1-R1M	HE	1	R	1	M	80	3/4" BSPP	700	1335	15600
KU0		HE1-R1U	HE	1	R	1	U	81	3/4" BSPP	700	2270	15600
TC20		HE2-R1L	HE	2	R	1	L	83	3/4" BSPP	700	400	16090
IP10		HE2-R1M	HE	2	R	1	M	84	3/4" BSPP	700	1335	16090
TC17		HE2-R1U	HE	2	R	1	U	85	3/4" BSPP	700	2270	16090
KU1		HE3-R1L	HE	3	R	1	L	87	3/4" BSPP	700	400	16580
-		HE3-R1M	HE	3	R	1	M	88	3/4" BSPP	700	1335	16580
-		HE3-R1U	HE	3	R	1	U	89	3/4" BSPP	700	2270	16580
OP3		HE1-T1	HE	1	T	1		82	3/4" BSPP HOLE	-47	2735	15600
-		HE2-T1	HE	2	T	1		86	3/4" BSPP HOLE	0	2735	16090
OP4		HE3-T1	HE	3	T	1		90	3/4" BSPP HOLE	-47	2735	16580
OP6		HR4-T1	HR	4	T	1		91	1" BSPP	0	2735	16985
-		HR4-B1	HR	4	B	1		92	1" BSPP	0	-65	16985
OP5		HR4-R1L	HR	4	R	1	L	93	3/4" BSPP	700	400	16985
IP13		HR4-L1L	HR	4	L	1	L	94	3/4" BSPP	-700	400	16985
IP12		HR4-R1M	HR	4	R	1	M	95	3/4" BSPP	700	1335	16985
TC28		HR4-L1M	HR	4	L	1	M	96	3/4" BSPP	-700	1335	16985
KU2		HR4-R1U	HR	4	R	1	U	97	3/4" BSPP	700	2270	16985
-		HR4-L1U	HR	4	L	1	U	98	3/4" BSPP	-700	2270	16985
RA3		HR4-R3M	HR	4	R	3	M	99	11/4" BSPP	700	1335	17575
RA3		HR4-L3M	HR	4	L	3	M	100	11/4" BSPP	-700	1335	17575
IP14		HR4-R5M	HR	4	R	5	M	101	3/4" BSPP	700	1335	18165
-		HR4-L5M	HR	4	L	5	M	102	3/4" BSPP	-700	1335	18165
TC21		HR5-R1M	HR	5	R	1	M	NA	SURFACE	700	1200	18455
OP7		HR5-T2	HR	5	T	2		103	1" BSPP	0	2735	18775
-		HR5-B2	HR	5	B	2		104	1" BSPP	0	-65	18775
KU3		HR5-R2L	HR	5	R	2	L	105	3/4" BSPP	700	400	18775
IP16		HR5-L2L	HR	5	L	2	L	106	3/4" BSPP	-700	400	18775
IP15		HR5-R2M	HR	5	R	2	M	107	3/4" BSPP	700	1335	18775
KU4		HR5-L2M	HR	5	L	2	M	108	3/4" BSPP	-700	1335	18775
-		HR5-R2U	HR	5	R	2	U	109	3/4" BSPP	700	2270	18775
TC29		HR5-L2U	HR	5	L	2	U	110	3/4" BSPP	-700	2270	18775
RA4		HR5-R4M	HR	5	R	4	M	111	11/4" BSPP	700	1335	19375
RA4		HR5-L4M	HR	5	L	4	M	112	11/4" BSPP	-700	1335	19375
IP17		HR6-R1M	HR	6	R	1	M	113	3/4" BSPP	700	1335	19985

Sensor	OLD DESIGNATION	NEW DESIGNATION	Section	Section Number	Side	Horizontal Location	Vertical Location	PORT REF	SIZE	"X"	"Y"	"Z"
-		HR6-L1M	HR	6	L	1	M	114	3/4" BSPP	-700	1335	19985
OP8		HR6-T3	HR	6	T	3		115	1" BSPP	0	2735	20575
-		HR6-B3	HR	6	B	3		116	3/4" BSPP	0	-65	20575
TC18		HR6-R3L	HR	6	R	3	L	117	3/4" BSPP	700	400	20575
IP19		HR6-L3L	HR	6	L	3	L	118	3/4" BSPP	-700	400	20575
-		HR6-R3M	HR	6	R	3	M	119	11/4" BSPP	700	1335	20575
-		HR6-L3M	HR	6	L	3	M	120	11/4" BSPP	-700	1335	20575
-		HR6-R3U	HR	6	R	3	U	121	3/4" BSPP	700	2270	20575
TC30		HR6-L3U	HR	6	L	3	U	122	3/4" BSPP	-700	2270	20575
-		HR6-B5	HR	6	B	5		123	1" BSPP	0	-65	21165
TC23		HR6-R5L	HR	6	R	5	L	124	3/4" BSPP	700	400	21165
IP20		HR6-L5L	HR	6	L	5	L	125	3/4" BSPP	-700	400	21165
IP18		HR6-R5M	HR	6	R	5	M	126	3/4" BSPP	700	1335	21165
KU5		HR6-L5M	HR	6	L	5	M	127	3/4" BSPP	-700	1335	21165
OP9		HR6-R5U	HR	6	R	5	U	128	3/4" BSPP	700	2270	21165
TC31		HR6-L5U	HR	6	L	5	U	129	3/4" BSPP	-700	2270	21165
-		EP-1L	EP			1	L	130	1" BSPP	650	-15	21330
-		EP-2L	EP			2	L	131	1" BSPP	0	-15	21330
-		EP-3L	EP			3	L	132	1" BSPP	-650	-15	21330
-		EP-1M	EP			1	M	133	1" BSPP	250	1335	21330
-		EP-2M	EP			2	M	134	1" BSPP	-250	1335	21330
-		EP-1U	EP			1	U	135	3/4" BSPP	0	2270	21330

0	0	0	0	0	0	0	0	0	0	0	-47	0	-47	0	0	0	0	0	0	0
298	-298	298	-298	298	-298	298	-298	1122	-100	2315	2735	2735	2735	2735	-65	2735	-65	2735	-65	-65
258	258	3258	2358	6258	6258	9258	9258	14215	14745	14745	15600	16090	16580	16985	16985	18775	18775	20575	20575	21165

	0	12000	14215	14745	15600	22000
top	298	298	1122	2315	2735	2735
bottom	-298	-298	-100	-100	-65	-65

