condensing
derwent

INSTALLATION, OPERATION & MAINTENANCE MANUAL

APRIL 2002

POTTERTON
COMMERCIAL

Fig 1.1 – General Data and Dimensions

Figures in brackets are for 20 and 22 section boilers.

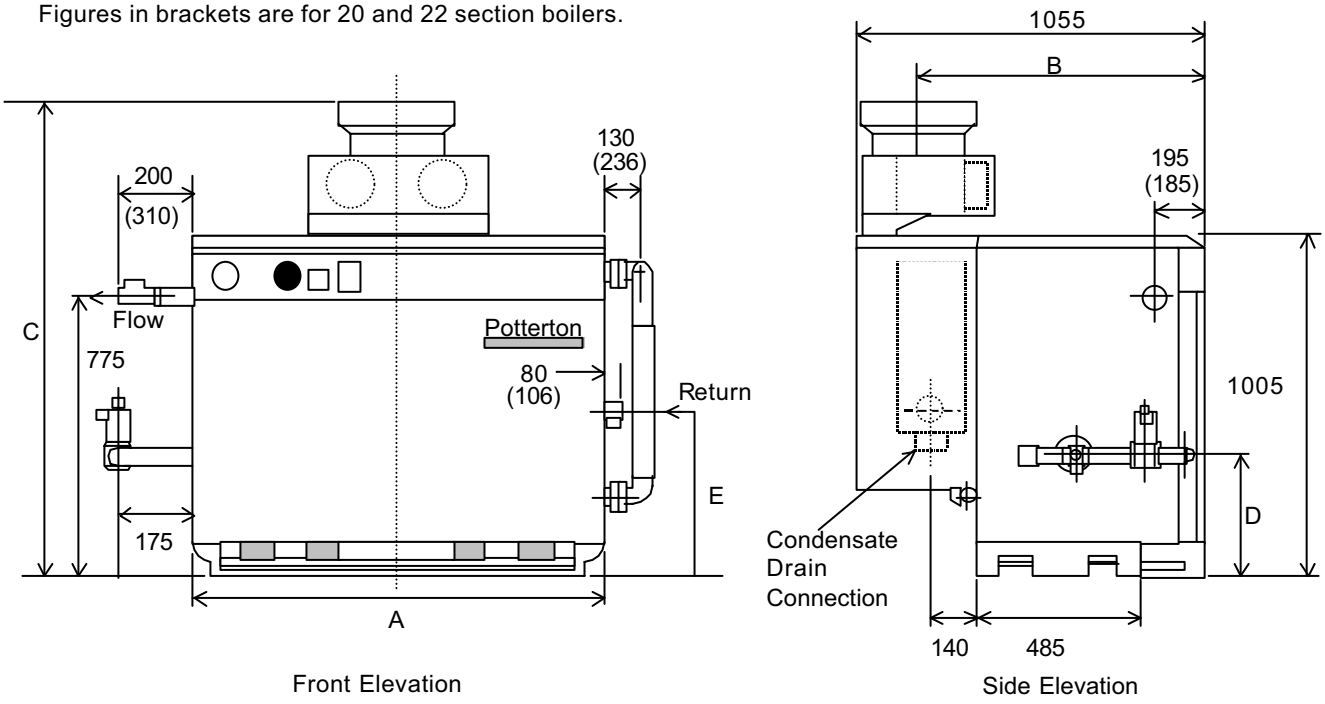


Table 1.1 – Boiler Dimensions

No. of Sections	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20	22
A mm	465	545	625	705	790	870	950	1030	1110	1195	1275	1355	1435	1515	1680	1840
B mm	915								900							
C mm	1355			1420		1445				1580				1600		
D mm	393															
E mm	460							465							475	

Connections:

Water – Flow & Return; 5 to 11 section– 1 ½" BSP
12 to 18 section – 2" BSP
20 and 22 section – Flanged, mating flange supplied and screwed 2 ½" BSP.

Drain: ¾ BSP – drain cock supplied.

Gas: 5 to 6 section – 1" BSP
7 to 11 section – 1 ½ BSP
12 to 22 section – 2" BSP

Condensate Drain: 32mm O.D.

TABLE 1.2A – Technical Data (5 to 12 section)

	Number of Sections		5	6	7	8	9	10	11	12
	Output at 60°C Return	kW	69	86	104	121	138	156	173	190
	Output at 40°C Return	kW	74	92	111	130	148	167	185	203
1	Fuel Consumption	m^3/hr	7.45	9.41	11.19	13.05	14.89	16.75	18.73	20.59
	Input (Gross)	kW	80	100	120	140	160	181	201	221
	Maximum Design Pressure	Bar	5							
2	Minimum Operating Pressure	Bar	0.1							
3	Nominal Flue Connection Size	mm	175			200		250		
	Internal Diameter of Diverter Socket to BS 835	mm	213			240		290		
4	Flue Gas Volume	m^3/hr	118	147	178	207	236	267	296	325
	Flue Draught Requirements		Positive Pressure Available – See Section 3							
5	High Level Natural Ventilation to BS 6644	cm^2	315	360	405	450	495	540	587	632
5	Low Level Natural Ventilation to BS 6644	cm^2	630	720	810	900	990	1080	1174	1264
6	Mechanical Inlet to BS 6644	m^3/sec	0.089	0.11	0.133	0.154	0.176	0.198	0.22	0.243
7	Water Connection Size	BSP	1 ½							2”
8	Water Flow at 11°C Δt Min water flow at 25°C Δt	lit/sec lit/sec	1.5 0.65	1.86 0.8	2.26 0.99	2.63 1.15	3.0 1.31	3.39 1.48	3.76 1.64	4.13 1.8
8	Hydraulic resistance at 11°C Δt	kPA	7.1	11.0	16.5	22.5	29.5	34.8	42.6	29.8
8	Hydraulic resistance at 20°C Δt	kPA	2.15	3.41	4.99	6.81	8.92	10.53	12.9	9
9	Cold feed size to BS 6644 Minimum Bore	mm	25					32		
9	Open Vent size to BS 6644 Minimum Bore	mm	32					38		
	Safety Valve Size to BS 6644 Nominal Bore	mm	19							
2	Maximum Flow Temperature	°C	90°C							
10	Minimum Return temperature	°C	35°C							
11	Dry Weight	kg	327	379	432	485	537	589	642	696
	Water Content	kg	41	48	54	61	67	73	80	86
	Power Requirements		IP 30 – 240 V 50Hz I Ph – Isolator and 5A fuse required							

For metric to imperial conversions refer to Page 1.6

	Number of Sections		13	14	15	16	17	18	20	22
	Output at 60°C Return	kW	208	225	242	260	277	294	315	348
	Output at 40°C Return	kW	223	241	259	278	297	315	337	373
1	Fuel Consumption	m^3/hr	22.43	24.29	26.16	28.02	29.89	31.75	33.98	37.25
	Input (Gross)	kW	241	261	281	301	321	341	365	403
	Maximum Design Pressure	Bar	5							
2	Minimum Operating Pressure	Bar	0.1							
3	Nominal Flue Connection Size	mm	250	300						
	Internal Diameter of Diverter Socket to BS 835	mm	290	344						
4	Flue Gas Volume	m^3/hr	356	385	414	445	474	503	539	595
	Flue Draught Requirements		Positive Pressure Available – See Section 3							
5	High Level Natural Ventilation to BS 6644	cm^2	677	722	767	812	857	902	956	1042
5	Low Level Natural Ventilation to BS 6644	cm^2	1354	1444	1534	1624	1714	1804	1912	2084
6	Mechanical Inlet to BS 6644	m^3/sec	0.265	0.287	0.309	0.331	0.353	0.374	0.402	0.444
7	Water Connection Size	BSP	2”						2 ½Flanged	
8	Water Flow at 11°C Δt Min water flow at 25°C Δt	lit/sec lit/sec	4.52 1.98	4.89 2.14	5.26 2.3	5.65 2.47	6.02 2.63	6.39 2.8	6.84 3.0	7.56 3.31
8	Hydraulic resistance at 11°C Δt	kPA	34.4	35.9	40.7	46.6	52.2	58.6	66.8	81.9
8	Hydraulic resistance at 20°C Δt	kPA	10.4	10.87	12.3	14.1	15.8	17.74	20.2	24.8
9	Cold feed size to BS 6644 Minimum Bore	mm	32						38	
9	Open Vent size to BS 6644 Minimum Bore	mm	38						50	
	Safety Valve Size to BS 6644 Nominal Bore	mm	19				25			
2	Maximum Flow Temperature	°C	90°C							
10	Minimum Return temperature	°C	35°C							
11	Dry Weight	kg	748	805	857	909	961	1014	1120	1226
	Water Content	kg	93	99	106	112	119	125	144	158
	Power Requirements		IP 30 – 240 V 50Hz I Ph– Isolator and 5A fuse required							

For metric to imperial conversions refer to Page 1.6

1. FUEL CONSUMPTION
Gas fuel consumption is based on natural gas with a gross calorific value of 38.6 mj/m^3, refer to relevant burner data sheet for maximum and minimum fuel pressures. The gas rate should be corrected for the meter supply pressure particularly on high pressure supplies to prevent overfiring. Supply pressure for LPG is 35 mbar.

2. MINIMUM OPERATING PRESSURE

This is the minimum operating pressure of the boilers with pumps operating (NOT static pressure). The requirements of the Health & Safety Executive guidance note PM5 regarding maximum operating temperatures should be observed. See section 3 for further details.

3. BOILER FLUE CONNECTION
The boilers are provided with a socket with internal diameters as shown in Table 1.2A and 1.2B.

4. FLUE GAS VOLUME
Flue gas volumes are given at STP (standard temperature and pressure [15°C and 1013.25 mbar]). Typical flue gas temperatures for flue gas sizing are 180°C at 4% CO_2 with 1mm draught at the boiler flue connection.

5. NATURAL VENTILATION
The sizes indicated are free grille areas and are based on a single boiler installation. See Section 3 for further details on ventilation.

6. MECHANICAL VENTILATION
The volume given is for a single boiler installation. See Section 3 for further details on mechanical ventilati on.

7. CONNECTION SIZES
The boiler connections are screwed Bs up to 18 section size and 20 and 22 section sizes are flanged 2 ½ with screwed counter flanges provided. For further details on water connections see Fig 1.1

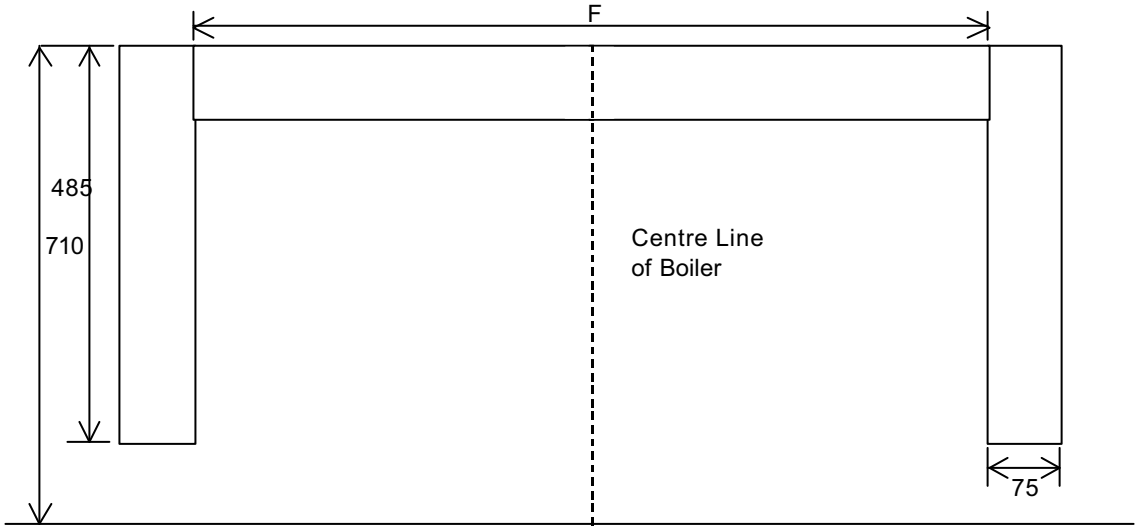
8. WATER FLOW RATES
Water flow rates are given for boiler flow and return water temperature differences of 11°C. See section 3 for further details of maximum/minimum flow rates and hydraulic resistances at alternative flow rates.

9. COLD FEED/ OPEN VENT/ SAFETY VALVE SIZES
Sizes indicated are minimum sizes for single boiler installations. See Section 3 for further details.

10. MINIMUM RETURN TEMPERATURE
This is the minimum operating return temperature to prevent condensation within the boiler system. See Section 3 for further details on back end protection.

11. WEIGHT
The dry weight is inclusive of the casing and controls.

Fig 1.2 – Steel Base Strip Details. (See Section 2– Boiler Siting & Base)



BOILER FRONT

No. of Sections	5	6	7	8	9	10	11	12	13	14	15	16	14	18	20	22
F mm	243	324	405	486	567	648	729	810	891	972	1053	1134	1215	1296	1458	1620

CLEARANCES

The minimum boiler room clearances for access, erection and maintenance are as follows;

REAR - 500mm (2 in) from rear of flue hood

SIDES - 500mm (19 in) on gas train side, 100 mm from other

FRONT - 600mm to allow for burner removal

TOP - 1000mm to allow for cleaning

BURNER INFORMATION

The standard Condensing Derwent boiler is fitted with Bray atmospheric burners.

CONDENSATE

The boiler can produce condensate at an approximate rate of 0.1 lit/hr per kwh. The condensate is slightly acidic with a pH of 3.5. Copper pipe should not be used for drainage purposes.

CONVERSION TABLE

GENERAL

The Potterton Condensing Derwent cast iron sectional boiler is available in sixteen sizes with outputs at 60 °C return temperature from 69kW (5 section model) to 348kW (22 section model). Tables 1.2A and 1.2B give kW outputs and technical data for each model.

They are approved by British Gas for use on open vented systems, however, they are suitable for use on sealed systems with a maximum operating pressure of 5 bar (73.5 p.s.i.). Refer to relevant British Standards and Codes of Practice re installation of Derwent HE boilers on sealed systems.

For ease of installation 5 to 10 section boilers are delivered with the primary heat exchanger sections assembled with burners and secondary heat exchanger fitted. The casing and control panel are packed on another pallet and the gas train is cartoned separately.

The 11 to 16 section boilers have the secondary heat exchanger and fan assembly packed separately.

The 16 to 22 section boilers are unassembled and are delivered with the sections packed on one pallet with casing pack and burner. The secondary heat exchanger and fan assembly are packed on a separate pallet and the gas train is separately cartoned.

NOTE: Unlike the Derwent He the condensing Derwent boiler cannot be handed on its connections. They are only available with the flow and gas train on the left hand side looking from the front and the return connection on the right.

The boiler sections are cast iron with pips to aid heat transfer and they are joined by neoprene 'O' rings to flow and return manifolds. The secondary heat exchanger is constructed from stainless steel plain tubes, stainless steel end plates with mild steel cover plates.

The fully automatic control system which incorporates full safety features includes control and high limit thermostats, thermometer and on/off switch with lamp. All models have automatic ignition with a sequential control box and an ionisation flame failure device fitted to an interrupted low energy pilot burner.

The gas train assembly must be connected on site and, apart from the incoming supply, all other electrical connections are made by plug and socket.

The boiler sections are insulated by glass fibre insulation ranging in thickness from 30 to 60 mm. The case is finished in a powder coat paint as follows.

Control panel – Red, Paint Code RAL3020
Top & Front – Dark Grey, Paint Code RAL7011
Sides & Rear – Light Grey, Paint Code RAL7004

INSTALLATION

The installation should comply with the relevant British Standard Specifications, Codes of Practice and current Building Regulations, together with any special regional requirements of the local authorities, gas undertaking and insurance company. All electrical wiring must comply with I.E.E. Regulations for the Electrical Equipment of Buildings.

The installation of the boiler must be in accordance with the relevant requirements of:-

Health & Safety at Work Act 1974.

CP331:3 Low Pressure Installation Pipes

BS 6644: 1991 – Installation of Gas Fired Boilers

BS 779: 1989 Cast Iron Boilers for Central Heating & Indirect Hot Water Supply (Rated Output 44kW and above).

BS 7074: 1989: Part 2 – Application, Selection & Installation of Expansion Vessels & Ancillary Equipment for Sealed Water Systems

PM5 Health & Safety executive Guidance Note for Automatically Controlled Steam & Hot Water Boilers.

CP341:300-307 Central Heating by Low Pressure Hot Water.

CP342:2 – Centralised Hot Water Supply

Also for gas fired appliances the following British Gas Publications:-

Gas Safety (Installation & Use) Regulations 1984

IM/11 – Flues for Commercial & Industrial Gas Fired Boilers & Air Heaters

IM/2 Purging Procedure for Non-Domestic Installations.

CIBSE AM3 Applications Manual for Condensing Boilers.

IM/5 Soundness Testing for Non-Domestic Installations.

In the event of a gas booster being necessary refer to IM16 ' Guidance Notes on the Installation of Gas Pipework, boosters and Compressors in Customers Premises' and the Gas Act 1972, Schedule 4, Paragraph 18.

Manufacturers notes must not be taken in any way as overriding statutory obligations.

BOILER SITING & BASE

The boiler should be sited in accordance with BS 6644: 1991 with respect to protecting the boiler from damage, air for combustion and ventilation, discharge of products of combustion, clearances for service and access, temperatures, noise levels, the disposal of boiler house water and the effects of flooding of the boiler house or seepage from a roof top boiler house. See section 1 for required boiler clearances for service and cleaning.

A level non-combustible floor capable of supporting the weight of the boiler filled with water, see Table 1.2, together with any additional weight bearing down on the base from connections, etc, must be provided. This will typically be a 50mm concrete plinth with an area equal to that of the plan of the boiler.

Steel strips should be provided (not supplied by Potterton Commercial) to support the left and right hand section feet and the back feet of the intermediate sections, see Fig 1.2, page 1.4 for details. These strips should typically be 3" wide and 1/8 " thick.

It is not recommended to install commercial boilers in kitchens or living areas.

ELECTRICAL SUPPLY

A 230V, 50Hz, single phase electrical supply is required. The incoming mains supply should be terminated via a double pole fused isolator to the boiler, see Section 6 for wiring details. A 5A fused supply is required for all sizes.

Power requirements

The electrical supply is to feed control circuits and gas valves. Typical loading is;

0.42 KVA – 5 to 12 Section
0.62 KVA – 13 to 22 Section

The external supply must be fitted with a 5A fuse.

All on site wiring must conform to I.E.E. Regulations.

FUEL SUPPLY

NATURAL GAS

Where there is an existing primary gas meter, the appropriate gas supplier/undertaking must be consulted to ensure that the service/meter supply capacity is adequate for the proposed installation.

The burner gas connection sizes are given in Section 1 and minimum and maximum inlet pressures are 17.5 mbar and 35 mbar respectively.

The gas supply pipe should be sized to allow the minimum operating pressure to be available at the burner inlet under full running conditions. The pipe should be sized to prevent excessive pressure drops under full running conditions.

Where gas boosters are required attention is drawn to the Gas Act 1986, Schedule 5, Part II, paragraph 8 (4). Guidance is given in IM/16 “Guidance Notes on the Installation of Gas Pipework, Boosters & Compressors in Customers Premises” published by British Gas PLC. The gas booster should be electrically interlocked to the burner.

VENTILATION

Safe, efficient and trouble free operation of conventionally flued boilers is vitally dependent on the provision of an adequate supply of fresh air to the room in which the appliance is installed. Account must also be taken of any other fuel burning appliance existing or to be fitted when designing the ventilation and combustion air systems.

The air supplied for boiler house ventilation shall be such that the maximum temperatures within the boiler house shall not exceed 25°C at floor level, 32°C at mid level (1.5m above floor level) and 40°C at ceiling level (or 100mm below ceiling level). Refer to BS 6644: 1991 for further details.

Air Supply by Natural Ventilation

Ventilation by grilles communicating directly with the outside air is required at both high and low levels.

A minimum free area of the grilles for a single boiler is given in Table 3. Where plant is likely to used at or near maximum capacity during the summer months, additional ventilation may be required to prevent excess temperatures.

For boiler houses with multiple boiler installations the minimum ventilation should be sized in accordance with BS 6644 as follows:-

Low Level (inlet) - 540 cm^2 plus 4.5 cm^2 per kW in excess of 60 kW total rated input.

High Level (outlet) - 270 cm^2 plus 2.25 cm^2 per kW in excess of 60kW total rated input.

The above calculated areas are "free" grille areas. Grilles should be designed to minimise high velocity air streams within the boiler house. Typical free area of a standard louvre is approximately 50%.

For boilers installed in a basement boiler house or similar, it is recommended that the inlet air be ducted to low level in ducting not less than equal to the free grille area. Should the inlet duct length be excessive then mechanical ventilation should be used.

Position ventilation grilles to avoid accidental obstruction by blockage or flooding.

Further guidance on ventilation for gas appliances is provided by BS 6644: 1991.

Air Supply by Mechanical Ventilation

The supply of air to a space housing the boiler by mechanical means should be by mechanical inlet with natural. Mechanical ventilation with natural inlet must not be used, see Table 1.2A and 1.2B for mechanical inlet ventilation rates for single boiler applications

For multiple boiler installations the ventilation rate is based on a 1.1 m^3/sec flow rate per 1000 kW total rated input. The design extract rate should be based on 0.45m^3/sec flow rate per 100 kW total rated input.

For mechanical ventilation systems, an automatic control should be provided to cut off the supply of fuel to the boiler(s) in the event of failure of air flow in either inlet or extraction fans.

IMPORTANT: **The use of an extractor fan in the same room as the boiler (or in an adjacent room in communication) can, in certain conditions, adversely affect the safe operation of the boiler and therefore must be avoided.**

Tests for spillage of products from the flue system when the extractor fan is running and all doors and windows are shut should be carried out during commissioning. If spillage is detected, the area of permanent ventilation must be increased.

Contaminated Combustion Air

It is essential that fresh and uncontaminated air is introduced to the boiler for combustion.

Air contaminated with chlorine vapours and CFC gases must not be allowed to enter boiler combustion chambers or formation of chlorine gas and hydrochloric acid will create severe and rapid boiler corrosion. There is also a danger that toxic chlorine gas will be emitted from the boiler flue.

In areas where such products are used, and these include degreasants, dry cleaning fluids, refrigerants and aerosol propellants, steps must be taken to isolate the boiler from the area by situating it in a separate area where fresh air can be introduced. Care should be taken in positioning extract ducts from contaminated areas in relation to boiler house grilles to ensure that cross contamination will not occur.

Dust contamination in the combustion air may cause blockage of the burner slots or localised overheating of the burner surface leading to premature failure. it is recommended that where there is a likelihood of a contaminated air supply a fanned filtered air supply should be used. A differential pressure switch fitted across the filter should shut the boiler down if the air supply is reduced owing to the partial blockage of the filter.

FLUE

The flue gas temperature at the boiler flue outlet will be no greater than 10C above the return water temperature under normal running conditions and the buoyancy in the stack will be relatively low. The boiler fan is therefore dessigned to overcome the flue resistance.

The flue gases will be at or near saturation point under all running conditions and droplets of condensate will precipitate onto the walls of the flue system. The flue system must therefore be corrosion resistant, water and gas tight, and free draining.

Typically a flue system must be constructed in 316 grade stainless steel with gasketed joints. Most flexible flue liners are unsuitable as they are not gas and water tight under positive pressure. Advice on flexible flue liners should be sought form a flue specialist.

The use of insulated or twin wall type flue systems should be avoided. The only neccessity for insulation is for personnel protection. Exposed surfaces of the flue would reach a maximum temperature of 90°C.

The number of bends used should be kept to a minimum. Any bend used must be of the slow radius type, 90° tees must not be used.

All flue runs should be run to allow free drainage and all low points must be drained. Material for drainage should be stainless steel or plastic, avoid the use of copper.

Flue systems should meet the applicable sections of:-

BS 6644: 1991
British Gas publication IM11
CIBSE Applications Manual AM3 – Condensing Boilers
Third edition of the 1956 Clean Air Act Memorandum

In addition to the above requirements of the building Regulations should be strictly observed.

Care should be exercised with tall flue systems to ensure that excess buoyancy is not created. If this is unavoidable draught stabilisers should be considered plus a time delay device to prevent the boiler short cycling otherwise frequent nuisance lockouts may occur.

Flue Terminals

Flue sizes 200 mm and above should not be fitted with a flue terminal below 200mm. The flue should be fitted ith a mesh ball with mesh spacings of 25mm.

In all cases the discharge must be vertically upwards to allow the plume to dissipate.

Table 3.1 shows maximum flue lengths for each boiler using up to four slow radius bends. Do not use more than four bends..

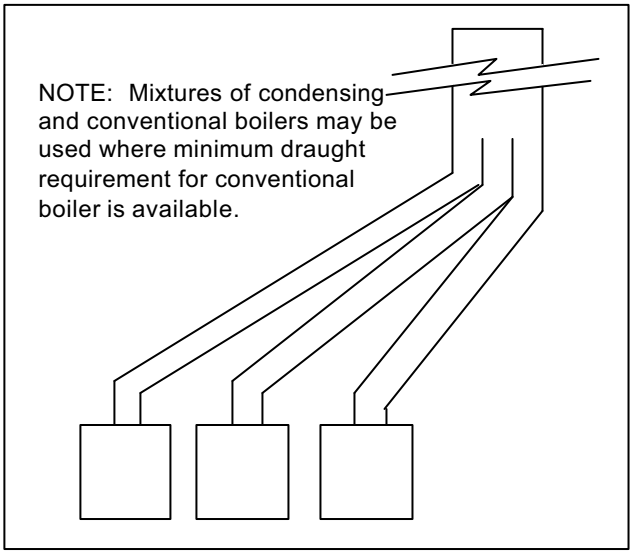
Table 3.1 – Maximum Flue Lengths (in metres) for systems Including Fittings

Boiler size	Nominal Flue Size Mm	Number of Fittings			
		None	2 Bends	3 Bends	4 Bends
5/235	130	8	5	-	-
	150	20	17	15	13
	180	42	42	42	42
6/293	150	11	7	-	-
	180	35	31	28	25
7/355	150	7	4	-	-
	180	22	19	17	15
	200	42	37	35	33
8/413	180	16	13	10	7
	200	29	25	22	19
	250	42	42	42	42
9/471	180	11	8	5	-
	200	20	16	14	12
	250	42	42	42	42
10/532	180	7	4	-	-
	200	15	11	9	7
	250	42	42	42	42
11/590	180	5	-	-	-
	200	11	7	5	-
	250	42	39	36	33
12/648	200	8	5	-	-
	250	34	31	28	25
	300	42			
13/710	200	6	-	-	-
	250	28	24	20	16
	300	42	42	42	42
14/768	200	4	-	-	-
	250	23	19	16	13
	300	42	42	42	42
15/826	250	18	15	12	9
	300	42	42	42	42
16/887	250	15	11	8	5
	300	42	42	39	38
17/945	250	13	8	5	-
	300	39	35	33	30
18/1003	250	10	6	-	-
	300	35	29	26	23
20/1075	250	6	-	-	-
	300	24	20	17	14
	350	42	42	42	42
22/1187	250	3	-	-	-
	300	18	13	10	7
	350	42	42	42	39

MULTIPLE BOILER FLUES

It is best to run separate flues from individual boilers. However, if this is unavoidable extreme care must be exercised to prevent flue gases being forced through off cycle boilers. This can be achieved by using a flue dilution system as described in the following section or by running individual connections t discharge vertically into a common stack, see Fig.3.1. The common stack size should be the equivalent cross sectional area of the total boiler flue connections.

Fig 3.1 – Multiple Boilers Utilising Individual Flues into a Common Stack



FAN DILUTION SYSTEMS

Potterton Commercial gas fired boilers are suitable for fan dilution systems for low level discharge of products of combustion in accordance with BS 6644 .

The fan dilution system should be designed to reduce the CO_2 concentration of the vented combustion products to 1% (volumetric) or less.

The discharge velocity from the fan dilution system should be a minimum of 7.5 m/sec and should be at least 2m above ground level for systems up to 1MW input.

The outlet grille should diffuse the products of combustion upwards and be located so that recirculation of combustion products is avoided, in particular the positioning of fan dilution systems in totally enclosed wells or courtyards should be avoided. The inlet and outlet grilles must be located on the same face of the building.

Fan dilution systems must be interlocked to prevent operation of the boilers unless adequate air flow is proved.

In accordance with BS 6644: 1991 the position of the outlet grille should comply with the following:-

1. The outlet grille shall not be less than 2 x 'U'm from any fan assisted intake, where 'U' is the uncorrected chimney height in metres, as defined in the Clean Air Act and is calculated from:-

$$'U' = 1.3\ Q^{0.6}$$

(where 'Q' is the heat input in MW)

2. The outlet shall not be within 2 x 'U' of an openable window or 6 x 'U' from an adjacent building.

3. The fan dilution system should be designed to provide a flue draught at each boiler of 1-2 mm.w.g.

Typical duct sizes, fan volumes and values of 'U' are given in Table 3.2.

It is important that adequate ventilation is provided into the boiler house especially as a proportion of the dilution air is drawn through the draught diverters on atmospheric appliances. Ventilation requirements must take this into account and may require larger louvres.

It should be noted that flue dilution systems on condensing boilers may run below dew point especially during the winter months. The dilution system should therefore be constructed from corrosion resistant material, e.g. 316 stainless steel, and be water and gas tight. All points, including the fan housing should be fitted with adequate drain facilities. The fan should also be constructed from corrosion resistant materials.

Care should be exercised when locating the discharge grille as condensate droplets may be discharged in cold weather.

Table 3.2 – Typical duct Sizes and Fan Volumes

Boiler Size	Input kW	* Flue Volume @ 1% CO_2 m^3/sec	Duct Size (diameter) mm	Velocity m^3/sec	**"U" m
5/235	80	0.216	200	6.86	0.286
6/ 293	100	0.269	250	5.49	0.327
7/355	120	0.323	250	6.59	0.364
8/ 413	140	0.377	250	7.683	0.400
9/471	160	0.431	300	6.1	0.433
10/532	180	0.485	300	6.86	0.465
11/590	201	0.542	300	7.66	0.496
12/648	221	0.595	350	6.19	0.526
13/ 710	241	0.649	350	6.75	0.554
14/768	261	0.703	350	7.31	0.581
15/826	281	0.757	350	7.87	0.607
16/887	301	0.811	400	6.45	0.633
17/945	321	0.865	400	6.88	0.657
18/1003	341	0.919	400	7.31	0.682
20/1075	365	0.983	400	7.83	0.710
22/1187	403	1.0857	450	6.83	0.754

* Flue Gas Volume @ 1013.25 mbar and 15C. Typical diluted flue gas temperature is 14C above ambient.

** Uncorrected chimney height from "Clean Air Act".

WATER CIRCULATION SYSTEMS

The water circulation systems should be indirect and installed in accordance with the relevant parts of British Standards Codes of Practice CP342 and BS 6644: 1991.

The maximum and minimum design temperature differential across the boiler should be 20°C and 10°C and the boiler should be prevented from operating with flow rates giving a temperature difference across the boiler greater than 25°C based on the full boiler output. Boilers operating under constant flow conditions can be more accurately controlled and are not subject to excessive temperature stresses. The minimum return temperature is 30°C.

On systems with variable flow rates due to flow reducing devices, ie. TRVs, zone valves, etc, or where the minimum heat demand, ie. summer domestic hot water load, does not achieve the minimum boiler flow rate then consideration shall be given to incorporating a primary loop system. For further information see Potterton Publication Technical Bulletin No.1 Issue 2.

The flow rate and hydraulic resistance for an 11°C boiler temperature rise are given in Table 1.2A and 1.2B, alternatively, flow rates through boilers can be calculated from:-

$$\text{FLOW (lit/sec)} = \frac{\text{kW (Boiler Output)}}{4.2 \times \text{Boiler Temperature Rise °C}}$$

The minimum design flow rate relates to a 20°C boiler temperature rise and should not be misinterpreted as the system design temperature drop particularly where systems have been designed with stand-by capacity.

The efficiency of the Potterton Condensing Derwent boiler varies with the temperature of the return water below 54 °C. See Fig. 3.2.

Typically the boiler will have gross efficiency of 86.4% at 54°C return water temperature and above. The efficiency rises to 92.5% at a return temperature of 40°C.

Care should be exercised when designing a system incorporating condensing boilers to ensure that the boiler return temperature is as low as possible (but above 30°C under normal running conditions).

The boilers are ideally suited to the use of direct weather compensated control systems which reduce the required flow and return temperatures to suit the reducing load on rising outside temperatures.

For further information see Potterton Technical Bulletin No.3 “General Information on Systems with Condensing Boilers”.

Fig 3.2 – Condensing Boiler Efficiency Curve

The hydraulic resistance of the boiler is proportional for flow rates equating to a boiler temperature of between 10°C and 20°C. The hydraulic resistance at 11°C is given in Table 1.2A and 1.2B, hydraulic resistance at alternative flow rates can be calculated from:-

$$R_2 = R_1 \times \left(\frac{T_1}{T_2}\right)^2$$

where: R_1 = Boiler Resistance at 11°C
R_2 = Boiler Resistance at T_2 °C
T_1 = 11°C
T_2 = Alternative Boiler Temperature Rise

The maximum and minimum design pressures are 5 bar (170 ft.w.g.) and 0.1 bar (3 ft.w.g.). Care is needed in siting the pump relative to the cold feed and open vent connections. (NOTE: The above are not static pressures).

It is recommended that the system is designed to give a constant flow rate. For further information on water circulation systems see Potterton publication Technical Bulletin No.1 Issue 2, and Technical Bulletin No.3.

Boiler Condensation

Care should be exercised to keep the boiler return temperature above 30°C. Prolonged operation at very low tempertures may cause the boiler to condense in the primary heat exchanger with the possibility that combustion conditions may be affected.

BOILER PROTECTION

The provision of pump overrun by a time delay relay or a thermostat situated in the flow pipe close to the boiler is essential to remove residual heat from the boiler, see Fig. 6.2, Section 6.

The boiler and system should be protected by suitable frost thermostats.

Unions and isolating valves should be fitted to the flow and return manifolds so that the boiler can be isolated from the system if the need arises.

Strainers

Migrating sludge and debris will have a detrimental effect on the life and operation of the boiler and this must not occur. If all debris cannot be removed, strainers and/or other devices should be fitted. Consideration should be given to water treatment and inhibitors to maintain water quality. Migration of system debris or scaling of the waterways will impair the life expectancy of the boiler sections.

System Filling

When filling the boiler system with water care should be taken that the water does not backwash system debris into the boiler via the flow connection by-passing any strainers that may have been fitted.

It is essential that all systems are thoroughly flushed through with a flushing agent to remove all debris and scale prior to fitting the boilers. Cleaning systems with acidic descaling agents is not generally recommended as, if incorrectly used, the scale and deposits may continue to break up after the system has been flushed and the boiler installed.

Where the boiler is being installed as a replacement for an existing boiler it is recommended that where possible sections of the removed boiler are cut open and internally examined to determine the presence of scale or system debris to foresee and rectify any potential problems for the new boilers.

The fitting of strainers is strongly recommended.

The system should be checked to ensure that there is no raw water make-up. It is strongly recommended that a suitable water meter is fitted to the cold feed supply of the boiler system to monitor for unregulated water make-up.

The quality of the water in both the heating system and the water supply should be checked to ensure that the hardness (100 ppm) and salinity (TDS) are not excessive. In the case of systems containing aluminium components the pH should be monitored to prevent corrosion.

On systems where unregulated raw water make-up or system debris is known to exist but remedial action cannot be implemented then consideration should be given to installing a heat exchanger to isolate the boiler from the water system to protect the boiler otherwise premature failure may occur.

A specialist water treatment company should be consulted if in doubt.

OPEN VENTED SYSTEMS

Maximum Operating Temperature

The maximum operating temperature of a system is dependent on the operating pressure. The minimum design operating pressure (not static) at any point of a system should be sufficient to prevent boiling within any part of the heating system and the boiler control thermostat should be set to provide a 17°C safety margin below the saturated steam absolute pressure given in Table 3.3 corresponding to the minimum design operating pressure.

COLD FEED SUPPLY

A cold feed pipe should be provided and taken directly from a feed and expansion cistern which shall not supply water for any other purpose. It shall not be smaller than as specified in Table 1.4 and shall be connected to the boiler or boiler side of any valve on the return pipe.

The cold feed pipe shall be situated within the building and shall be insulated along those parts of its length where freezing conditions or condensation may be expected to occur.

For multiple and modular boiler installations the cold feed connection shall be either to the common return pipe upstream of the individual boiler isolating valves or to each individual boiler return pipe downstream of the isolating valve.

The cold feed to a multiple or modular boiler installation shall be provided with a lockable isolating valve and sized in accordance with Table 3.5.

TABLE 3.3 - Saturated Steam Pressures

Temperature °C	110	120	130	140	160
Saturated Steam Absolute Pressure *	1.43 Bar	1.98 Bar	2.7 Bar	3.61 Bar	6.18 Bar

* **NOTE: These are absolute pressures not gauge. For gauge pressure 1 bar must be subtracted.**

EXAMPLE: A boiler system with a maximum operating temperature of 93°C and allowing for a safety margin of 17°C the temperature would be 93°C + 17°C = 110°C. From above the minimum gauge pressure within the system should be 1.43 bar - 1 bar = 0.43 bar.

CISTERN SIZING

The cistern should be sized to accommodate the water expansion in the system from 0°C to the maximum operating temperature. Where the volume of the system is not known then it can be estimated at 12 litres per kw of design load.

For systems with a maximum operating temperatures of up to 100°C the water can expand by 4% (for systems up to 140°C the expansion is 8%). Therefore assuming a system loading of 1000 kw, the approximate system volume is 1000 x 12 litres = 12000 litres and the expansion of water in a system with a maximum design temperature of 100°C is 4% x 12000 = 480 litres. In this instance the cistern should have an expansion capacity between the cold fill level and the overflow pipe of 480 litres (minimum), (overflow should be 80mm above the highest expansion level).

IMPORTANT: The water level in the cistern or expansion tank should be minimal on cold charge to allow expansion without discharge from the overflow between cold and hot operating conditions.

Multiple or modular boiler installations shall have an open vent pipe or pipes of the size stated in Table 3.4 as appropriate. Individual open vent pipes shall be either routed independently to the venting point or be connected to a common open vent pipe of appropriate size for the total rated heat input of the installation (see Table 1.4 for individual boiler open vent sizes).

TABLE 3.4 – Open Vent Pipe Sizes from BS 6644: 1991

Rated Output kw	Minimum Bore mm	Nominal Size (DN[1]) mm
45 - 60	25	25
61 - 150	32	32
151 - 300	38	40
301 - 600	50	50

[1] Steel pipe sizes complying with medium or heavy quality of BS 1387

For rated outputs above 600 kW the minimum cross sectional area of the venting pipe A (in mm^2) shall be determined as:- 3.5 x QR where QR is the rated output in kW

The open vent pipe shall rise continuously by the shortest practical route to the venting point. The open vent pipe shall discharge into the feed and expansion cistern above the overflow level and for a single boiler installation the pipe shall not be fitted with valves (apart from a 3-way type such that when closed the boiler is open to atmosphere through the third port and shall incorporate means of indicating the position of the open port). The nominal bore of the valve shall be not less than that of the open vent pipe in which it is fitted). Nor shall there be any obstruction which could prevent safe venting of the boiler. The vent pipe shall be insulated along those parts of its length where freezing may be expected and shall be situated as far as is practicable inside the building to reduce freezing problems.

TABLE 3.5 – Cold Feed Pipe Sizes from BS 6644: 1991

Rated Output Kw	Minimum Bore mm	Nominal Size (DN[1]) mm
Below 60	19	20
60 - 150	25	25
150 - 300	32	32
300 - 600	38	40
Over 600	50	50

[1] Steel pipe sizes complying with medium or heavy quality of BS 1387

For further details see BS 6644: 1991.

Boiler Safety Valves

Each boiler, whether in single or multiple installations, shall be fitted with an individual safety valve complying with BS 6759 Part 1.

In the case of modular boiler installations each bank of boilers shall be provided with a common safety valve sized in accordance Table 3.6 to suit the total rated output of the boiler bank. Any boiler in a modular installation that can be isolated from the water supply shall be fitted with an individual safety valve.

The safety valve shall be sized to suit the total rated output of the boiler and shall be located between the boiler and the water isolating valve. See Table 3.6 for safety valve sizes on open vented systems. Refer to notes on sealed systems for safety valve sizes on sealed systems.

TABLE 3.6 – Safety Valve Sizes to BS 6644: 1991 (Open Vented Systems Only)

Rated Output Kw	Nominal Size mm	Minimum Area (A) mm^2
45 - 264	19	284
265 - 352	25	491
353 - 440	32	802
441 - 528	40	1135
529 - 732	50	2050
733 – 1142	65	3210
1142 – 1640	80	4540

Alternatively: -

'A' can be calculated from:- $A = \frac{R}{0.659 \times P1 \times Kdr}$

where R = Boiler Output in kW
P1 = 7.6
Kdr = The derated coefficient of discharge available from the safety valve manufacturer.
A = Flow Area in mm^2

The safety valves shall be fitted in the flow pipework between the boiler and the next valve in line and the safety valves shall not be more than 1m from the boiler measured along the flow pipe.

Boiler safety valves shall be of the direct spring loaded type or dead weight type and the maximum setting shall not exceed the following equation:-

MAXIMUM VALVE SETTING (IN BAR) = 0.1 + MAX BOILER DESIGN PRESSURE (IN BAR)

NB: 1 Bar = 33.5 ft head or 14.5 lb/in^2

On systems containing components with lower maximum operating pressures than the boiler, the rating of the safety valve should be reduced accordingly or additional safety valves provided to protect these items.

Spring loaded valves are recommended where the static head exceeds 2.5 bar and/or where the boiler may be affected by external vibrations.

The size of the connecting pipe from the safety valve shall terminate in a visible position where discharge will not result in hazard to the user or plant. The size of the discharge pipe shall be not less than the nominal size of the valve outlet.

For further guidance on safety valve sizes see BS 6644: 1991.

SEALED SYSTEMS

General

Potterton Commercial boilers are suitable for use on sealed systems designed in accordance with BS 6644: 1991 and BS 6880 Part 2. In addition, reference should be made to the Health & Safety Executive guidance note PM5 "Automatically Controlled Steam & Hot Water Boilers".

Expansion Vessels

The sealed system should incorporate an expansion vessel complying with BS 4814 sized to accommodate the volumetric hydraulic expansion of the heating system between 0°C and the temperature setting of the overheat thermostat without exceeding the maximum design pressure of the boiler. The position of the expansion vessel(s) should be such that the manufacturers maximum operating temperature is not exceeded and the provision of an anti gravity tank may be required for systems operating above 100°C. In addition, the position of the expansion vessel(s) should prevent inadvertent isolation of the boiler system from the expansion vessel, where isolating devices, ie, valves, etc, are incorporated between the boiler(s) and the expansion vessel these should be capable of being locked in the open position during normal operation. See BS 6880 Part 2 for further details.

System Filling & Water Make-Up

The sealed system should incorporate suitable means for initial filling, ie. pressure boost pump, which shall comply with the local water authority bye laws and the cold feed supply to the system should incorporate a non-return valve and an isolating valve with the capability of being locked in the open position during normal operation. An automatic air vent should be provided between the isolating valve and the non-return valve and provision should be made within the sealed system to allow automatic replacement of water lost from the system. This may include a pressure boost pump and associated controls or an independent primary feed cistern. However, it is recommended that a suitable device such as a water meter is installed to detect unregulated raw water make-up. See BS 6644: 1991 for further details on provision for filling and make-up on sealed systems.

Maximum Operating Temperature

The maximum operating temperature of a sealed system is dependent on the operating pressure. The minimum design operating pressure (not static) at any point of a sealed system should be sufficient to prevent boiling within the any part of the heating system and the boiler control thermostat should be set to provide a 17°C safety margin below the absolute saturated steam pressure given in Table 8 corresponding to the minimum design operating pressure.

The boiler overheat thermostat should provide a safety margin of at least 6°C below the absolute saturated steam pressure.

Minimum Operating Pressure

The minimum operating pressure (not static) or cold fill pressure should be sufficient to maintain a positive pressure within the heating system to prevent boiling as detailed above. Care should be taken in positioning of the circulating pump(s) relative to the expansion vessel (zero or null point) particularly on systems where a high hydraulic resistance is present to ensure that operation of the pump does not cause a reduction in operating pressure at any point in the system below the minimum operating pressure.

A low water pressure cut off device shall be incorporated to prevent operation of the boiler plant on low water pressure. The pressure cut off device should be set at a pressure to prevent boiling in any part of the heating system while operating at the design working temperature.

Consideration should be given to the positioning of safety valves, low level cut off devices and automatic air vents relative to the minimum operating pressure to ensure that the influence of pump operation does not cause or prevent operation of these devices.

Maximum Operating Pressure

The boiler plant should be prevented from operating when the system pressure rises to within 0.35 bar of the safety valve setting.

Safety Valves

The safety valve on a sealed system should be sized in accordance with the following equation.

$$A = \frac{R}{2.5 \times Kdr}$$

where; R = Boiler output in kW
Kdr = the derated coefficient of discharge available from the safety valve manufacturer.
A = flow area in mm

NOISE LEVEL

Condensing Derwent atmospheric boilers are regarded as being commercially quiet, ie. <NR60, under typical operating conditions. These boilers are only suitable for installation in dedicated boiler rooms.

INSTALLING FULLY ASSEMBLED BOILERS

NB: See below for installing unassembled boilers.

5-10 section boilers have primary and secondary heat exchangers assembled.

11-16 section boilers have primary heat exchanger assembled on one pallet and secondary heat exchanger assembled on a second heat pallet and should be assembled on site.

Should access to the site be restricted the secondary heat exchanger may be removed as a single unit. No attempt should be made to trip this assembly further.

Fully assembled primary cast iron heat exchangers can aslo be disassembled for ease of access if necessary, see page 4.5.

When moving the boiler block into position the burner assembly should be removed if there is any likelihood of damage occurring. The burner assembly is fixed by two M8 studs, washers, and brass lock nuts located in each end section.

Jacks and crow bars should not be used against flow and return manifolds.

Assembly of Secondary Heat Exchanger

The 5-10 section boilers have the secondary heat exchanger fitted. It may however be removed by releasing the four wing nuts and clamps shown in Fig.4.1, disconnect the interconnecting pipework at the two unions provided and lift the assembly of taking care not to damage the sealing strips.

Reassembly is the reverse of the above. Ensure that the sealing strips top front, side and rear are in place and undamaged. Tighten the four wing nuts evenly then refit the interconnecting pipework and tighten the unions.

INSTALLING UNASSEMBLED BOILERS

17 to 22 section boilers are delivered unassembled. The boiler sections are delivered on one pallet secured by metal straps. The flue hood, gas train, burners, casing and control panel are delivered on another pallet. All pallets are covered over with shrink wrap polythene.

Assembly of the Boiler Block

Remove the shrink wrap and metal straps securing the components to the pallets. Identify the bag of fasteners, thermostat pocket and spacers, ceramic rope, glue and Vaseline packed in the casing box.

Clean the O ring ports on the sections with a dry rag. DO NOT use oil or any other compound. Check that the sections are clear of swarf, sand or any other debris.

Fit the M10 studs to the sections, two at the front and two at the back. For 5 to 22 section boilers these studs have an overall length of 82mm.

Add the sealing rope to the right hand side of the sections. The rope is pre-cut to two different lengths, one for the front and one for the back, and should be glued with the adhesive provided and trimmed to length if necessary.

WARNING: The adhesive gives off a flammable vapour and skin and eye contact should be avoided.

If the adhesive comes into contact with :-

a) **SKIN – then resin removing cream should be used and not a solvent to remove it.**

b) **EYES – the eye should be irrigated with water and medical treatment sought.**

c) **INHALATION – continued exposure should be prevented and the user should be removed to open air and if necessary medical advice sought.**

The adhesive should be used sparingly as it is only used to keep the rope in position until the sections are clamped together.

Stand the left and right hand end sections up and secure to the front manifold using the two small clamping plates provided. See Fig. 4.6. The manifold connections should be made to the left or right hand as required.

The front manifold has two BSP tappings, ¾" and 1½, while the rear manifold has one 3¼ BSP tapping.

The end sections should be at right angles to the floor and sitting on the steel strips required under the section feet (see Fig 1.2).

The sections should be spaced so that the distance between the centres of the sections are as Dimension B + 2cm given in Fig 4.5, Table 4.1. It is essential that this dimension is maintained at top and bottom otherwise the bottom feet of the end sections may toe in and it will be difficult to fit the base tray.

The boiler will now be sitting in its final position to avoid further movement when it is fully assembled.

Take an intermediate section and hang it on to the front manifold against the left hand end section taking care not to snag and pull off the sealing rope. Add all of the intermediate sections until the last one is in place.

Loosen the clamping plate holding the right hand end section and push the section up against the intermediate sections.

Add the three tie bars, one at the front and two at the back. Loosen the two clamping plates, fit the base tray in position as shown in Fig. 4.6 and tighten the tie rods on the boiler up to dimension B, Fig.4.5, Table 4.1.

Check this dimension carefully and check that the sections are at right angles, sitting on the steel trips and the sealing ropes are still in position. the base tray should be sitting on the lugs on the inside of the end section feet and not on the boiler base.

Fit the return manifold to the back of the boiler with the return connection to the left or right hand as required as follows:-

Fit the O rings to the sections using the Vaseline provided. No other compound should be used on the O rings or in the ports.

Push the manifold up against the O rings, position the U channel capping so that the hole in it lines up with the drain off cock tapping and fasten with the plain washers, spring washers and nuts. There should be one plain washer against the U channel capping, a spring washer above it and then the nut. The nuts should be tightened evenly until the spring washers are nearly flat.

Remove the clamping plates holding the front manifold and pull the manifold back but do not take it off the studs.

Fit the O rings into the sections using the Vaseline provided to hold them into place. Do not use any other type of compound.

Reposition the manifold and fit the U channel capping and secure with the plain washers, spring washers and nuts as for the rear manifold.

The drain off cock, thermostat pocket and the ¾ BSP blanking plug are fitted to the manifolds before despatch.

The boiler is now ready for hydraulic testing.

Hydraulic Test of Boiler
This is to be carried out on boilers assembled on site or where the water manifolds have been disturbed.

Fit a hydraulic test pump to the return manifold and fit a valve to vent air from the flow connection.

Fill the boiler with cold water and, in accordance with BS 779, 1976, pressurise up to 1.5 times the design pressure, i.e. 7.5 bar maximum, and observe for 30 seconds.

INSTALLING MULTIPLE UNASSEMBLED BOILERS

When two boilers are being built side by side with the minimum practical clearance between them ad with one flow connection to the left and the other to the right, the end sections should be positioned on the base as shown in Fig. 4.7.

Fitting the Secondary Heat Exchanger

Take the roll of Ceramic felt packed with the boiler and cut a strip and glue it across the front end of the sections. Next cut two pieces of sealing strip to form the side seal n top of each end section. See Fig.4.2 and Fig.4.3 for the position of the flue hood sealing strip.

The secondary heat exchanger is constructed from stainless steel and may require up to four people to lift it, particularly for the larger sizes.

It should be decided whether to fit the secondary heat exchanger before the boiler is moved to its final position particularly if there is restricted access around it.

Fit the two secondary heat exchanger support brackets as shown in Fig.4.1. Fit the spacer washers to the lower stud on the left hand side which corresponds with the gas train rear support bracket. The spacer washer is packed with the gas train.

Lift the flue hood and secondary heat exchanger onto the boiler block ensuring that it is sitting squarely on the ceramic felt sealing strips glued to the cast iron sections.

Use bottle jacks or similar to take the weight of the secondary heat exchanger while the two support brackets are adjusted to the correct position.

Secure the flue hood to the boiler block ensuring that it is sitting squarely on the ceramic felt sealing strips glued to the sections. The flue hood is secured by clamps as shown in Fig.4.1A.

Fit the interconnecting pipe between the secondary heat exchanger and boiler block as shown in Fig.4.1.

Fit the condensate drain “U” trap to the bottom stub pipe on the secondary heat exchanger, see Fig.1.1 for location.

BOILER DISASSEMBLY

If the boiler has to be disassembled it should be noted that the sections are not self supporting. Remove the return manifold only and then remove the sections individually from the flow manifold.

Fig 4.6 – Position of Base Tray

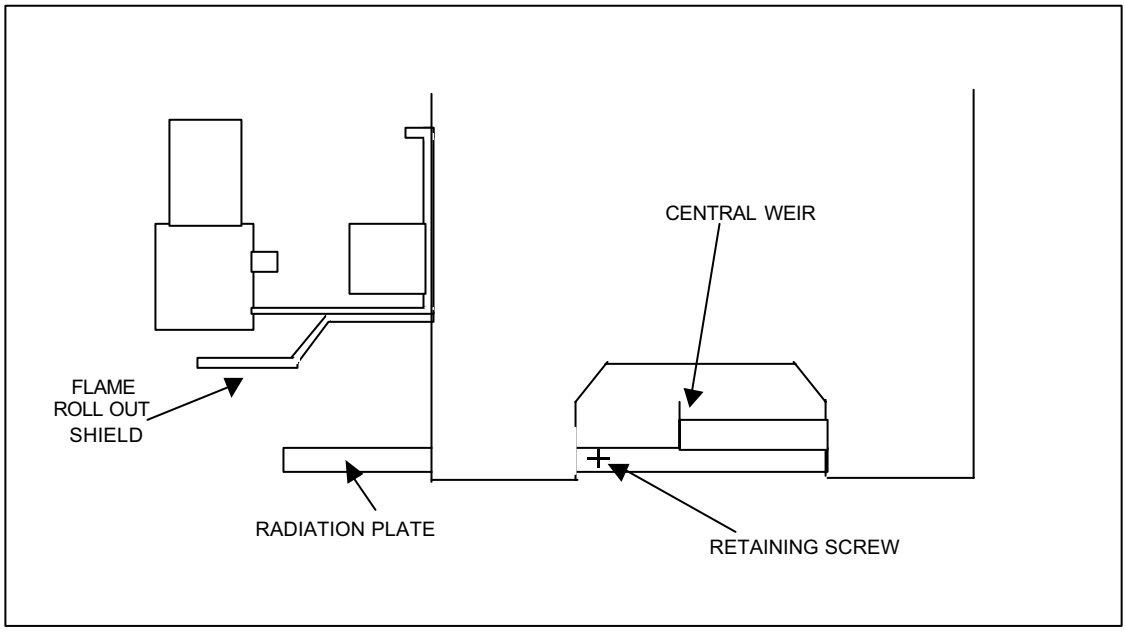
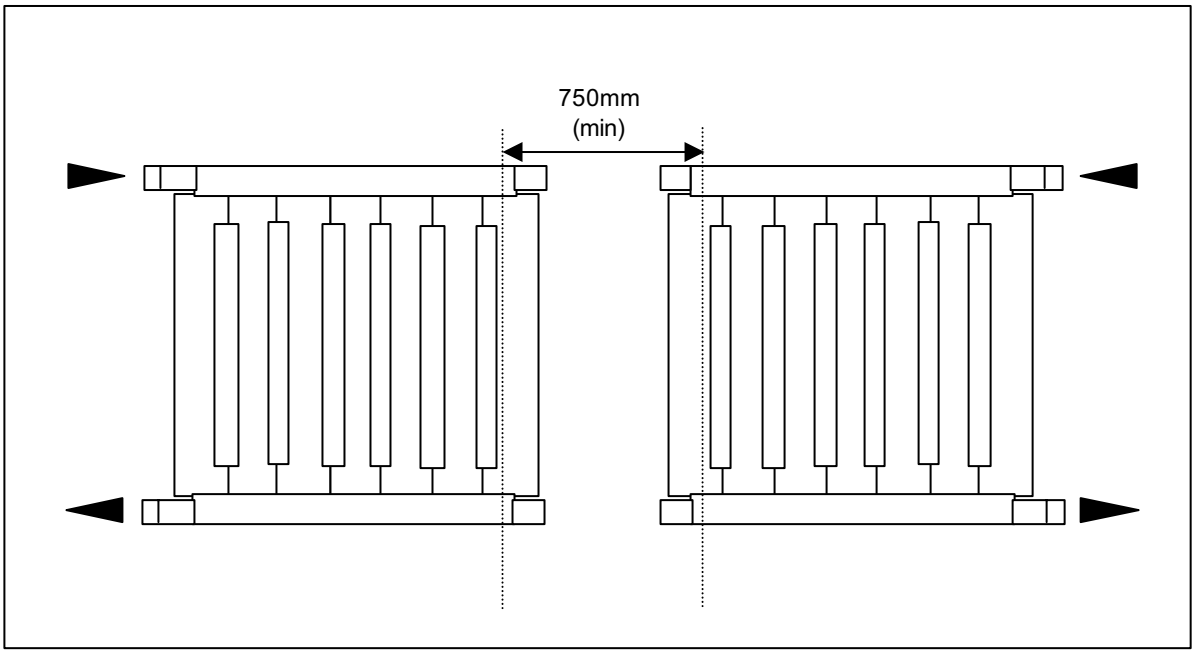


Fig. 4.7 – Installing Multiple Unassembled Boilers



Assembly of Casing

See Fig.4.8 for number references.

1. Take one of the side panels (items 2 and 3) which have cut outs in them to accommodate the flow manifold connections and fit the side casing support brackets (item 1). This should be fitted inside the panel between the lagging and the bottom edge. Make sure that the fixing holes between the support bracket and casing panel align and the support bracket projects 78mm in front of the panel for securing the side panel extension pieces (items 6 and 7).

   Secure the casing support bracket to the side casing panel with the wing nuts provided.

   AT THIS STAGE DO NOT FULLY TIGHTEN THE WING NUTS

2. Once the 78mm projection has been achieved the front side extension panels (items 6 and 7) can be secured to the side panel using the screws provided.

3. The side panel can now be positioned on the appropriate side of the boiler engaging the wing nuts into the lugs on the end section. Tighten the wing nuts and provide temporary support for the panel.

4. Repeat the above procedure for the other side panel.

5. The rear side extension panels (items 10 and 11) can now be fitted. This is done by fixing the bottom of the panel with wing nuts to the casing support bracket and with two self tapping screws to the side panel already fitted.

6. Take the aluminium front combustion chamber panel (item 5) complete with boiler data plate and secure it between and just behind the front of the two side panels using four self tapping screws provided in the casing pack.

7. Take the rear panel (item 12) and secure it between the two side panels using four self tapping screws provided.

8. Fit the gas train provided to the boiler.

9. Remove the control panel from its box and remove the two securing screws from the ends so that the panel fascia hinges forward.

10. In order to fit the control panel casing the side extension panels have to be eased out to allow the gas train plug and cable to pass through the cut-out provided. The control panel can now be fitted.

11. Secure the control panel with four self tapping screws at top and bottom on both ends of the panel.

12. Fit the two pieces of insulation provided between the control panel and flue hood (see Fig.4.2).

13. Place the top panel (item 15) and rear top panel (item 16) in position so that they locate securely on the side panels. Fasten with self tapping screws providede.

14. At this stage the two thermostat phials, thermometer phials, dummy pieces and sealing strip should be positioned in the thermostat pocket. Ensure that the retaining clip is fitted to keep the phials in place. See Fig. 4.9.

15. Place the base tray beneath the burners and secure with two screws.

16. Fit the front door locating strip (item 13) with two self tapping screws into the front of the side casing extension panels.

17. Fit the front door panel into the locating strip.

18. After completion of casing fitting fit the fillet pieces (items 18 & 19) with the screws provided.

Assembling the Gas Train

Remove the g as train from its box and remove the boiler front cover.

There are four wires coming out of the bottom of the control panel. The short earth wire with large eyelet should be connected to the flow manifold underneath one of the nuts and spring washer. The remaining earth wire, ignition lead and ionisation probe lead should be fastened to the boiler front panel by the two plastic clips on the panel.

The pilot has been supplied fixed to the burner see Fig.4.10.

The pilot assembly is also protected with a shield fastened to the front combustion chamber door by two nuts. This shield should be removed before fitting the gas train and replaced afterwards ensuring that the three wires and the pilot bundy pass through it.

Fig. 4.9 – Thermostat/Thermometer Phial Assembly

Fig. 4.10 – Pilot Burner Assembly

Remove the female half of the gas train elbow union from the gas train and fit it to the stub pipe on the burner manifold.

Check the gas train and pilot bundy for swarf or ingress of other bodies before continuing.

NOTE: The gas train is not self supporting and must be supported with the main gas pipework.

Connecting the Pilot Gas Line

The pilot line supplied is of sufficient length for the largest model and therefore may require shortening for some models. This should be accomplished by using a pipe cutter ensuring that the pipe is clean of swarf internally and externally before fitting.

A piece of bundy tube is supplied in the gas train box. This is connected to the pilot burner and the pilot line by compression fittings. The nut and olive fir the pilot burner is strapped to the pilot burner underneath the pilot shield.

Put the cap nuts on the bundy then the olives and position both pipe ends right into the fittings before tightening.

Tighten the fittings together and do not use pipe jointing compound on these connections.

Finally connect the gas train wiring to the boiler wiring by the plug and socket provided.

Connect the earth eyelet beneath the earth screw and washer on top of the pilot burner.

Plug the ignition lead to the ignition probe and fit the ionisation lead by the eyelet underneath the nut and washer on the ionisation probe, see Fig. 4.10.

Fit the pilot burner assembly using the two securing nuts to the front of the burner assembly.

Connecting the Gas Supply

The connection should be made to the female connection (size given in Table 1.2A and 1.2B). A union and isolating valve should be fitted close to the boiler to allow disconnection of the boiler controls for maintenance and repair.

The gas supply should be made through a suitable meter and the Local Gas Undertaking should be consulted to determine the suitability of the meter and the gas supply to meet existing and additional demands for gas.

The installation shall be made in accordance with the requirements of the Gas Safety (Installation & Use) regulations and all other Regulations and Codes of Practice given on page 2.1

In particular a manual valve for isolation of the boiler shall be fitted in an accessible position and readily identifiable.

The gas supply should be supported adequately.

For large single and multiple boiler installations consideration should be given to the installation of additional gas meters to assist in the monitoring of boiler performance.

Attention is drawn to the need for adequately sized pipework according to the maximum gas demand for multiple boiler installations and each boiler shall be provided with an isolating valve so that it is possible to isolate the boiler from a common gas supply for maintenance purposes.

Boosters will not be necessary if a minimum inlet pressure of 7 in.w.g. (17.5 mbar) can be provided at the inlet to each gas train and maintained during full load conditions. If a booster is required the Local Gas Undertaking must be consulted and the booster shall be fitted with a low pressure cut off switch upstream of the booster in the event of reduced pressure and to prevent automatic restart on pressure restoration. The cut off pressure shall be decided by the Local Gas Undertaking.

Connecting the Water System

The flow and return connections should be made to the appropriate manifolds.

For 20 and 22 section boilers the connections should be made to the female BSP connections on flanges provided fitted to the manifolds.

The water system should be in accordance with the notes given on page 3.6.

Under certain circumstances the primary and secondary heat exchangers may be connected to the system separately. See Potterton publication Technical Bulletin No. 3 for details.

Link pipe connection dimensions are shown in Fig. 4.11.

Connecting the Electrical Supply

The electrical supply should be 240V 1Ph 50HZ. A 5A fuse and a suitable two pole isolator having a contact separation of at least 3 mm in all poles has to be provided by the installer for isolation of the boiler.

All on site wiring shall conform to I.E.E. Regulations.

The supply should be made to the left or right hand side of the boiler control panel by flexible conduit.

The entry should be made by a spare bulkhead connector on the control panel. The bulkhead connectors can be switched from one side to the other and blanking caps should be fitted over the unused entry holes. The blanking caps should always be used to cover spare holes.

The live, neutral and earth connections should be made to the control panel terminal block. The earth connection should be made to the earth stud adjacent to the terminal block. The length of the conductors between the cord anchorage and the terminals must be such that the current carrying conductors become taut before the earth conductor if the cable or cord slips out of the cod anchorage. The wiring diagram is included in this manual on page 6.1 and also on the front inner panel of the boiler.

For multiple boiler installations each boiler shall have an isolator and fuse as detailed above to protect the boiler and allow for maintenance.

Boiler Controls

The operation of the boiler is under the control of its own multi-functional control valve, boiler thermostat and high limit thermostat.

In addition, the boiler should be controlled by a time switch, frost thermostat, pump overrun facility and, for multiple boiler installations, a boiler sequence controller. The boiler can be controlled by removing links L – 3 and 3 – 3 and providing volt free contacts across these terminals to switch the boiler.

High limit thermostat trip signal and control box lock out signals can be picked up from terminals 6 and 7 respectively. These are 240V AC single phase signals that can be used to illuminate a lamp or other low current device with a suitable neutral.

Connecting the Flue System

A flue adaptor socket is provided with each boiler for use with flues to BS 835, for flues to BS 715 this flue adaptor socket can be discarded.

The flue system should be made in accordance with the notes given on page 3.3. The flue pipe should be supported so that no weight is transferred to the boiler draught diverter. Facilities for disconnecting the flue system from the boiler should be provided.

Connecting the Condensate Drain

The boiler is capable of producing condensate at a rate of up o 0.1 lit/sec per kwh at a temperature of up to 70°C.

The condensate is mildly acidic with a pH of 3.5. The use of copper in the condensate system is not permissable.

The boiler is supplied with a condensate trap that must be fitted to the secondary heat exchanger. The condensate drain should be run away from the boiler with a minimum fall of 2.5% (1 in 20). The drainage system must include

a tundish to prevent water backing up into the boiler. The condensate should run to a suitable drain point or soakaway.

The condensing boiler will cause condensate to be formed in the flue system which should therefore incorporate drainage points.

Fig.4.10 – Condensing Derwent Boiler:

5-11 Section tapping Positions
12 – 18 Section tapping Positions – Shown ( )
20 – 22 Section Tapping Positions – Shown [ ]

BOILER MAINTENANCE

It is essential for efficient and trouble free operation that the boiler plant is regularly maintained. This must be carried out by qualified and experienced engineers and in the case of gas fired appliances attention is drawn to the mandatory requirement of CORGI (Confederation of Registered Gas Installers) registration of personnel undertaking work on these appliances. This facility is available from Potterton Commercial Division, details are available from regional offices listed on the back page of this manual.

Boilers should be serviced and re-commissioned as a minimum on an annual basis but frequency may depend on usage and application of the boiler.

It is strongly advised that a maintenance contract be entered into with Potterton Commercial Division to ensure that the boiler/burner unit is correctly and properly maintained.

WARNING Isolate the electrical and fuel supplies before attempting any maintenance work.

Following completion of maintenance on the boiler, the boiler should be re-commissioned as detailed on page 5.2 of this section.

BOILER CLEANING

At every service visit, the boiler should be cleaned as detailed below and the soundness of the gas control assembly must be checked. The boiler should be fully re-commissioned as detailed on page 5.2 with attention also paid to;

1. The effectiveness of natural and mechanical ventilation and in particular the safe operation of an air flow switch on a mechanical ventilation system.

2. That the chimney system is sound and adequately evacuating the products of combustion and that there is no spillage of flue products.

3. That the burner gas pressure is correct and that the boiler is still on rate.

4. That the low pressure switch on the boiler, if fitted, is operating correctly.

5. That the water flow switch, if fitted, is operating correctly.

To clean the boiler it will be necessary to remove the boiler flue hood cover and burner assembly as detailed below.

1. Remove the boiler door by lifting forwards and upwards.

2. Disconnect the burner manifold from the gas train union.

3. Disconnect the ignition and flame detection leads from the pilot burner. This will require removal of the pilot burner cover.

4. Disconnect the pilot burner bundy pipe from the pilot burner.

5. Release the four M8 nuts securing the front combustion chamber cover mounted above the burner assembly and remove the panel.

6. Release the four M8 nuts securing the burner assembly to the boiler and remove the burner assembly.

7. Remove the fan assembly protective mesh cover. This requires the electrical plug connection on the side of the assembly to be unplugged and the fixing screws to be removed.

8. Remove the front and rear boiler top panels.

9. Remove the air pressure switch pipes connected to the boiler top panel, identifying and noting each pipe position.

10. Remove the screws securing the flueway clean out cover and remove the cover

11. With the flue brushes provided clean the flueways of the cast iron heat exchanger.

Following completion remove the debris from the bottom of the boiler.

To clean the secondary heat exchanger use water, by means of a hose connected to the water mains. Care should be taken to prevent water from contaminating the fan motor assemblies.

IMPORTANT: DO NOT USE BRUSHES OR CHEMICALS ON THE SECONDARY HEAT EXCHANGER

The condensate drain will drain away the cleaning water.

12. Following completion of the above, the boiler should be reassembled. The integrity of the gaskets and insulation should be checked and replaced if necessary during reassembly.

13. Clean the burner bars and ensure that the holes/slots are clear. If necessary blow the slots and internals clear with compressed air or soft brush and vacuum. On no account should the burners be wire brushed. Check the condition of the kanthal bars, if there are any signs of bending the bars should be replaced.

14. After reassembly test for gas soundness as detailed under commissioning and check the burner manifold union and pilot burner union for gas leaks.

COMMISSIONING

IMPORTANT: The boiler must be commissioned following completion of installation. Operation of an uncommissioned appliance may cause injury to personnel and damage to the boiler/burner unit and could invalidate the manufacturers warranties.

Commissioning should only be carried out by personnel approved and competent to do so. This facility is available from Potterton Commercial Service Offices at the addresses as listed on the back page of this manual.

Before commencing to commission ensure that any cling film is removed from the casing panels and then check the following.

1. Electrical supply is switched off. All electrical connections are sound and correctly made.

2. Electrical system and the boiler are correctly earthed and is correct supply voltage and polarity.

3. Gas supply is tested for soundness and purged of air. Ensure the burner is suitable for the connected gas supply and pressure.

4. Test for gas soundness of gas trains as described on page 5.12.

5. Appliance gas cocks are all turned off.

6. Gas supply is turned on at the meter.

7. Boiler and system are filled with water and operating pressure is within appliance range.

8. Flow and return valves are open.

9. Any external controls and the on/off switch are in the “ON” position.

10. The circulating pumps are operational. Check that the pump is scheduled to run and not on pump overrun if the boiler has previously been fired. Check that any flow proving interlocks are functional.

11. Check that the high limit thermostat has not been tripped by pressing the green reset button on the control panel fascia, on earlier models, the reset button underneath the hexagon cap nut on the fascia. The high limit thermostat has been set by the manufacturer to 98°C and no attempt should be made to alter it on site.

12. Ventilation is adequate and, in the case of mechanical ventilation systems, operation of the boiler is inhibited unless the ventilation fan is proved.

13. On mechanically assisted flue systems the operation of the boiler plant should be inhibited unless the mechanical flue system is operational and flow proved.

14. The safety valve should be checked to ensure that it is the correct size and pressure. See Section 3 for further details.

15. The cold feed and open vent sizes should be checked. See Section 3 for further details.

16. Check the condensate trap has been fitted to the boiler.

Following completion of the above checks the burner should be commissioned. Typical combustion figures are detailed below. The combustion figures, etc. should be completed on the commissioning form provided at the back of this manual and returned to Potterton Commercial at the address on the back page.

Commissioning figures should be taken at a boiler flow temperature of 80° C.

The main injector size is 3.45mm ∅, one per burner. There are one less burners than sections, ie a 12 section boiler has 11 burners.

The main burner pressure should be 15.5mbar (6.1 in.w.g.) for the 5 to 11 section and 16 mbar (6.3 in.w.g.) for the 12 to 22 section.

The pilot injector should be 0.75mm running at a pressure of 16 mbar (6.3 in.w.g.). The pilot input rate is 0.9kW.

GAS

CO_2	-	4 - 5%
CO	-	0 – 50 ppm
Flue Gas Temp	-	120 – 160°C

IMPORTANT: The boiler/burner units are supplied in accordance with Potterton Commercial Quality Assurance plan registered to meet the requirements of BS 5750 Part 2. A condition of this supply of the appliance for compliance with this Quality Assurance plan is the return of the appliance commissioning report.

Following/during commissioning of the burner unit the following additional checks should be carried out.

1. Operation of the control, high/low and high limit thermostats should be checked for correct operation.

2. The flue draught available at the appliance flue outlet should be checked under all operating conditions (hot and cold) and should be within the boiler operating parameters, see Table 1.2A and 1.2B.

3. The fuel supply to the appliance should be isolated and the burner operated to ensure safety shut down and lockout of the burner on flame failure.

4. Shut down of the boiler plant by external controls does not cause a hazardous condition and pump overrun is provided to remove residual heat from the boiler.

5. Following commissioning the boiler overheat and control thermostat should be set to the required operating setting. See Section 3 for maximum operating temperature.

6. Following completion of commissioning the soundness of all automatic fuel valves should be checked for leakage.

Additional Checks

Where possible the system should be checked to ensure that following purging of air there is no raw water make-up. In particular, when the system is operated in the hot condition, there should be no discharge of water from the safety valve, open vent or cold feed tank overflow that would otherwise lead to unregulated raw water make-up when the system cools down.

Pre-Lighting

Before attempting to light the boiler start he circulating pump and check that it is scheduled to run and not on pump overrun if the boiler has been fired previously.

Check that the main and pilot gas cocks and electrical supply are turned off.

Set the boiler control thermostat to the required position and the time clock to an “ON” position. Check that the high limit thermostat has not been tripped by pressing the green button on the control panel fascia. With early boilers this is done by removing the hexagon cap nut and pressing the button beneath it.

Start the boiler by switching on the main isolator and the on/off switch on the boiler control panel fascia and the boiler will attempt to light. The fan will start and after a delay of approximately 55 seconds the ignition spark should be heard and after 5 seconds the control box should lock out.

If the ignition spark is not detected or the control box does not lock out see Fault Finding on page 5.7.

Commissioning Live Run

After one minute turn the pilot gas cock on (ensure that the main gas cock is turned off).

Turn on the electricity supply at the main isolator and at the on/off switch on the control panel fascia (ensuring that time clocks and any other external controls are made or are in the “ON” position).

The fan will start and, following safety checks and prepurge (approximately 55 seconds), the ignition spark should appear. If the control box locks out or continues to cycle see Fault Finding, page 5.7.

The control box may be re-set after a delay of one minute by pressing the red button on the control panel and the red light will go out. The Satronic MMI 810 control box is a cyclic type and will complete its internal cycle before arriving at the start position again to start the fan prepurge. When the flame is established on the pilot burner, turn off the pilot gas cock and check that the pilot shuts down. An ignition spark should start followed after 5 seconds by lockout.

Connect a pressure gauge to a pilot test point on the inlet to the pilot solenoid valve called TP6, see Fig.5.3 on page 5.14. Open the main and pilot gas cocks and reset the lockout button after a delay of one minute. The pilot burner will re-light followed 10-15 seconds later by the main burners. Check the pilot gas pressure of 16mbar (6.3 in.w.g.) and adjust if necessary.

Test the gas connection between the safety shut off valve and the pilot burner for soundness with a soap solution or other approved method and seal any leakages. Switch off the electrical supply and check that the burner is extinguished. Remove the pressure gauge from the pilot test point and replace the sealing screw.

Fit a pressure test gauge to the test point on the burner manifold. Switch on the electrical supply. When all the burners are operating check the pressure. If the burner is not approximately 16mbar (6.3 in.w.g) then it should be adjusted. The burner pressure should be checked again after approximately 30 minutes and adjusted again if necessary.

During this period test for soundness between the last burner safety shut off valve and the burner injectors with a soap solution or any other approved method and seal any leakages.

Turn off the main isolating valve to the boiler and the main burner and pilot burner will close down. The ignition spark should start followed after 5 seconds by lockout.

Also check the gas consumption by meter if possible and adjust as necessary to obtain the correct gas rate as give in Table 1.2Aand 1.2B. Remove the pressure gauge and replace the sealing screws.

Switch the boiler off at its on/off switch and at the main isolator. Open the control panel fascia and connect a microammeter into the test link between terminals 11 and 12 on the main terminal block. Remove the two nuts securing the pilot burner cover and disconnect the ionisation lead from its ionisation probe. Close the control panel fascia taking care not to trap the wires to the microammeter. Switch on the main isolator and the on/off switch and after the 15 seconds the ignition spark should be heard followed after 15 seconds by lockout of the control box.

Switch off the main isolator and the on/off switch and re-make the ionisation lead connection to the ionisation probe and replace the pilot burner cover with the two nuts. Switch on the main isolator and the on/off switch and after 15 seconds the ignition spark should be heard followed by lighting of the pilot burner. The microammeter should read approximately 7μA.

Switch off the main isolator and the on/off switch, open the control panel fascia, remove the microammeter connections and replace the link between terminals 11 and 12 on the main terminal block. Close the control panel fascia and fasten with two screws.

Commissioning Combustion Performance

In order for a condensing boiler to operate at its most efficient the fan must be matched to the flue system.

Switch the boiler on and allow it to warm up for 30 minutes so that the boiler and system are operating in their normal mode. Combustion should only be checked out of the condensing mode, i.e. with the return temperature above 60°C.

Remove the rear casing panel and insert a CO_2 measuring device into the secondary heat exchanger so that it is halfway into the sampling hole provided for this purpose.

For optimum performance the CO_2 should be 6.5%. The CO_2 level can be adjusted to this value by the balancing door situated on the rear of the fan assembly just below the flue socket. To increase CO_2 open the balancing door by releasing the two securing screws and opening the door.

Always check that CO is not excessive. The boiler should be capable of running with no CO but levels up to 70ppm are acceptable under some site conditions.

When commissioning the combustion performance always check that the condensate drain U-trap is full of water.

Cover the CO_2 probe test hole with a piece of silver foil flue sealing tape and replace the rear casing panel.

Check that the flue is operating correctly and that there are no leaks.

For boiler houses with natural ventilation, the area of the grilles should be checked against the notes given on ventilation in Section 3.

For boiler houses with mechanical ventilation, the suitability of the ventilation and extract system should be checked against the notes given on mechanical ventilation in Section 3.

In addition, the installer should check that it is not possible for the boiler to operate if either the ventilation or extract fans are not running.

OPERATION OF ANCILLARY CONTROLS

After lighting the boiler, the operation of the above mentioned controls, e.g. clock and thermostats, should be checked.

TO LIGHT BOILER – NORMAL OPERATION

1. Turn green on/off switch so that the lamp is not lit.
2. Check that both gas cocks on the gas train on the side of the boiler are on and the service gas cock at the meter.
3. Check that all ancillary controls, e.g. time clocks, are turned on.
4. Check that the electricity supply is turned on.
5. Switch on the green on/off switch so that the lamp lights.
6. Check that the control box lockout lamp is not lit, and if so, reset by pressing it.
7. Turn the boiler thermostat to the required setting.
8. The boiler will now light.
9. Replace the front casing panel.

WARNING: If the pilot burner fails to establish or the boiler closed down after it has established, or, if the boiler closes down after the main flame has been established, no attempt should be made to relight the boiler for a period of one minute.

TO SHUT DOWN BOILER

1. Temporarily – Switch the on/off switch to "OFF". Switch off the electrical supply so that the mains indicator lamp is not lit.
2. Long Periods - As above but in addition turn off both gas cocks on the gas train at the side of the boiler.

SETTING THE FLOW TEMPERATURE

The required flow setting should be set by the control thermostat against the expanding scale. The temperatures which correspond to the positions on this scale are given in Fig.5.1. The boiler thermometer should be used to check and adjust the setting as necessary.

Fig 5.1 – Control Thermostat Expanding Scale

WATER FLOW SWITCH

For boilers fitted with a water flow switch, the installer should check that it is not possible for the boiler to flow when there is no water flow. This may be done by checking the boiler closes down when the pumps are switched off or the water flow is gated off. Always restore the water flow before completing commissioning.

FAULT FINDING

Set out below are general guidance notes on system fault finding.

Overheat Operation

Operation of the boiler overheat thermostat is associated with a reduction in boiler water flow. Where overheat operation is reported the following should be checked.

a) The boiler/system pump has not tripped.

b) Pump overrun is operational to dissipate residual heat from the boiler on system shut down.

c) System valves are open.

d) The boiler is operating at the correct rate and is not overfired.

To reset the overheat thermostat allow the boiler to cool down, remove the overheat thermostat knob and press the reset button.

The use of a constant flow direct compensated system is highly recommended to provide a constant boiler flow rate under all operating conditions. For further information refer to Potterton Publication Technical Bulletin No.1 Issue 2, and Technical Bulletin No.3.

Burner Lockout

The boilers have and integral safety system to allow the safe and reliable operation of the burner. Failure of the burner to operate correctly will cause the burner control box to "lockout" and the lockout button on the burner will illuminate to indicate this.

The lockout condition can be manually reset by pushing the rest button and the control box should restart its control sequence in an attempt to light the burner. if the control box lockout will not reset or goes to lockout after being reset then the services of a boiler repair/ maintenance company should be sought. this service is available from Potterton Commercial Division service offices at the addresses on the back page of this manual.

WARNING: The lockout reset button should not be repeatedly operated otherwise a hazardous situation may occur.

Should the boiler go to lockout, check the following before attempting to re-light the burner.

1. Fuel is available at the burner.

2. The electrical supply to the appliance is of the correct voltage and polarity.

The boiler control boxes have indicator dials as an aid to fault finding on boiler lockout.

Before resetting the boiler lockout button, the position of the lockout indicator should be noted as follows:-

1. Isolate the electrical supply to the boiler.

2. Remove the top two fixing screws on the boiler control panel and hinge down the boiler control panel fascia. This will require removal of the lower front cover plate.

3. Unplug the control box from its base. This requires loosening of the fixing screw located in the front centre of the control box.

4. Note the position of the control box indicator dial and compare it with the fault finding seqeunce on page 5.7 for indication of where the fault occurred.

5. Replace the control box and access panel (reversal of items 1 – 4 above).

6. Switch on the elctrical supply to the boiler.

7. Re-set the control box and monitor performance for compliance with the fault fiding sequence below.

FAULT FINDING

The Derwent Condensing boiler is fitted with a Satronic MMI 810 Mod.45 control box with a 5 second safety time. The control box has a 45 second pre-purge period.

The timing of the control box is performed by a micro-switch cam assembly and a synchronous motor. When the control box is re-set from lockout the cam assembly and motor will rotate to the start point of the control sequence before commencing to light the boiler.

Stage 1 Boiler does not attempt to light. Control Box does not lockout. Fan does not run. Control Box indicator positioned on BLUE line in WHITE sector.	a) Check electricity supply is available to boiler and on/off switch is illuminated. The boiler has an integral fuse. b) Check the boiler is being called to operate. Thermostat calling lamp should be lit unless internal thermostat is satisfied or external control circuit is broken. c) Check overheat cut off device has not operated. d) Check power supply is available to control box (see wiring diagram) and control box terminals 1 and 9 are linked. Replace box if faulty.
Stage 2 Boiler does not attempt to light. Control Box does not lockout. Fan does not run. Control Box indicator continuously rotates.	a) Air Pressure Switch has not returned to No Air position since last cycle. Check operation of pressure switch and replace as necessary as detailed under component replacement.
Stage 3 Fan motor does not run. Control Box locks out after approx. 10 seconds Control Box indicator on RED line in BLUE sector.	a) Check operation of fan relay. b) Check electrical continuity to fan motor. Check fan assembly is plugged in. c) Check operation of fan motor. Replace if necessary.
Stage 4 Fan starts to run but stops and control box locks out after approximately 10 seconds. Control Box indicator on RED line in BLUE sector.	a) Air pressure switch is not changing over from NO AIR position. Check air pressure switch connecting pipes and electrical connections. b) Check operation of pressure switch and replace as necessary. c) Check there is an electrical load on terminal 5 of the control box (pilot solenoid connection). The control box uses the continuity on this circuit during fan proving period. d) Check the gas train assembly is electrically connected to the control panel via the plug and socket. e) Check for flame simulation or earth fault on flame probe circuit.
Stage 5 No Ignition Spark Pilot does not light Control Box goes to lockout Control Box indicator stopped at end of YELLOW sector/ start of RED sector	a) Check ignition electrode continuity for earth fault. b) Check power supply is available to electronic ignitor during ignition period. c) Check operation of ignitor. Replace if necessary

Stage 6 Ignition sparks Pilot Burner does not light Control Box locks out Control Box indicator stopped at end of YELLOW sector/start of RED sector.	a) Check gas supply is available at the pilot burner at the correct pressure. b) Check the gas supply is purged of air. c) Check pilot solenoid. d) Check ignition electrode position.
Stage 7 Pilot burner lights Control Box goes to lockout after 5 seconds Control Box indicator stopped at end of YELLOW sector/start of RED sector. Stage 8 Pilot burner lights. Main burner does not light. Control box does not lockout. Control box indicator stopped at end of GREEN sector.	a) Check electrical supply polarity. b) Check earth continuity to pilot burner. c) Check pilot burner pressure is correct. d) Check there is no earth leakage on ionisation probe circuit. e) Check ionisation probe circuit for correct flame current. This is achieved by removing the test link between 14 and 15 of the boiler control panel and connecting a DC micoammeter in series. A reading of at least 7 μA DC should be obtained. If this is obtained and the control box continues to lockout then replace the control box. a) Check main burner gas cock is open. b) Check electrical continuity to main gas valve. c) Check operation of gas valve and replace if necessary. d) Check control box. Replace if necessary.
Stage 9 Pilot burner lights. Main burner lights. Control Box locks out. Control box indicator stopped at end of GREEN sector.	a) Check ignition of main flame is smooth and reliable. Note: The main gas valve has a slow opening function. This should set at the minimum. There is a time delay of approximately 20 seconds between energising the main gas valve and starting to open. b) Check voltage supply for interference.

COMPONENT REPLACEMENT

Before commencing any component replacement, isolate the electrical and gas supplies to the boiler. After every service visit the soundness of the gas control assembly must be checked as described on page 5.14.

Main Burner Bar

1. Remove the main burner assembly as described under “Cleaning the Boiler” on page 5.1.
2. Release the M4 nut and paint cutting washer securing the end of the burner to the fixing strip.
3. Release the two M6 brass nuts and washers securing the burner bar to the burner manifold and slide the burner bar out.
4. Refitting the burners is the reverse of the above procedure.

Pilot Burner & Electrodes

1. Remove the main burner assembly as described.
2. Release the pilot burner and pilot burner cover by undoing the two brass nuts and washers securing the pilot burner to the mounting studs.
3. Release the clamping plates and screws and fit new electrodes if necessary.
4. Fit the pilot burner and check the electrode position as shown in Fig. 4.9.
5. A new olive should be used when connecting the pilot burner bundy tube to a new pilot burner.
6. Replace the main burner assembly as the reverse of the above procedure.

High Temperature Thermostat

1. Remove the two screws securing the control panel front fascia and hinge it down. This will require the removal of the boiler door.
2. Remove the thermostat phial from the thermostat pocket and thread it through the bulkhead grommet into the control panel.
3. Remove the electrical connections to the thermostat which are made by push on female connectors.
4. Remove the two screws securing the thermostat to the control panel fascia. For the control thermostat the screws are locates beneath the thermostat knob which can be pulled off.
5. Fitting the new thermostat is the reversal of the above procedure. The thermostat phial should be positioned as shown in Fig.4.8 and secured in position with the retaining clip.

Thermometer

1. Remove the two screws securing the control panel front fascia and hinge it down. This will require removal of the boiler door.
2. Remove the thermometer phial from the thermometer pocket and thread it through the bulkhead grommet into the control panel,
3. Remove the two knurled nuts and clamping pieces securing the thermometer body.
4. Fit the new thermometer as the reversal of the above procedure. The thermometer phial should be positioned as shown in Fig.4.8 and secured with the retaining clip.

On/Off Switch & Lamp

1. Remove the two screws securing the control panel fascia and hinge it forward. This will require the removal of the boiler door.
2. Remove the electrical connections which are made by female push on connectors.
3. Push the switch out through the control panel fascia.
4. Fill the new switch as the reverse of the above procedure.

Control Box & Spark Generator

1. Remove the two screws securing the control panel fascia and hinge it down. This will require removal of the boiler door.
2. Remove the screw through the middle of the control box securing its base and then remove the control box.
3. If the control box only is to be replaced fit the new box as a reverse of the above procedure.

4. To change the spark generator disconnect the spark generator connections form the control box base.

5. Remove the four screws securing the control box back plate to the control panel.

6. Remove the two screws, nuts and washers securing the control box base and spark generator to the back plate.

7. Replace the spark generator as a reversal of the above procedure.

8. Recommission the boiler as described on page 5.2 to check the operation of the control box.

Pilot Line Components

1. Disconnect the electrical connection to the pilot solenoid valve by removing the screw which secures the plug-in connector, or, remove the circlip on the pilot solenoid valve and release the coil.

2. Remove the two screws securing the pilot line support bracket.

3. Release the pilot line union.

4. Replace the pilot line components as necessary and refit the pilot line to the main line and then refit the complete assembly as the reversal of the above procedure.

5. After replacing the gas train test for gas soundness as described on page 5.12.

Main Gas Line Components

1. Unplug the electrical connection to the gas train.

2. Release the burner manifold union and the pilot line connection to the pilot burner.

3. Disconnect the gas train rear union upstream and lift away the gas train complete.

4. Remove the complete gas assembly and pilot line as described for “Pilot Line Components” above.

5. Remove the screw securing the electrical connection socket, or, remove the cover plates and disconnect the electrical connections to the valve if necessary.

6. Change the valves or governor as necessary.

7. Remake the electrical connections and replace the pilot line and main gas line.

8. After replacing the complete gas train check for gas soundness as described on page 5.12.

Motor Relay

1. Remove the two screws securing the control panel fascia and hinge it down. This will require removal of the boiler door.

2. Unplug the relay and replace if necessary.

Base Relay

3. Remove the connections to the base made by screw connectors.

4. Remove the two screws securing the base to the control panel rear mounting plate.

5. Fitting a new relay and base is the reversal of the above procedure and refit the control panel fascia.

Fan Pressure Switch

1. Unplug the electrical connection to the fan assembly.

2. Remove the fan assembly mesh cover.

3. Remove the two plastic pipes from the fan noting which is which.

4. Remove the electrical connections to the fan made by the female push on connections.

5. Remove the screws securing the fan pressure switch mounting bracket to the fan assembly.

6. Release the fan pressure switch form the mounting bracket.

7. Replacement of the pressure switch is a reversal of the above procedure.

TO SET A NEW FAN PRESSURE SWITCH

The switches are pre-set by the manufacturer and there are different settings for different sizes of boiler as given below.

Boiler Size	Switch Setting mm.w.g.
5 – 10 Section	5
11/18/20/22 Section	6
12/13/14/16/17 Section	7
15 Section	8

Only the correct pressure switch should be used and this should be commissioned as described below.

Commissionning & Operation of Air Pressure Switch

The air pressure switch is of the differential type and checks that the fan is running by measuring the pressure difference between the two points separated by a baffle plate in the flue hood.

The fan pressure is set at works and the measured pressures are recorded on a label near to the switch beneath the fan protective mesh cover.

If the pressure switch does bot return to the normally closed position after it's last cycle of operation, the Satronic MMI 810 control box will cycle without starting the fan motor, i.e. the disc that can be seen in the control box with the coloured segments will rotate continuously.

If the pressure switch does not detect the fan running, its contacts will not change to the normally open position and the control box will lockout.

The operation of the pressure switch should be checked after commissioning the combustion performance of the boiler.

To commission the fan pressure switch turn off the boiler at the isolator switch and remove the protective mesh cover form the fan assembly. Disconnect the two plastic pipes form the switch and switch the boiler on. The switch should detect no differential pressure when the fan is running and should lockout the boiler. If it does not do this, the pressure switch should be replaced.

Reconnect the air pressure switch in circuit with an incline manometer connected in parallel using suitable "T" connectors as shown in Fig.5.4. The manometer should be capable of measuring the air pressure switch setting as given above.

To check operation of the air pressure switch an electrical continuity meter should be connected to measure the resistance between the NC (normally closed) contact and the C (common) contact of the air pressure switch. The electrical continuity between these two connections will break on operation of the pressure switch.

WARNING: The voltage potential to earth on these terminals can be 240V during operation and therefore the continuity meter and test leads should be of sufficient insulation resistance

Switch on the boiler and check that the air pressure switch operates at the correct pressure setting. Should the air pressure differential be low, check the flue for blockage or excess resistance and check the fan motor.

Switch off the boiler and replace the two plastic pipes to the switch as they were removed, replace the fan assembly mesh cover.

To Replace Fan Motor & Impellor

1. Remove fan assembly mesh cover.
2. Disconnect the live, neutral and earth connections made from he six-way plug to the terminal block on the fan cylindrical mesh cover.
3. Disconnect the fan's three connections from the terminal block.
4. Release the four Taptite screws with posidrive heads which secure the fan mounting flange to the flue gas collecting box.
5. Remove the fan and impellor assembly complete.
6. Remove the old red silicone sealant from the flue gas collecting box and apply a fresh bead of high temperature silicone sealant.
7. Refit the new fan and impellor assembly as a reversal of the above procedure.

See Fig.6.1 for details of fan and capacitor wiring.

The impellor and fan must be replaced as a complete unit as they are factory balanced.

To Replace Fan Capacitor

1. Remove the fan assembly mesh cover.
2. Release the tie clip securing the capacitor wires to the fan motor wires.

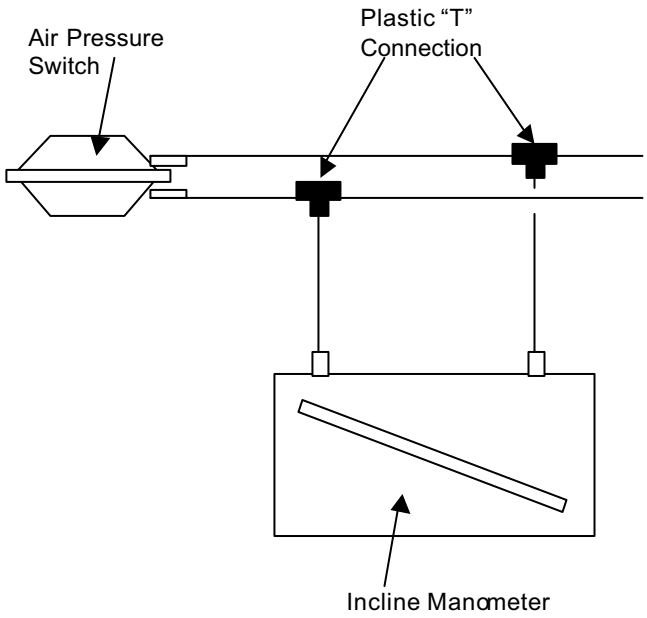
3. Disconnect the two wires from the capacitor to the terminal block on the cylindrical mesh cover.

4. Release the nut and washer securing the capacitor and replace it.

5. Reconnect the capacitor and replace the fan assembly mesh cover as a reversal of the above procedure.

See Fig.6.1 for details of fan and capacitor wiring.

Fig.5.2 - Incline Manometer



TO TEST FOR GAS SOUNDNESS OF CONTROL ASSEMBLY & SAFETY SHUT OFF VALVES.

To be read in conjunction with the schematic gas diagrams on page 5.14.

To test for Gas Soundness of ALL Pilot Solenoid Valves

1. Ensure electrical supply and pilot and main gas cocks are switched off.

2. Fit pressure gauge to TP6, pressure test point just upstream of the pilot solenoid valve, ensuring a gas tight connection.

3. Turn on pilot gas cock and pressurise up to seat of the pilot solenoid valve.

4. Turn off the pilot gas cock and observe the pressure gauge for a period of 2 minutes.

5. If any pressure loss is observed, repressurise by opening and closing the pilot gas cock and test for leaks with a soap solution.

6. If no external leaks are detected and loss of pressure occurs, this is the result of let-by by the pilot solenoid valve and it should be replaced.

7. Remove the test gauge and refit the test point sealing screw.

To Test Gas Soundness of Main Line on Option A – Dungs Multiblocks – 5 to 11 Section Boilers

1. Ensure electricity supply and pilot and main gas cocks are turned off.

2. Connect a pressure test gauge to test point TP1, inlet to the governor and first valve. Remove pressure test point TP3 sealing screw which is situated on the side of the valve block.

3. Open and close the main manual gas cock to pressurise up to the seat of the first valve.

4. Observe the pressure gauge for a period of two minutes.

5. If any loss of pressure is observed open and close the main gas cock to repressurise and check for leaks with a soap solution.

6. If no external leaks are observed and a loss of pressure is detected, this is caused by a let-by of the first valve seat and the valve assembly should be replaced.

If the first valve has been tested successfully, continue to test the second valve seat as follows

7. Connect pressure test points TP1 and TP3 to a pressure gauge with a tee piece.

8. Open and close the main gas cock to pressurise up to the second valve seat via the connection made.

9. Observe the pressure gauge for a period of two minutes.

10. If any loss of pressure is observed this is due to ley-by of the second valve seat and the valve unit should be replaced.

11. Remove the pressure test gauge and replace the pressure test point sealing screws.

To Test Gas Soundness of Main Line on :-

Option A - Dungs MVDLE & Landis & Gyr SKP20 – 17 to 22 section boilers

Option B - Interalbion AHMVKL & Landis & Gyr SKP20 – 17 to 22 section boilers

1. Ensure electricity supply and pilot and main gas cocks are turned off.
2. Connect a pressure test gauge to test point TP1, inlet to the governor and first valve. Remove pressure test point TP3 sealing screw which is situated on the side of the valve block.
3. Open and close the main manual gas cock to pressurise up to the seat of the first valve.
4. Observe the pressure gauge for a period of two minutes.
5. If any loss of pressure is observed open and close the main gas cock to repressurise and check for leaks with a soap solution.
6. If no external leaks are detected and a loss of pressure is observed, this is caused by let-by of the first valve seat and the valve assembly should be replaced

If the first valve has been tested successfully, continue to test the second valve seat as follows.

7. Connect pressure test points TP1 and TP3 to a pressure gauge with a tee piece.
8. Open and close the main gas cock to pressurise up to the second valve seat via the connection made.
9. Observe the pressure gauge for a period of two minutes.
10. If any loss of pressure is observed open and close the main gas cock to repressurise and check for leaks with a soap solution.
11. If any loss of pressure is observed this is due to ley-by of the second valve seat and the valve unit should be replaced.
12. If the valve is successfully tested, remove the pressure test gauge and replace the pressure test point sealing screws.

To Test Gas Soundness of Main Line on:

Option A - Dungs MVD & MVDLE & Jeavons Governor – 12 to 18 section boilers

Option B - Interalbion AHMVS & AHMVKL & Jeavons Governor – 5 to 16 Section Boilers

1. Ensure electricity supply and pilot and main gas cocks are turned off.
2. Connect a pressure test gauge to test point TP2. Remove pressure test point TP3 sealing screw.
3. Open and close the main manual gas cock to pressurise up to the seat of the first valve.
4. Observe the pressure gauge for a period of two minutes.
5. If any loss of pressure is observed open and close the main gas cock to repressurise and check for leaks with a soap solution.
6. If no external leaks are detected and a loss of pressure is observed, this is caused by let-by of the first valve seat and the valve assembly should be replaced

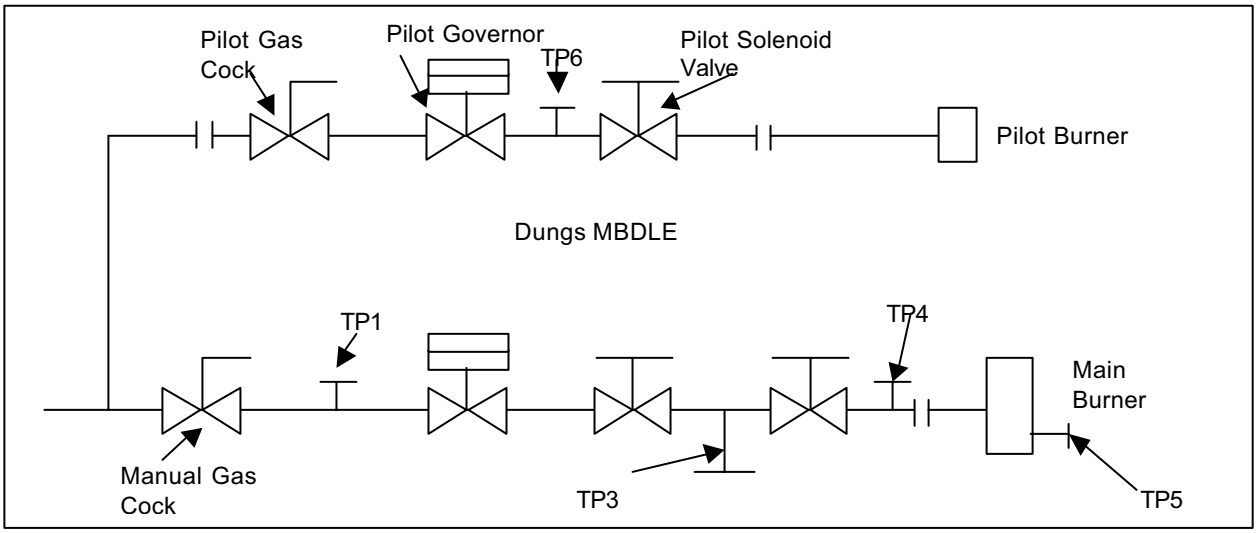
If the first valve has been tested successfully, continue to test the second valve seat as follows.

7. Connect pressure test points TP2 and TP3 to a pressure gauge with a tee piece.
8. Open and close the main gas cock to pressurise up to the second valve seat via the connection made.
9. Observe the pressure gauge for a period of two minutes.
10. If no external leaks are detected and a loss of pressure is observed this is due to ley-by of the second valve seat and the valve unit should be replaced.
11. If the second valve is successfully tested, remove the pressure test gauge and replace the pressure test point sealing screws.

IMPORTANT: THE INITIAL LIFT AND RATE OF OPENING OF THE SLOW OPENING VALVE AND THE MULTIBLOCK VALVES HAVE BEEN PRE-SET BY THE MANUFACTURER AND ONLY THE GOVERNOR SHOULD BE ADJUSTED ON SITE

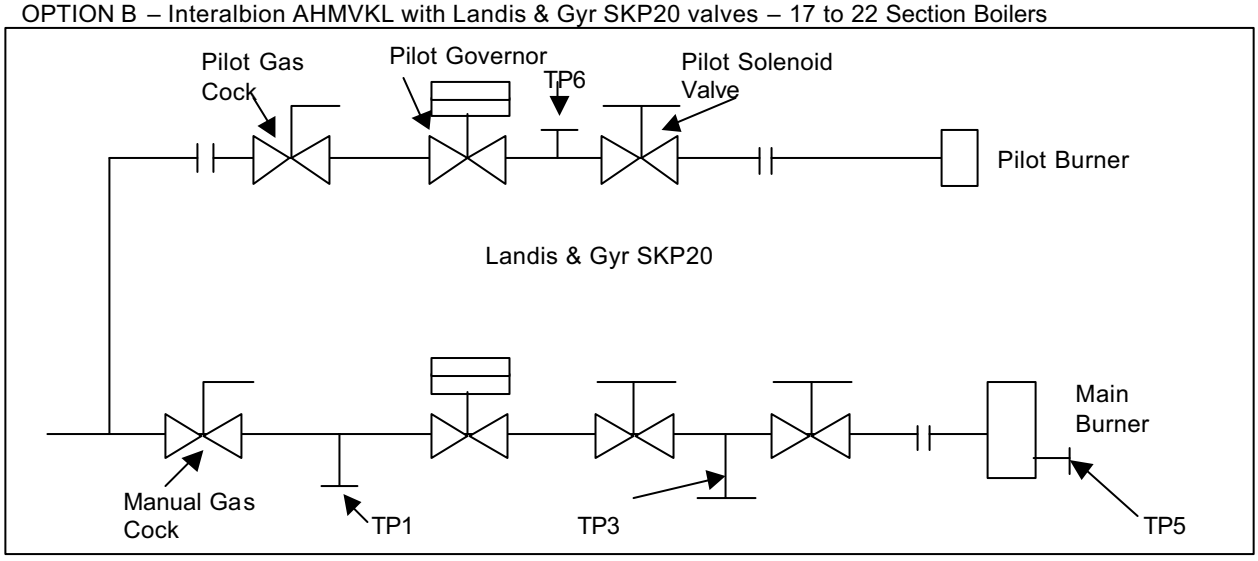
Fig.5.3 - Schematic Gas Train Diagrams

OPTION A – Dungs MBDLE Multiblock – 5 to 11 Section Boilers



OPTION A – Dungs MVDLE with Landis & Gyr SKP20 Valves– 20 to 22 Section Boilers

OPTION B – Interalbion AHMVKL with Landis & Gyr SKP20 valves – 17 to 22 Section Boilers



OPTION A – Dungs MVD & MVDLE Valves with Jeavons Governor – 12 to 18 Section Boilers

OPTION B – Interalbion AHMVKL & AHMVS Valves with Jeavons Governor – 5 to 16 Section Boilers

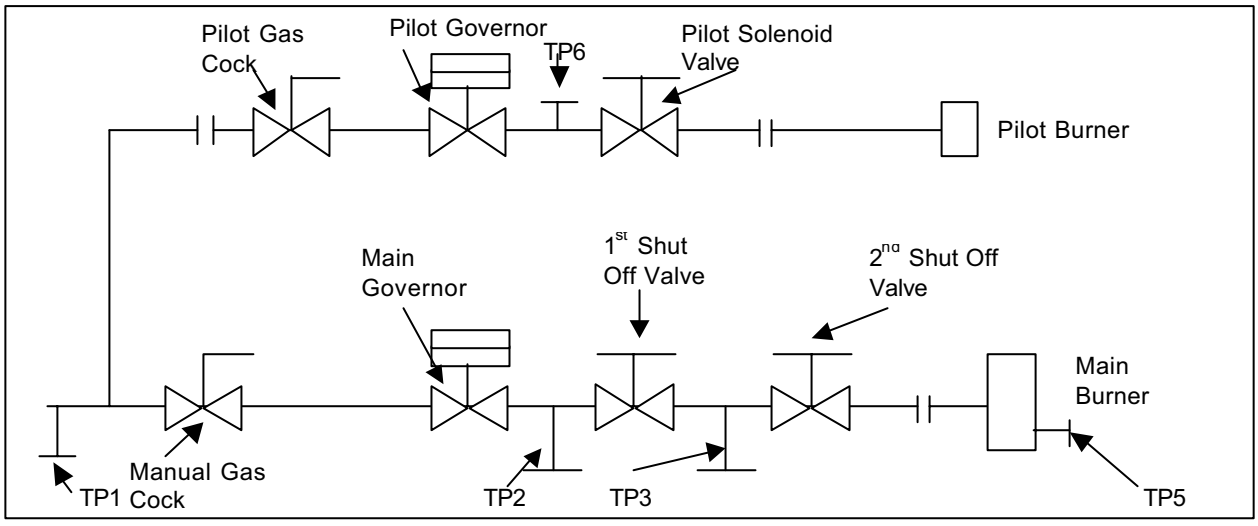
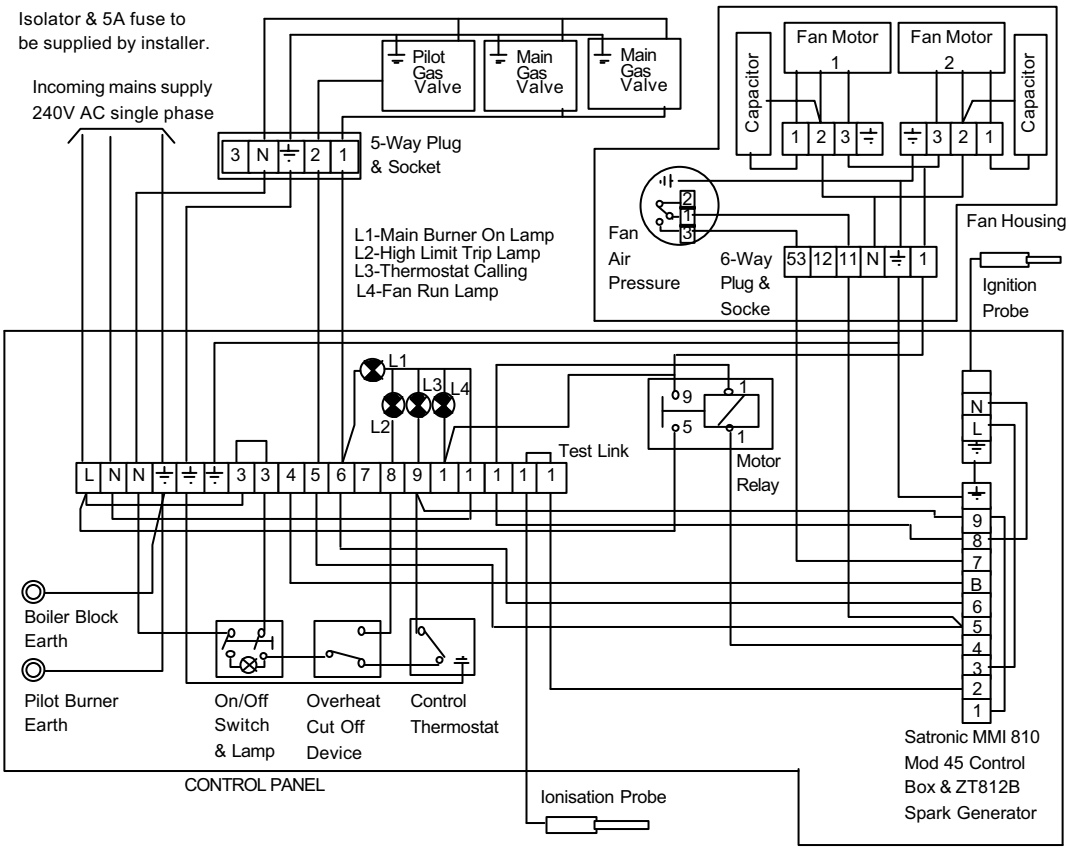


Fig 6.1 – Control Panel Wiring



Gas train, fan motor and pressure switch connections are made by pre-wired plug and socket arrangement as shown.

Time clocks, sequence controls, etc should be connected by removing links L – 3 and 3 – 3 and providing volt free switches..

Link 12 – 13 should be disconnected to test flame detection ionisation current.

Overheat cut-off device trip and ontrol box lockout signals can be taken from terminals 8 and 4 respectively. These are 240V single phase AC signals which can be used to illuminate a lamp or other low current device with a suitable neutral.

IMPORTANT: THE BOILER AND BOILER HOUSE CONTROL PANEL SHOULD BE ISOLATED BY THE SAME ISOLATOR. IT IS ALSO RECOMMENDED THAT MULTI-POLE ISOLATORS SHOULD BE USED TO BREAK EVERY CONNECTION TO THE BOILER

Fig 6.2 – Pump Overrun Using Changeover Pipe Thermostat

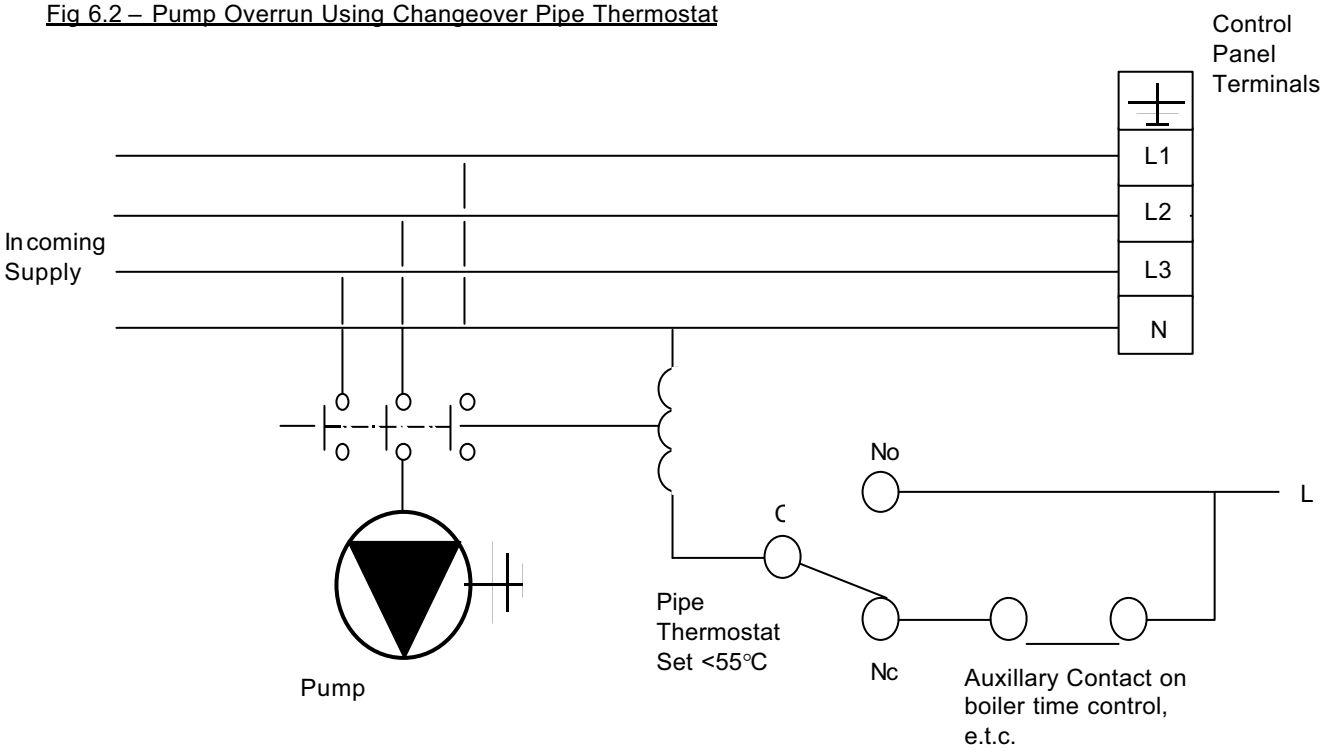
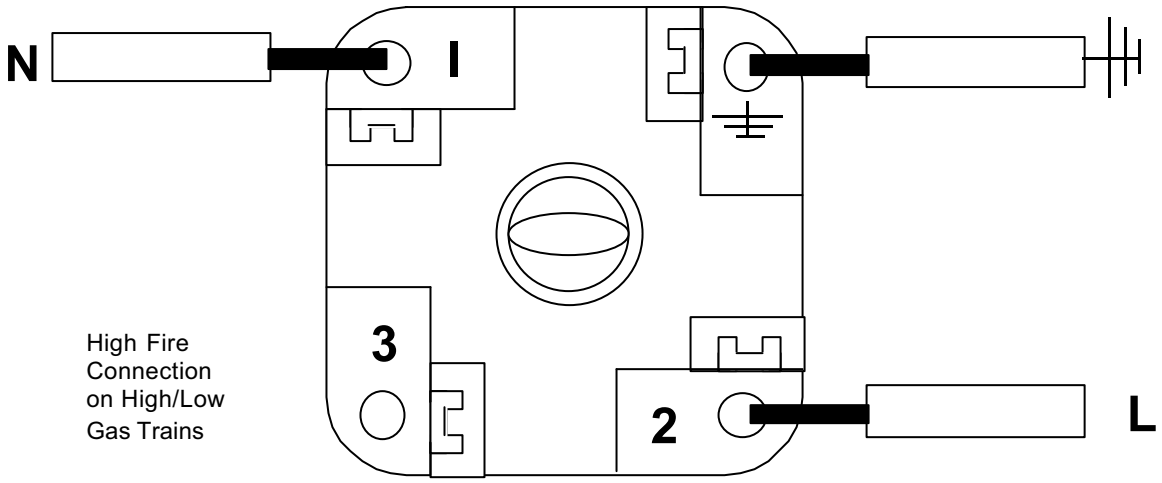


Fig 6.3 – Electrical Connections to Plug Cap Used on Dungs Multiblock Valves and SCEM Pilot Solenoid Valve (ON/OFF GAS TRAINS ONLY)



DERWENT HE SHORT PARTS LIST

Item	Description		Potterton Part Number
1	Right Hand End Section		357621
2	Left Hand End Section		357622
3	Intermediate Section		357623
4	'O' Ring		357825
5	Manifold Stud 82mm O/D (5 to 18 section)		357626
6	Manifold Stu d 102mm O/D (20 to 22 section)		357672
7	Ceramic Rope for Section Sealing		65063601
8	Flue Hood Sealing Strip		357324
9	Main Burner Injector		357826
10	Landis & Gyr QSZ1 SO2 Pilot Burner Complete		357317
11	Landis & Gyr Pilot Burner Injector – 0.75mm		357318
12			
13			
14	Pilot Burner Ignition Electrode		357320
15	Pilot Burner Ionisation Probe		357319
16	Flame Detection (Ionisation) Lead		641165
17	Satronic ZT812 Spark Generator and Lead		641165
18	Satronic MMI810 Mod.45 Control Box		906381
19	Satronic S701 Control Box Base		905609
20	Boiler Control Thermostat – Emmerson 718R (42 – 90°C)		357300
21	High Limit Thermostat – Landis & Gyr RAK 21.4/2926 (set at 98°C)		359154
22	On/Off switch and Lamp		357307
23	Thermometer		357303
24	Flow & Return Manifold Gas ket (20 to 22 Section Boilers only)		357925
25	Flue Brush		359174
26	Mounting Studs – M8 x 27mm		357626
27	Air Pressure Switch -	5 mm setting	359161
		6 mm setting	359162
		7 mm setting	359163
		8 mm setting	359164
28	Fan Motor Complete		359291
29	Fan Motor Relay		359356

Short Parts List for Derwent HE Gas Train– Dungs (Option A) (ON/OFF GAS TRAINS ONLY)

Boiler Size	DESCRIPTION			POTTERTON PART NO.
5 to 6 Section	1st Main Valve	-	Dungs MBDLE 407 B01 ¾	357047
	2nd Main Valve	-	Dungs MBDLE 407 B01 ¾	357047
	Main Governor	-	Dungs MBDLE 407 B01 ¾	357047
	Main Gas Cock	-	Giacomi R750 ¾	357051
	Pilot Gas Cock	-	Giacomi R 750 ¼"	357058
	Pilot Governor	-	Concentric ED2 ¼"	357065
	Pilot Solenoid	-	SCEM VE 131.4G ¼"	357062
	6mm Aluminium Pilot Bundy Tube (1.2m Length)			700705
7 to 8 Section	1st Main Valve	-	Dungs MBDLE 407 B01 1"	357085
	2nd Main Valve	-	Dungs MBDLE 407 B01 1"	357085
	Main Governor	-	Dungs MBDLE 407 B01 1"	357085
	Main Gas Cock	-	Giacomi R750 1"	357087
	Pilot Gas Cock	-	Giacomi R 750 ¼"	357058
	Pilot Governor	-	Concentric ED2 ¼"	357065
	Pilot Solenoid	-	SCEM VE 131.4G ¼"	357062
	6mm Aluminium Pilot Bundy Tube (1.2m Length)			700705
9 to 12 Section	1st Main Valve	-	Dungs MBDLE 407 B01 1 ½"	357432
	2nd Main Valve	-	Dungs MBDLE 407 B01 1 ½"	357432
	Main Governor	-	Dungs MBDLE 407 B01 1 ½"	357432
	Main Gas Cock	-	Giacomi R750 1 ½"	357120
	Pilot Gas Cock	-	Giacomi R 750 ¼"	357058
	Pilot Governor	-	Concentric ED2 ¼"	357065
	Pilot Solenoid	-	SCEM VE 131.4G ¼"	357062
	6mm Aluminium Pilot Bundy Tube (1.2m Length)			700705
13 to 14 Section	1st Main Valve	-	Dungs MBDLE 407 B01 1 ½	357114
	2nd Main Valve	-	Dungs MBDLE 407 B01 1 ½	357157
	Main Governor	-	Jeavons J48 2"	357185
	Main Gas Cock	-	Giacomi R750 1 ½	357120
	Pilot Gas Cock	-	Giacomi R 750 ¼"	357058
	Pilot Governor	-	Concentric ED2 ¼"	357065
	Pilot Solenoid	-	SCEM VE 131.4G ¼"	357062
	6mm Aluminium Pilot Bundy Tube (1.2m Length)			700705
15 to 18 Section	1st Main Valve	-	Dungs MBDLE 407 B01 2"	357422
	2nd Main Valve	-	Dungs MBDLE 407 B01 2"	357156
	Main Governor	-	Jeavons J48 2"	357185
	Main Gas Cock	-	Giacomi R750 2"	357425
	Pilot Gas Cock	-	Giacomi R 750 ¼"	357058
	Pilot Governor	-	Concentric ED2 ¼"	357065
	Pilot Solenoid	-	SCEM VE 131.4G ¼"	357062
	6mm Aluminium Pilot Bundy Tube (1.2m Length)			700705
15 to 18 Section	1st Main Valve	-	Landis & Gyr SKP20 2"	357401
	2nd Main Valve	-	Landis & Gyr SKP20 2"	357401
	Main Governor	-	Dungs MVDLE 2"	357422
	Main Gas Cock	-	Giacomi 750 2"	357425
	Pilot Gas Cock	-	Giacomi 750 ¼"	357058
	Pilot Governor	-	Concentric ED2 ¼"	357065
	Pilot Solenoid	-	SCEM VE 131.4G ¼"	357062

Short Parts List for Derwent HE Gas Train– Interalbion (Option B)
(ON/OFF GAS TRAINS ONLY)

Boiler Size	DESCRIPTION			POTTERTON PART NO.
5 to 6 Section	Main Governor	-	Jeavons J48 1"	
	1st Main Valve	-	Interalbion AHMV 32S 1" / 32	357162
	2nd Main Valve	-	Interalbion AHMV 32KL 1" / 32	357161
	Main Gas Cock	-	Interalbion 45 1" (Long Handle)	357412
	Pilot Gas Cock	-	Interalbion 45 ¼" (Short Handle)	357142
	Pilot Governor	-	Jeavons 60 DJ ¼"	357143
	Pilot Solenoid	-	Interalbion Ref. 1025104 (1/4")	357144
	6mm Aluminium Pilot Bundy Tube (1.2m Length)			700705
7 to 9 Section	Main Governor	-	Jeavons J48 1 ½	357136
	1st Main Valve	-	Interalbion AHMV 32S 1 ½/ 32	357162
	2nd Main Valve	-	Interalbion AHMV 32KL1 ½/ 32	357161
	Main Gas Cock	-	Interalbion 45 1" (Long Handle)	357136
	Pilot Gas Cock	-	Interalbion 45 ¼" (Short Handle)	357142
	Pilot Governor	-	Jeavons 60 DJ ¼"	357143
	Pilot Solenoid	-	Interalbion Ref. 1025104 (1/4")	357144
	6mm Aluminium Pilot Bundy Tube (1.2m Length)			700705
10 to 11 Section	Main Governor	-	Jeavons J48 1 ½	357136
	1st Main Valve	-	Interalbion AHMV 50S 1 ½/ 40	357135
	2nd Main Valve	-	Interalbion AHMV 50KL 1 ½/ 40	357133
	Main Gas Cock	-	Interalbion 45 1 ½" (Long Handle)	357138
	Pilot Gas Cock	-	Interalbion 45 ¼" (Short Handle)	357142
	Pilot Governor	-	Jeavons 60 DJ ¼"	357143
	Pilot Solenoid	-	Interalbion Ref. 1025104 (1/4")	357144
	6mm Aluminium Pilot Bundy Tube (1.2m Length)			700705
12 to 16 Section	Main Governor	-	Jeavons J48 2"	357185
	1st Main Valve	-	Interalbion AHMV 50S 2" / 50	357184
	2nd Main Valve	-	Interalbion AHMV 50KL 2" / 32	357182
	Main Gas Cock	-	Interalbion 45 2" (Long Handle)	357186
	Pilot Gas Cock	-	Interalbion 45 ¼" (Short Handle)	357142
	Pilot Governor	-	Jeavons 60 DJ ¼"	357143
	Pilot Solenoid	-	Interalbion Ref. 1025104 (1/4")	357144
	6mm Aluminium Pilot Bundy Tube (1.2m Length)			700705
17 to 22 Section	Main Governor	-	Landis & Gyr SKP 20 2"	357401
	2nd Main Valve	-	Interalbion AHMV 50KL 2"/ 50	357182
	Main Gas Cock	-	Interalbion 45 2" (Long Handle)	357186
	Pilot Gas Cock	-	Interalbion 45 ¼" (Short Handle)	357142
	Pilot Governor	-	Jeavons 60 DJ ¼"	357143
	Pilot Solenoid	-	Interalbion Ref. 1025104 (1/4")	357144
	6mm Aluminium Pilot Bundy Tube (1.2m Length)			700705

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