W O W

WARRIORS OF WARMTH

FIGHTING FUEL POVERTY

System design

Fault finding

Jonathon Hallam

Disclaimer

The following information is a guide only for training purposes, under no circumstanccces will Jonathon Hallam or Warriors of Warmth be laible for any content

Happy to help, here to help

Tools required for fault finding

			
			
			
			
			
			
		**Tools required to be an engineer**	

Disclaimer

It is illegal to work on gas appliances if you are not qualified or registered.

Do not work with electricty if you are not qualified

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Understanding your Multi meter

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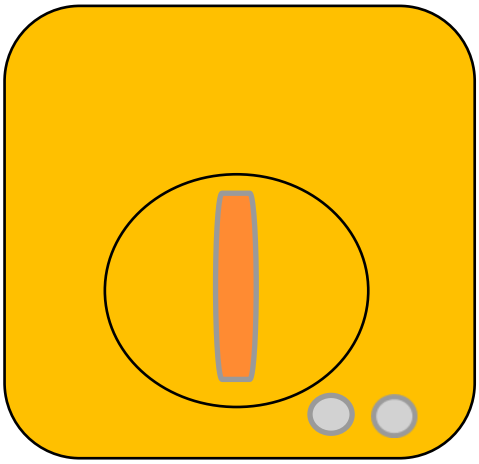


⎓

Ω

Permissionable allowance-

)))

mA

µA

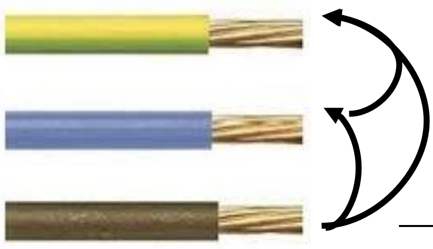
kΩ

Com
NC
NO

Electrical safety

External fuse______

Internal fuse_______



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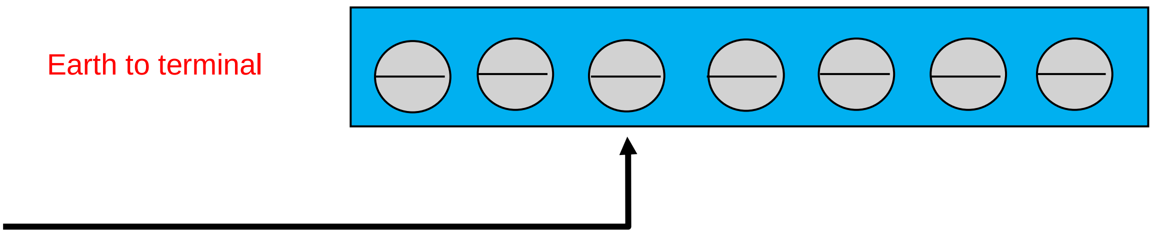
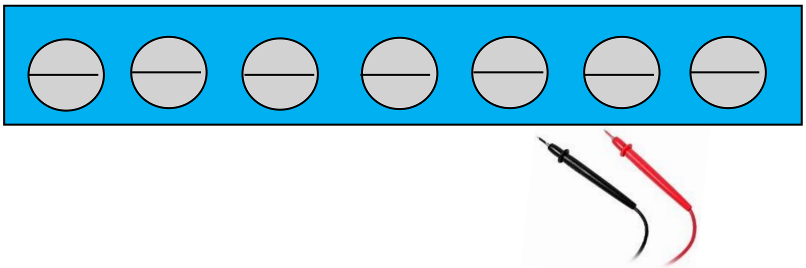
Methods of electrical testing

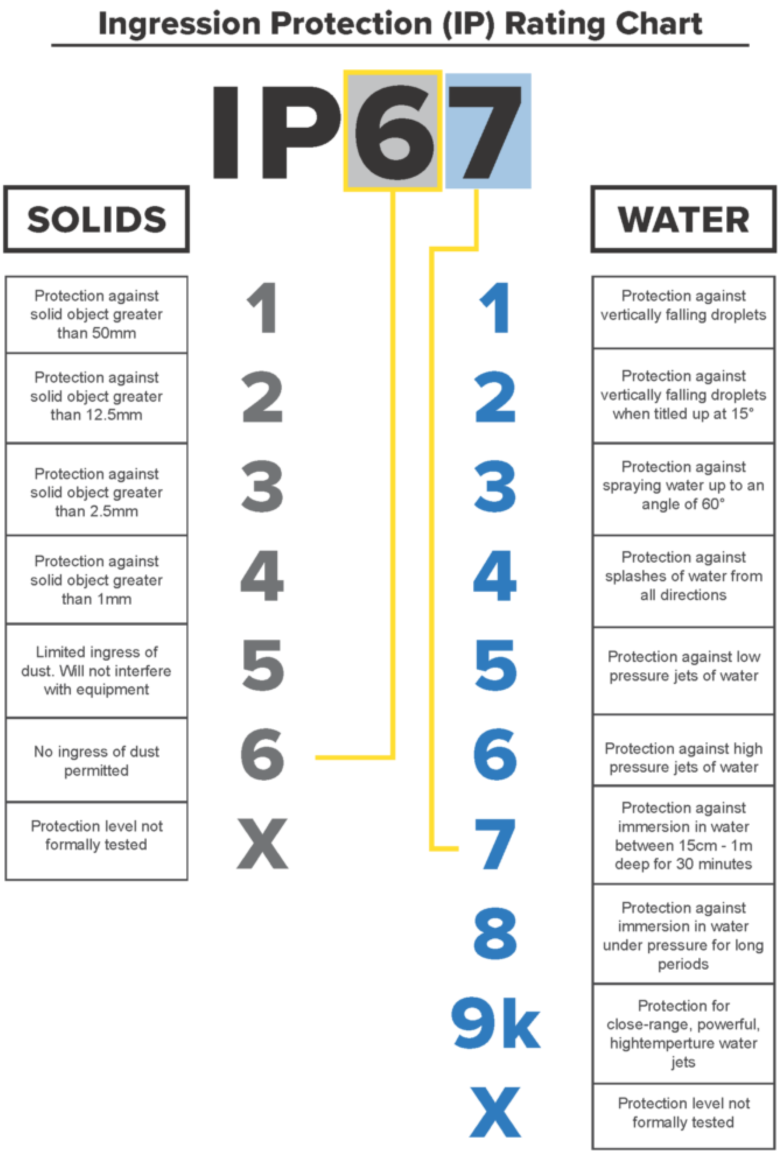
Earth to terminal



Terminal to terminal



Notes;



Ingression Protection (IP) Rating Chart

IP67

SOLIDS			WATER
Protection against solid object greater than 50mm	1	1	Protection against vertically falling droplets
Protection against solid object greater than 12.5mm	2	2	Protection against vertically falling droplets when titled up at 15°
Protection against solid object greater than 2.5mm	3	3	Protection against spraying water up to an angle of 60°
Protection against solid object greater than 1mm	4	4	Protection against splashes of water from all directions
Limited ingress of dust. Will not interfere with equipment	5	5	Protection against low pressure jets of water
No ingress of dust permitted	6	6	Protection against high pressure jets of water
Protection level not formally tested	X	7	Protection against immersion in water between 15cm - 1m deep for 30 minutes
		8	Protection against immersion in water under pressure for long periods
		9k	Protection for close-range, powerful, hightemperture water jets
		X	Protection level not formally tested

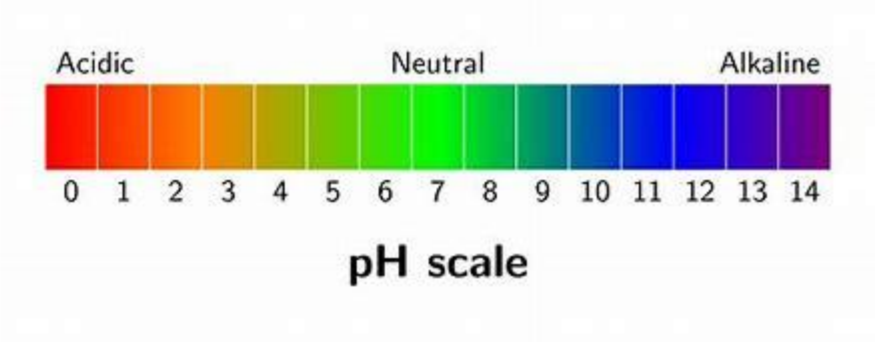
Above: Guidelines for installing appliances in bathrooms

Left: IP codes which are mentioned for Heat pumps

BS7671 Covers electical installations

Water Quality

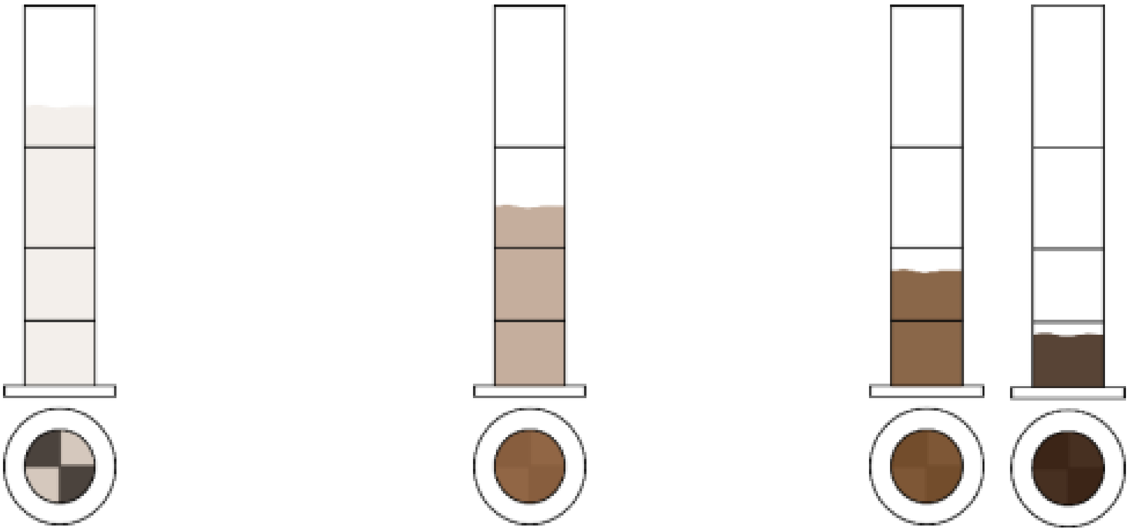
Testing Ph levels for heating
warranty results should be
between 8 – 8.5



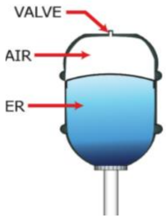
Turbidity

A turbidity tube is a visual tool to help you judge which water treatment best practice solution is appropriate.

Examples

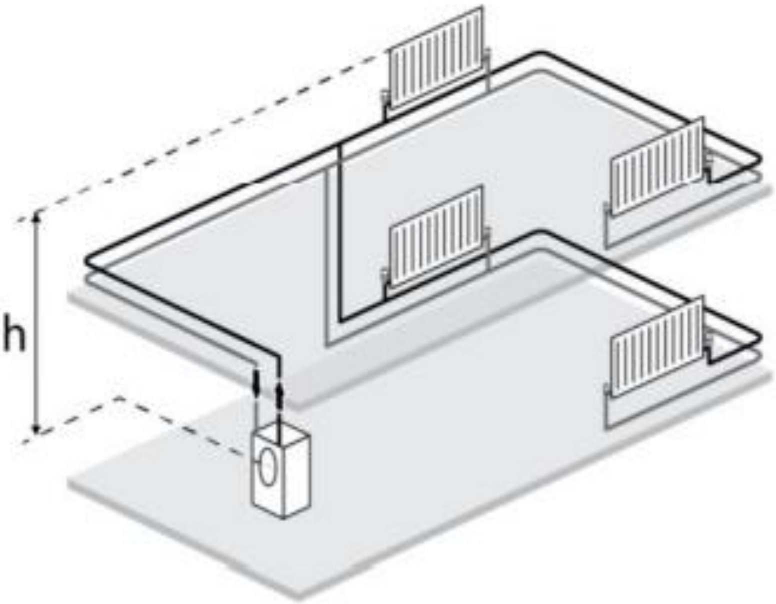


Clean System	Light Fouling	Heavy Fouling
Recommend check inhibitor levels.	Recommend drain system and re-dose with inhibitor.	Recommend system to be cleaned.



Vessel Pressures

Static Height, h (m)	Pre-Charge Pressure (bar)
0	0.5
1	
2	
3	
4	
5	
6	0.6
7	0.7
8	0.8
9	0.9
10	1.0



Example 150litres @1bar/PRV3bar = 16.3litre vessel

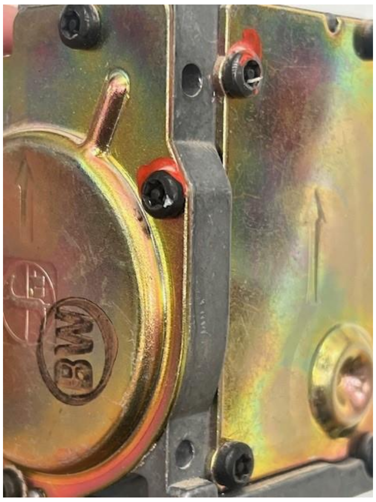
Or

150 x 0.109 = 16.3

Fact

Connections on heating vessels can block with sludge, when charging vessels lubricate Shrader valve

Safety valve setting (bar)	3.0			2.5			2.0	
Vessel charge and initial system pressure (bar)	0.5	1.0	1.5	0.5	1.0	1.5	0.5	1.0
Total water content of system (litres)	Select an Expansion Vessel with a nominal volume not less than that given below (litres)							
25	2.1	2.7	3.9	2.3	3.3	5.9	2.8	5.0
50	4.2	5.4	7.8	4.7	6.7	11.8	5.6	10.0
75	6.3	8.2	11.7	7.0	10.0	17.7	8.4	15.0
100	8.3	10.9	15.6	9.4	13.4	23.7	11.3	20.0
125	10.4	13.6	19.5	11.7	16.7	29.6	14.1	25.0
150	12.5	16.3	23.4	14.1	20.1	35.5	16.9	30.0
175	14.6	19.1	27.3	16.4	23.4	41.4	19.7	35.0
200	16.7	21.8	31.2	18.8	26.8	47.4	22.6	40.0
225	18.7	24.5	35.1	21.1	30.1	53.3	25.4	45.0
250	20.8	27.2	39.0	23.5	33.5	59.2	28.2	50.0
275	22.9	30.0	42.9	25.8	36.8	65.1	31.0	55.0
300	25.0	32.7	46.8	28.2	40.2	71.1	33.9	60.0
Multiplying factors for other system volumes	0.0833	0.109	0.156	0.094	0.134	0.237	0.113	0.2



Check filter to gas valve is clear
Warm base with hair dryer this may free solenoid jumper

Remove harness and measure resistance should be within 10% of manufacturers guidelines

Place U guage/manometer on gas valve inlet & isolate gas, check tightness then put boiler in demand, if pressure lost then gas valve is functioning

NTC

Isolate power and remove cables before using a multi metre on NTC

Vaillant/Glow Worm NTC

Temperature	Resistance
-15 °C	30.501 Ω
-10 °C	27.917 Ω
-5 °C	25.537 Ω
0 °C	22.913 Ω
5 °C	20.387 Ω
10 °C	17.862 Ω
15 °C	15.649 Ω
20 °C	12.486 Ω
25 °C	10.000 Ω
30 °C	8.060 Ω
35 °C	6.535 Ω
40 °C	5.330 Ω
45 °C	4.372 Ω
50 °C	3.605 Ω
55 °C	2.989 Ω
60 °C	2.490 Ω
65 °C	2.084 Ω
70 °C	1.753 Ω
75 °C	1.481 Ω
80 °C	1.256 Ω
85 °C	1.070 Ω
90 °C	0.916 Ω
95 °C	0.786 Ω
100 °C	0.678 Ω
105 °C	0.586 Ω
110 °C	0.509 Ω
115 °C	0.443 Ω

Clean wet pocket

Move clip on NTC to reconnect on pipe surface

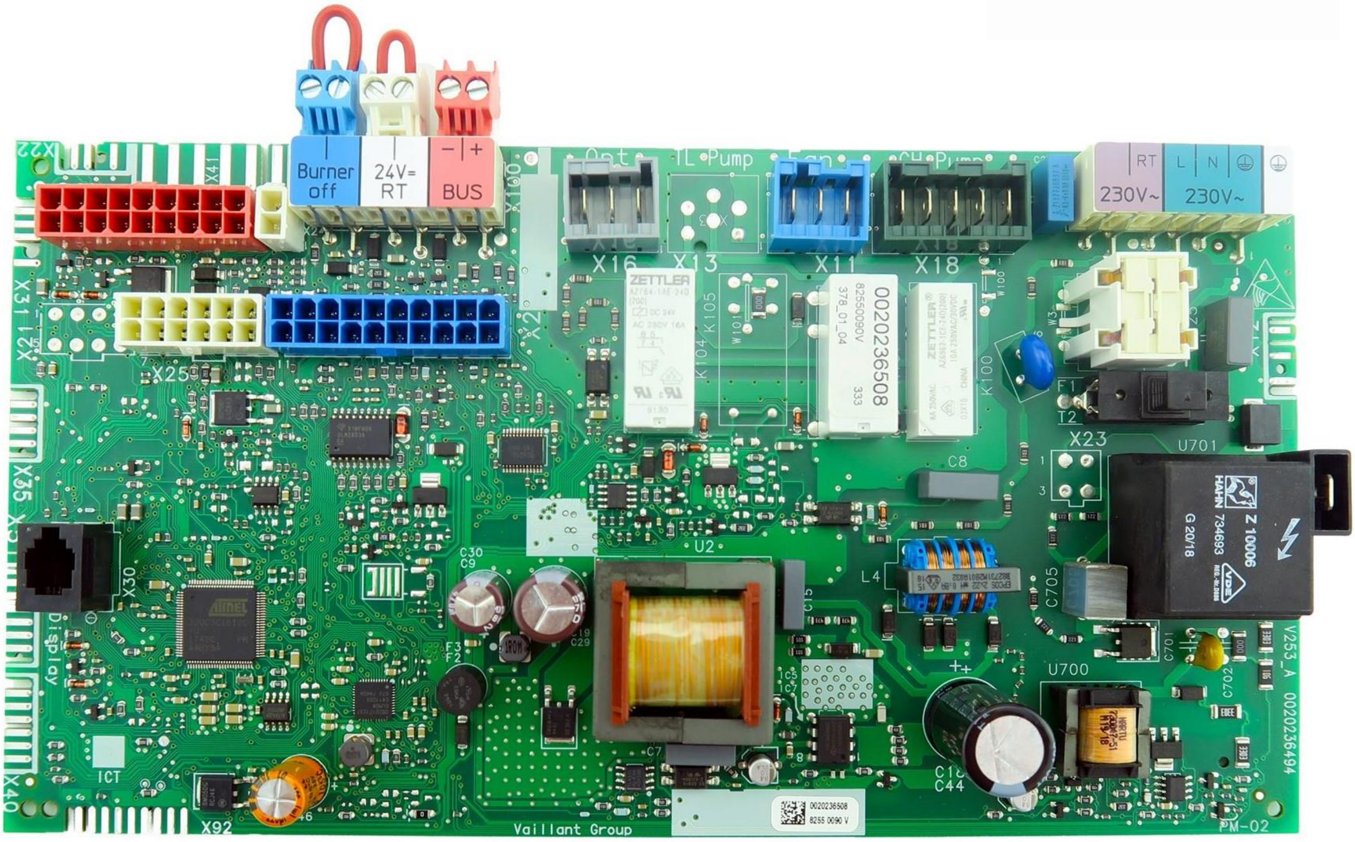
Temp (°C) ± 10%	Resistance (Ω)	Temp (°C) ± 10%	Resistance (Ω)
5	28,490	50	4,608
10	22,161	55	3,856
15	18,088	60	3,243
20	14,772	65	2,744
25	11,981	70	2,332
30	9,786	75	1,990
35	8,047	80	1,704
40	6,653	85	1,464
45	5,523	90	1,262

PCB

Check internal fuse, usually most Boilers are 1amp slow blow

Try warming hair PCBs with hair dryers to reenergise capacitors

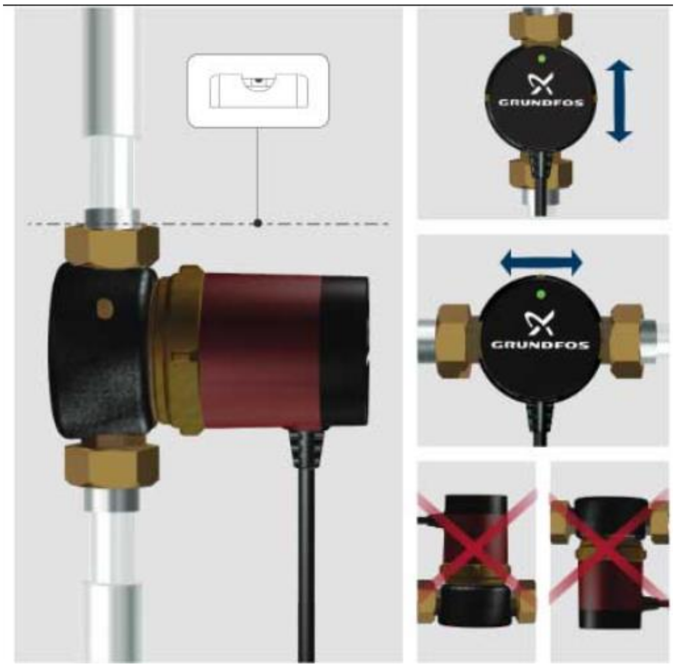
Whilst carrying out wet repairs on appliances use cling film to protect PCB



Youtube Video
https://youtu.be/mLzEWmsyKwE

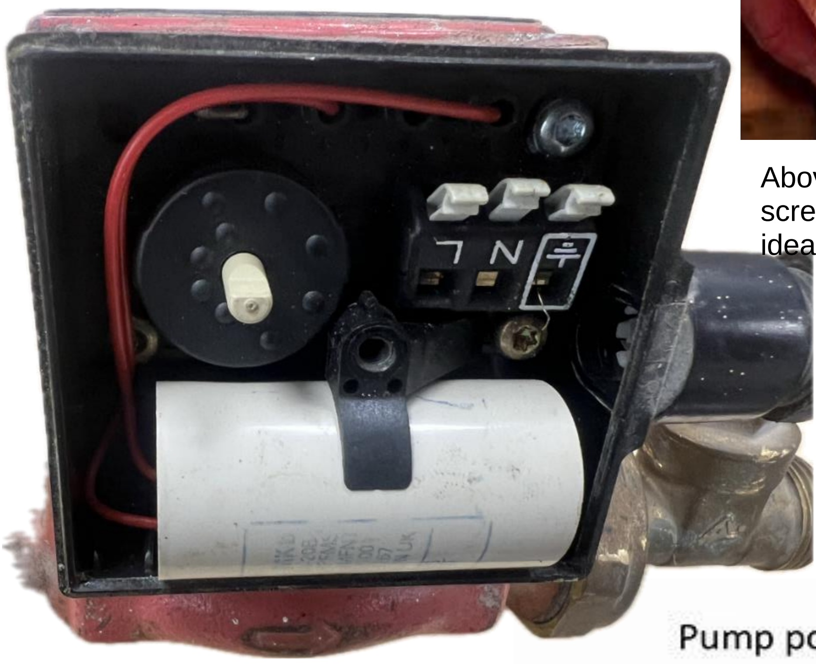
Heating pumps

- Set multi meter to resistance Ω
- Use probes across L & N
- Less than 100Ω = replace
- No resistance/infinity = replace
- Approx 120 - 250Ω = Ok
- If loud clean bearings
- Free & bleed shaft using anti seize screw
- If water runs out anti seize screw pump insufficant
- Usually blows fuse

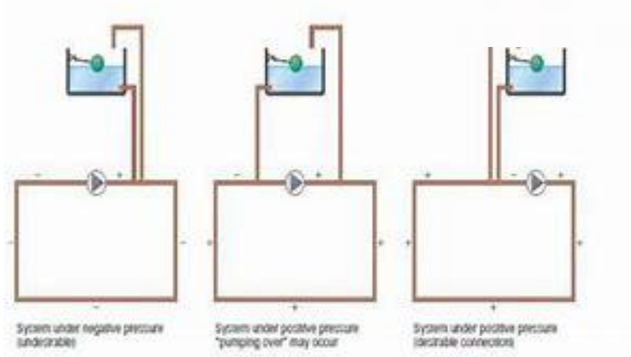


Above are recommended pump positions

Above is an unprofessional situation the pump screw is above the electical connections so ideally the head needs rotating



Stock pump nuts, incase old connections are cut off



Pump settings

Flow rate =

Kw = Kw of boiler
TD = temperature difference 20
SH = Specific heat 4.2

Multiply by 1000 for kg/s

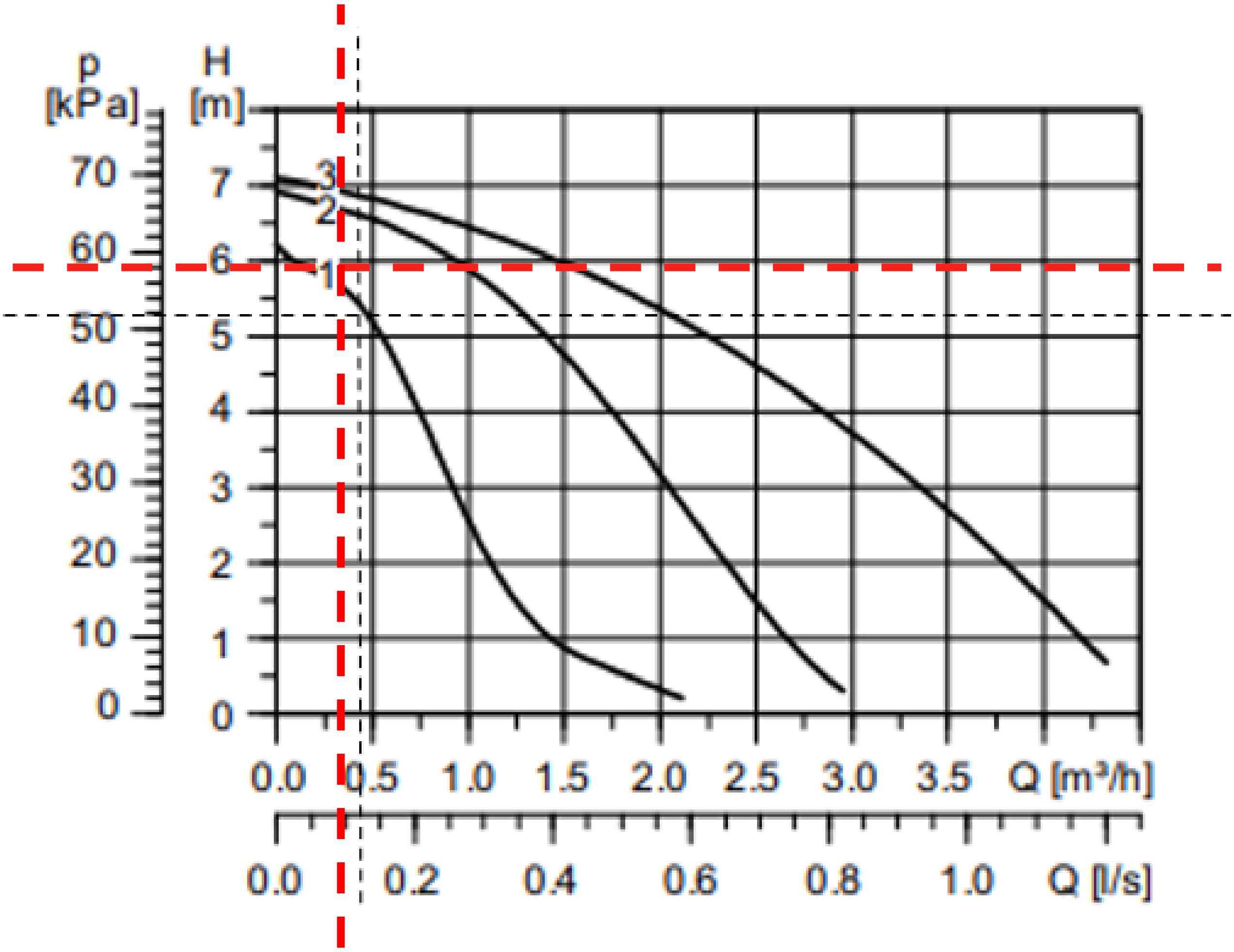
10m = 1bar
1bar = 9.807Kpa

Example;

3 bed house, 2 storey 6m head & 12Kw boiler

0.6 x 9.807 = 5.88kpa

20 x 4.2 = 84   20 ÷ 84 = 0.24



Fact

If you remove anti seize cap and water runs out when pump is on, this can indicate pump is running too slow

Motorised valves

- Check for demand
- Confirm arm / ball has moved
- Check power is present

Y Plan system

- Set multi meter to Ω
- From white to Neutral 2000 - 2500Ω

Cables

White = Htg on
Grey = Htg off
Orange = Boiler pump live

S Plan system

- Brown to Neitral 2000 - 2500Ω

Cables

Grey = Permanent live
Brown = Htg / DHW
Orange = Boiler pump live

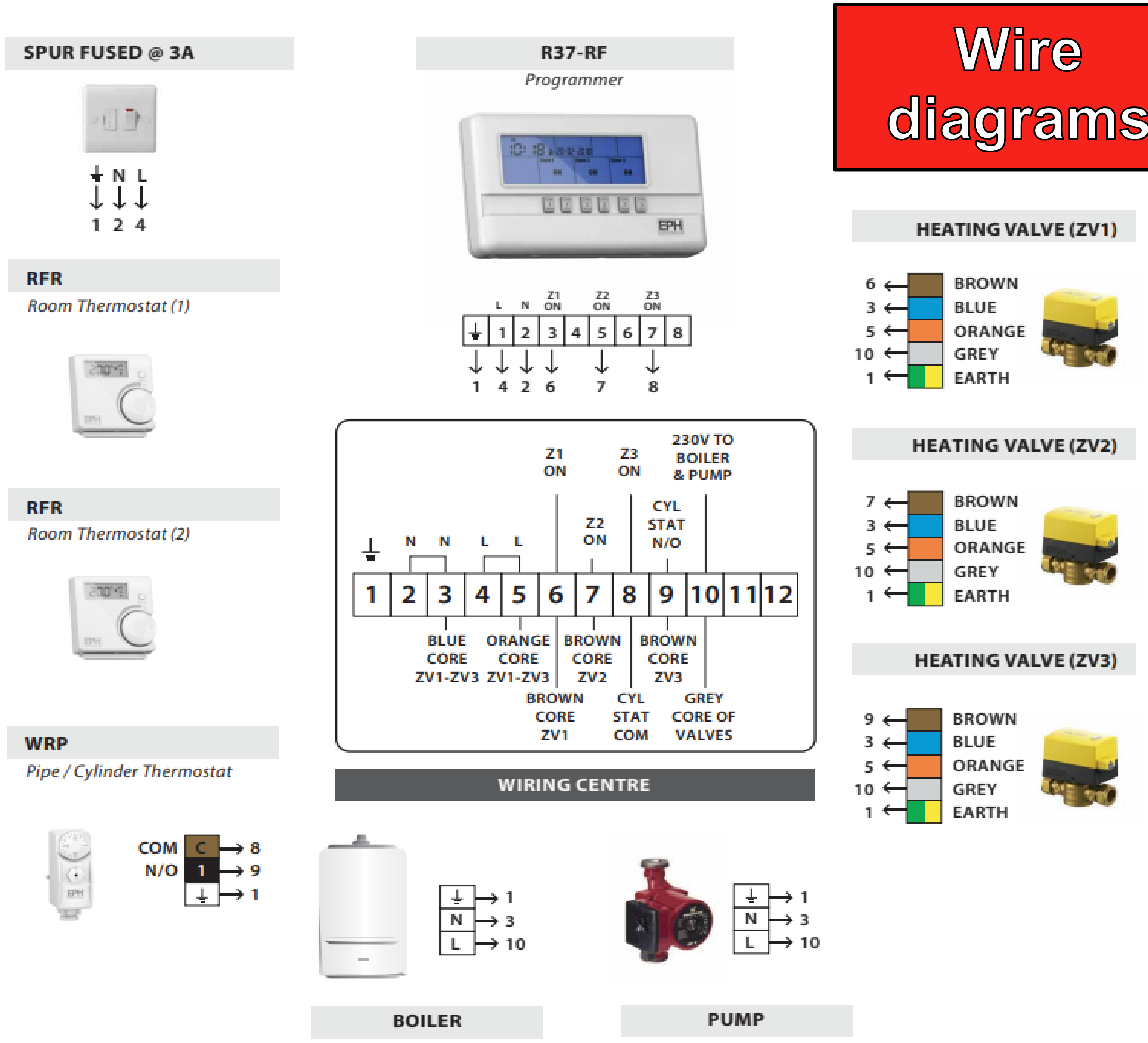
Live (brown)
From room/cylinderstat
Opens zone

Neutral

Permanent live(Grey)

Switch live (Orange)
Sends power to pump & boiler

Wire diagrams



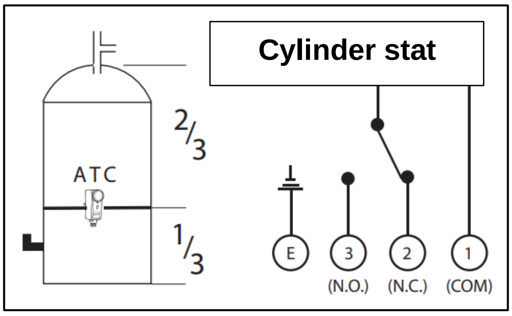
Warning

Using Ebus connections saves using NC or NO as Ebus sends information including temperatures, faults & helps modulation.

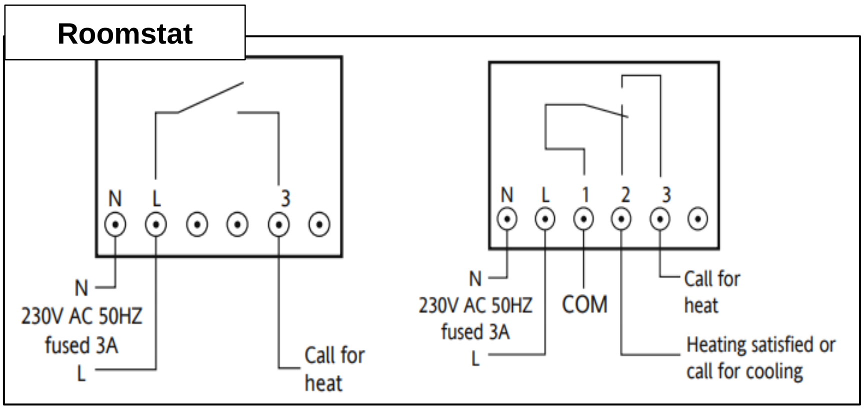
Ebus connections are 5 or 24vdc which can supply controls to function, however in some cases Live & Ebus is required especially recievers are used.

Ebus cables must be installed 25mm away from other cables

Cylinder stat



Roomstat



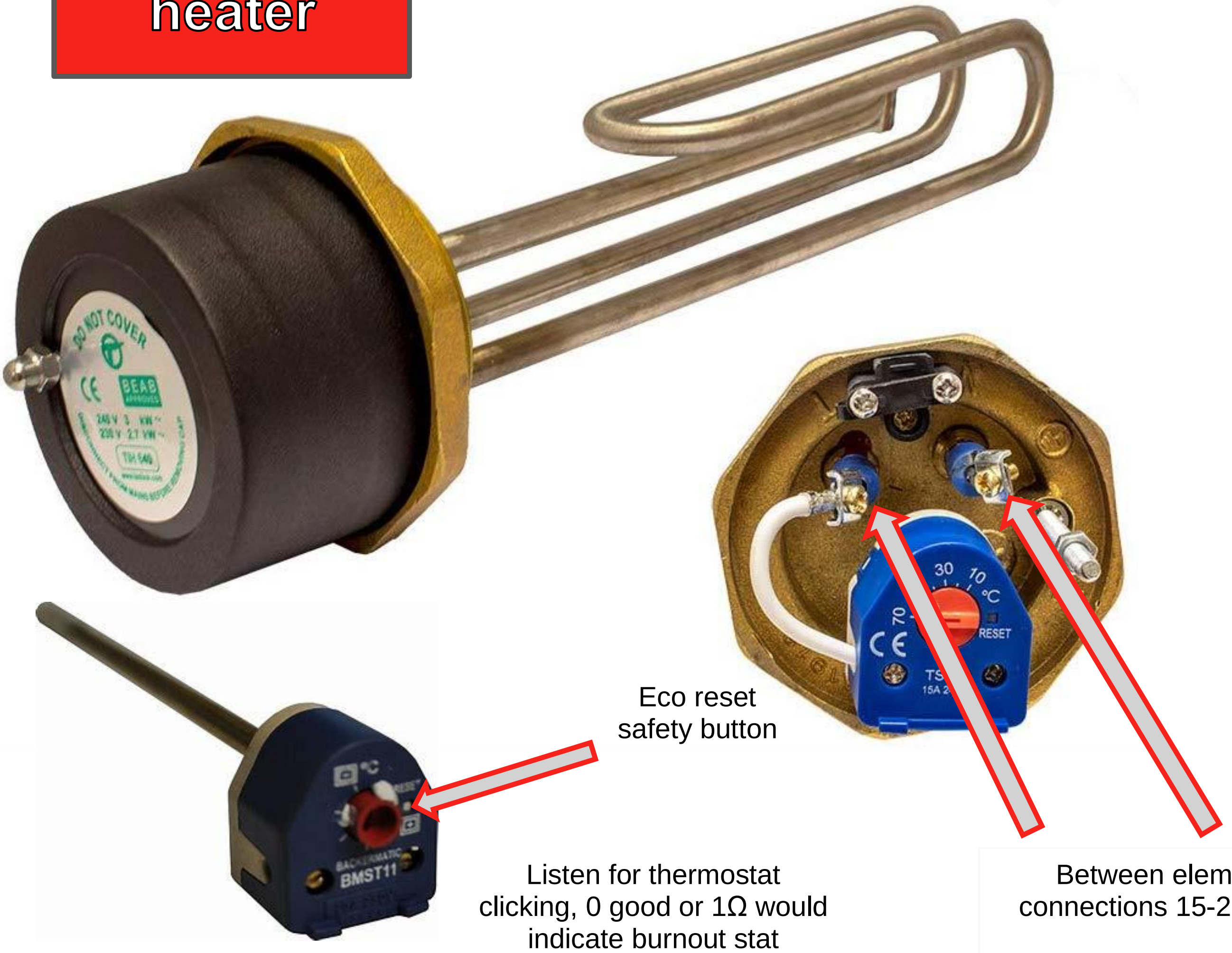
Bus connections are low voltage pulse signals like morse code, which sends information not switch live

Ebus	
+	--

NO = Normal open / on
NC = Normally closed / off
Com = Live supply

Plate

Immersion heater



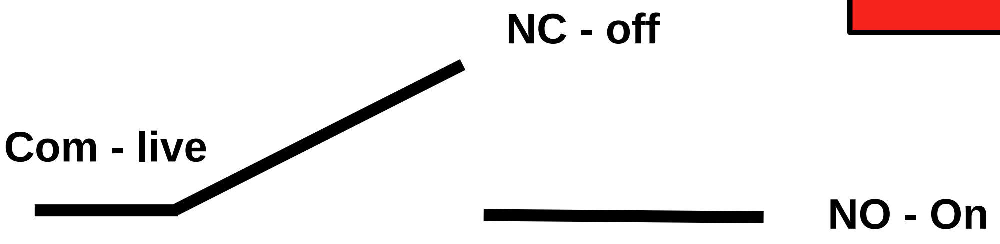
Eco reset safety button

Listen for thermostat clicking, 0 good or 1Ω would indicate burnout stat

Between elements connections 15-20 ohms

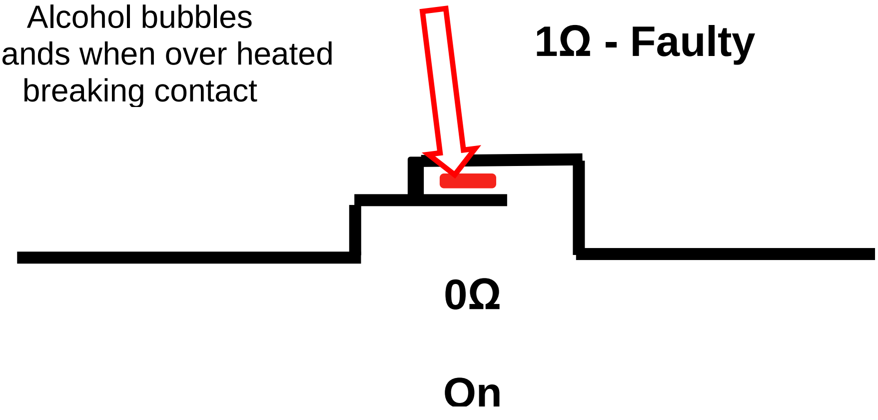
NO = Normally open
NC = Normally closed
Com = Live

Microswitches

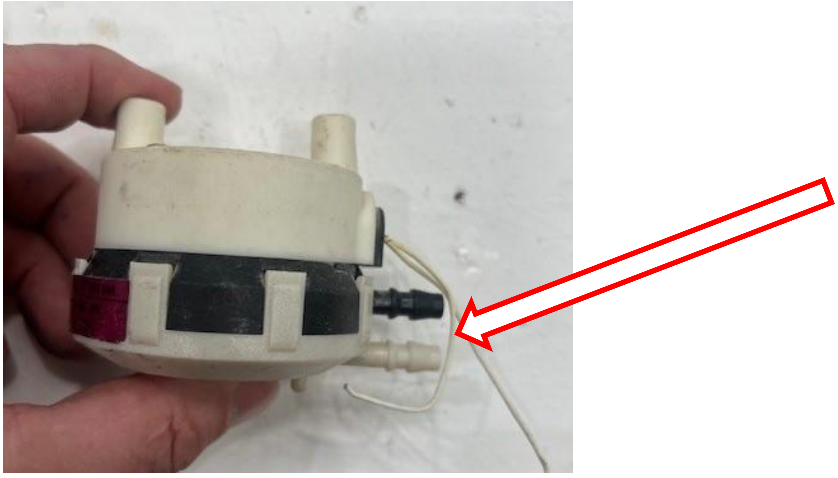


Highlimit stat

Alcohol bubbles
Expands when over heated
breaking contact



Air pressure switch



Air tubes connecting air pressure
switch must be assessed for
bloclages, water or blocked

Air pressure can give various faults when the micro switch seizes either leaving the appliance permanently off or on

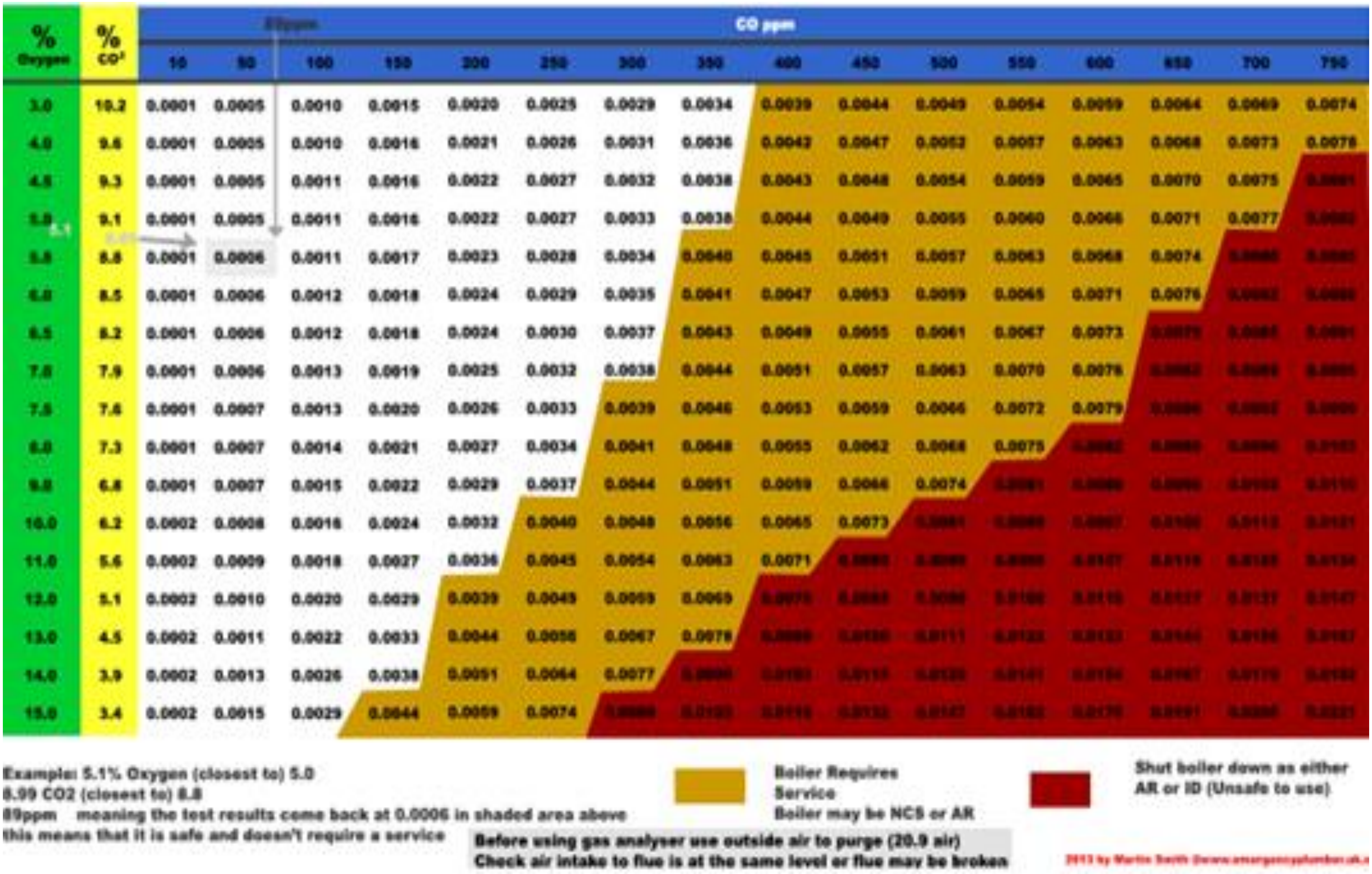
Servicing

White vinegar diluted mix or condensate from trap can be sprayed into Hex for cleaning.
Aluminium hot water only

Appliance type	Co/Co2 Ratio	
	No Air Gas ratio	With air gas ratio
Central heating boiler	0.008	0.004
BBu Fire	0.008 0.020	0.004 N/A
Fires (Flueless)	0.001	N/A
Flues (LFE)	0.020	N/A

Using a Flue Analzser

Flue intake tegrity check
20.9%



% Oxygen	% CO²	CO ppm															
		10	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750
3.0	10.2	0.0001	0.0005	0.0010	0.0015	0.0020	0.0025	0.0029	0.0034	0.0039	0.0044	0.0049	0.0054	0.0059	0.0064	0.0069	0.0074
4.0	9.6	0.0001	0.0005	0.0010	0.0016	0.0021	0.0026	0.0031	0.0036	0.0042	0.0047	0.0052	0.0057	0.0063	0.0068	0.0073	0.0078
4.5	9.3	0.0001	0.0005	0.0011	0.0016	0.0022	0.0027	0.0032	0.0038	0.0043	0.0048	0.0054	0.0059	0.0065	0.0070	0.0075	[illegible]
5.0	9.1	0.0001	0.0005	0.0011	0.0016	0.0022	0.0027	0.0033	0.0038	0.0044	0.0049	0.0055	0.0060	0.0066	0.0071	0.0077	[illegible]
5.5	8.8	0.0001	0.0006	0.0011	0.0017	0.0023	0.0028	0.0034	0.0040	0.0045	0.0051	0.0057	0.0063	0.0068	0.0074	[illegible]	[illegible]
6.0	8.5	0.0001	0.0006	0.0012	0.0018	0.0024	0.0029	0.0035	0.0041	0.0047	0.0053	0.0059	0.0065	0.0071	0.0076	[illegible]	[illegible]
6.5	8.2	0.0001	0.0006	0.0012	0.0018	0.0024	0.0030	0.0037	0.0043	0.0049	0.0055	0.0061	0.0067	0.0073	[illegible]	[illegible]	[illegible]
7.0	7.9	0.0001	0.0006	0.0013	0.0019	0.0025	0.0032	0.0038	0.0044	0.0051	0.0057	0.0063	0.0070	0.0076	[illegible]	[illegible]	[illegible]
7.5	7.6	0.0001	0.0007	0.0013	0.0020	0.0026	0.0033	0.0039	0.0046	0.0053	0.0059	0.0066	0.0072	0.0079	[illegible]	[illegible]	[illegible]
8.0	7.3	0.0001	0.0007	0.0014	0.0021	0.0027	0.0034	0.0041	0.0048	0.0055	0.0062	0.0068	0.0075	[illegible]	[illegible]	[illegible]	[illegible]
9.0	6.8	0.0001	0.0007	0.0015	0.0022	0.0029	0.0037	0.0044	0.0051	0.0059	0.0066	0.0074	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10.0	6.2	0.0002	0.0008	0.0016	0.0024	0.0032	0.0040	0.0048	0.0056	0.0065	0.0073	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
11.0	5.6	0.0002	0.0009	0.0018	0.0027	0.0036	0.0045	0.0054	0.0063	0.0071	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12.0	5.1	0.0002	0.0010	0.0020	0.0029	0.0039	0.0049	0.0059	0.0069	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
13.0	4.5	0.0002	0.0011	0.0022	0.0033	0.0044	0.0056	0.0067	0.0078	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
14.0	3.9	0.0002	0.0013	0.0026	0.0038	0.0051	0.0064	0.0077	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
15.0	3.4	0.0002	0.0015	0.0029	0.0044	0.0059	0.0074	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Example: 5.1% Oxygen (closest to) 5.0
8.99 CO2 (closest to) 8.8
89ppm meaning the test results come back at 0.0006 in shaded area above
this means that it is safe and doesn't require a service

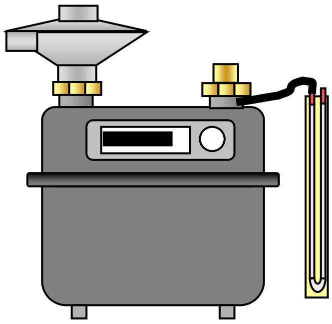
🟨 Boiler Requires Service
Boiler may be NCS or AR

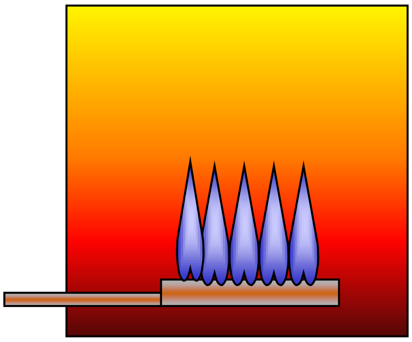
🟥 Shut boiler down as either AR or ID (Unsafe to use)

Before using gas analyser use outside air to purge (20.9 air)
Check air intake to flue is at the same level or flue may be broken

2013 by Martin Smith (www.emergencyplumber.uk.c

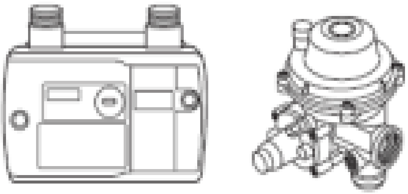
Working Pressure



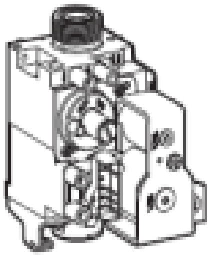


Appliance ON

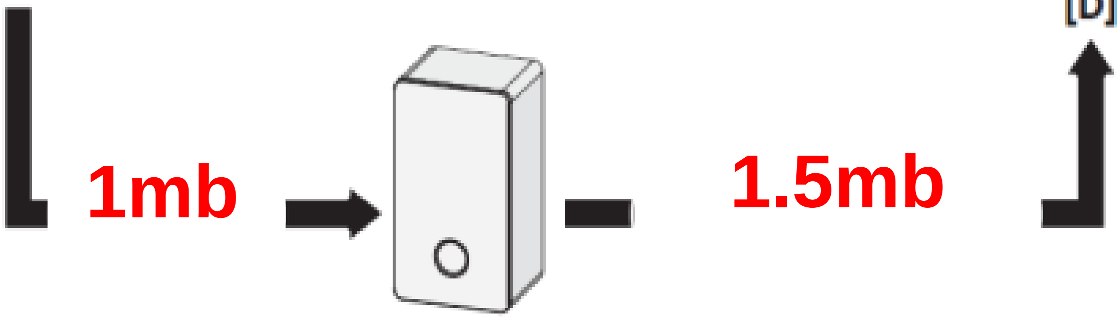
WORKING Pressure

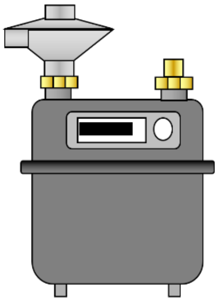


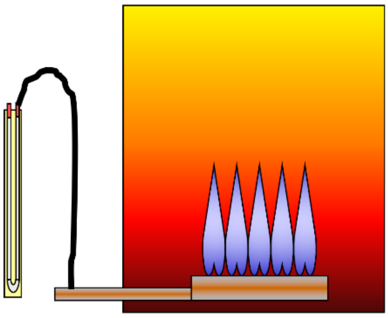
Meter or LPG Supply
[A]



Gas Valve Inlet
Test Point
[D]







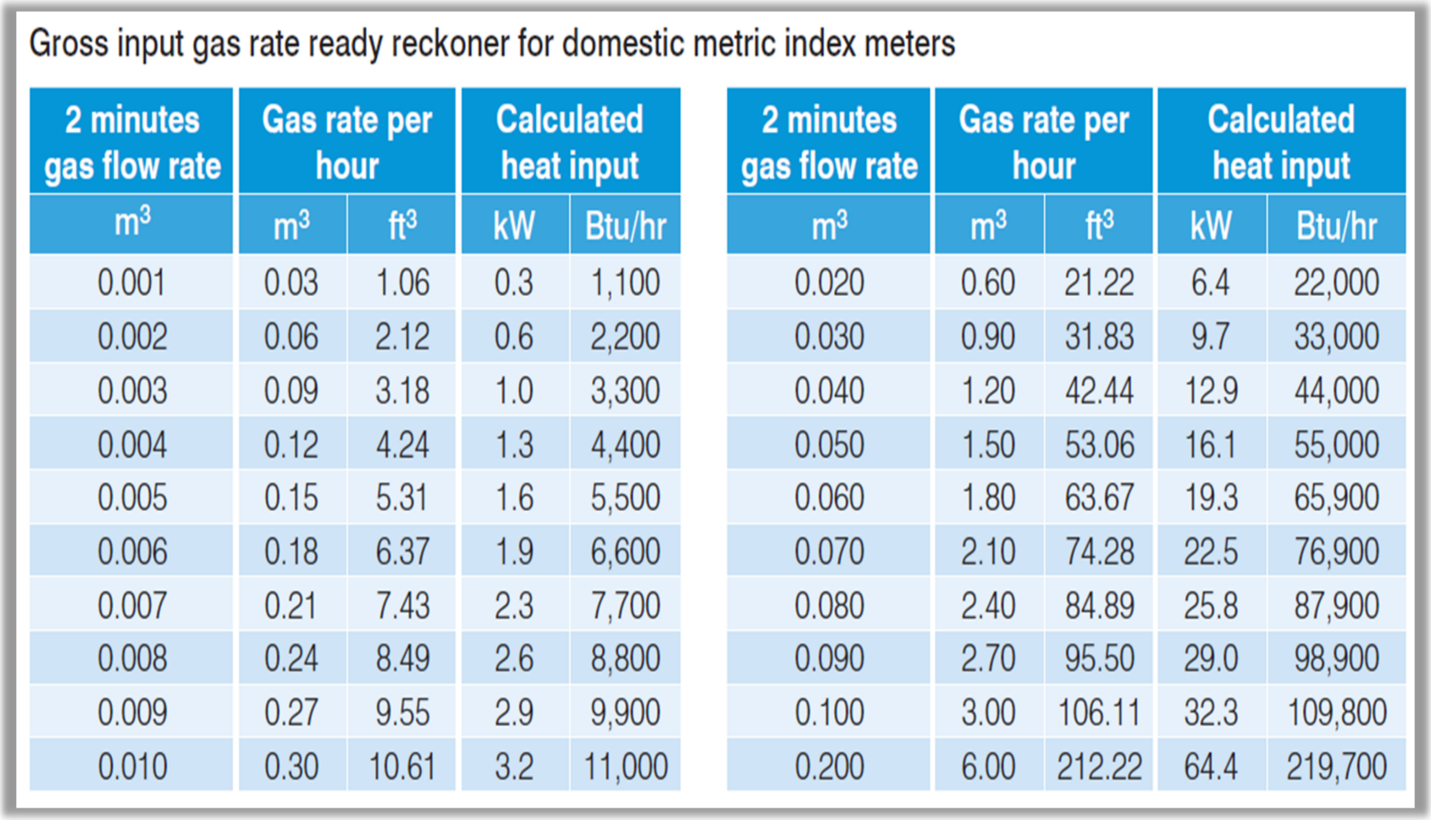
Appliance ON

WORKING Pressure at Appliance

Gas	
Mimium pressure loss	
Mimium pressure allowed	
Water	
Minimum water pressure	
Minimum flow rate	

2 min gas flow m³	Heat input Kw (gross)	Heat input Kw (net)	Answer	Answer
0.034	10.98	9.89	Boiler Kw (net)	Kw
0.036	11.63	10.48	Gas m³/hr	M³/hr
0.038	12.27	11.06		
0.040	12.92	11.64		
0.042	13.57	12.22		
0.044	14.21	12.80		

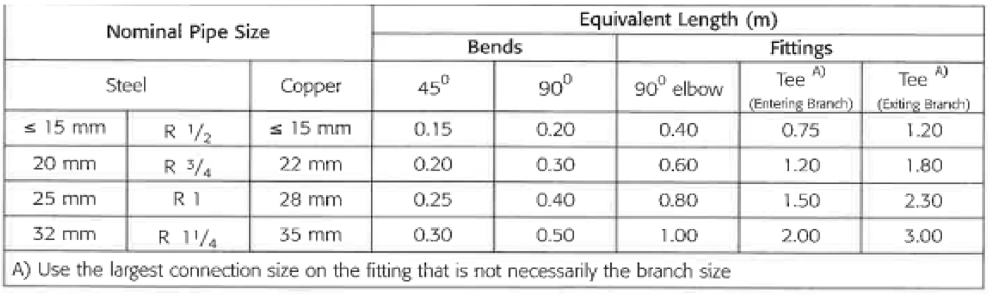
Gas rating



Gross input gas rate ready reckoner for domestic metric index meters

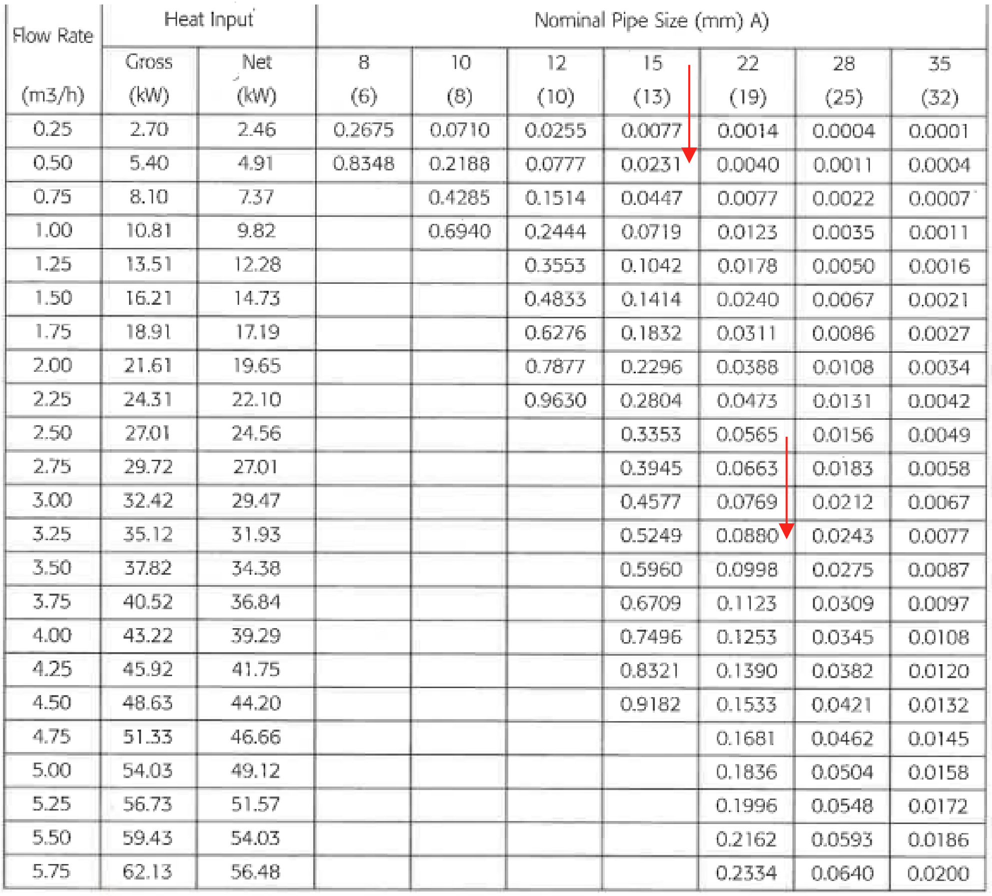
2 minutes gas flow rate	Gas rate per hour		Calculated heat input		2 minutes gas flow rate	Gas rate per hour		Calculated heat input	
m³	m³	ft³	kW	Btu/hr	m³	m³	ft³	kW	Btu/hr
0.001	0.03	1.06	0.3	1,100	0.020	0.60	21.22	6.4	22,000
0.002	0.06	2.12	0.6	2,200	0.030	0.90	31.83	9.7	33,000
0.003	0.09	3.18	1.0	3,300	0.040	1.20	42.44	12.9	44,000
0.004	0.12	4.24	1.3	4,400	0.050	1.50	53.06	16.1	55,000
0.005	0.15	5.31	1.6	5,500	0.060	1.80	63.67	19.3	65,900
0.006	0.18	6.37	1.9	6,600	0.070	2.10	74.28	22.5	76,900
0.007	0.21	7.43	2.3	7,700	0.080	2.40	84.89	25.8	87,900
0.008	0.24	8.49	2.6	8,800	0.090	2.70	95.50	29.0	98,900
0.009	0.27	9.55	2.9	9,900	0.100	3.00	106.11	32.3	109,800
0.010	0.30	10.61	3.2	11,000	0.200	6.00	212.22	64.4	219,700

Gas Pipe sizing



Nominal Pipe Size			Equivalent Length (m)				
			Bends		Fittings		
Steel		Copper	45°	90°	90° elbow	Tee A) (Entering Branch)	Tee A) (Exiting Branch)
≤ 15 mm	R 1/2	≤ 15 mm	0.15	0.20	0.40	0.75	1.20
20 mm	R 3/4	22 mm	0.20	0.30	0.60	1.20	1.80
25 mm	R 1	28 mm	0.25	0.40	0.80	1.50	2.30
32 mm	R 1 1/4	35 mm	0.30	0.50	1.00	2.00	3.00

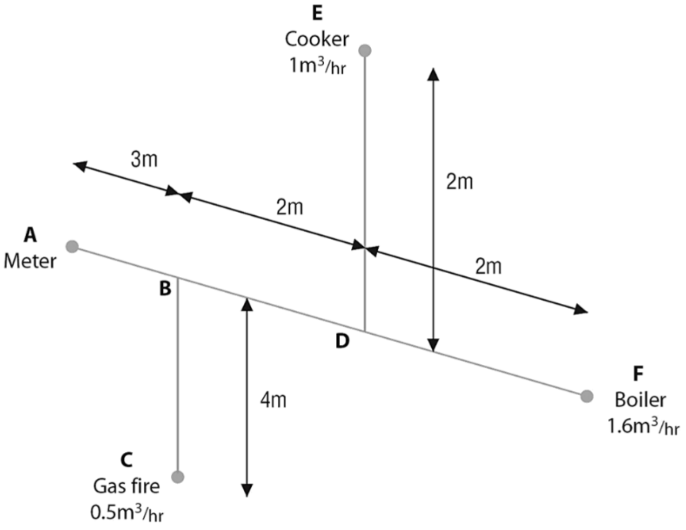
A) Use the largest connection size on the fitting that is not necessarily the branch size



Flow Rate	Heat Input		Nominal Pipe Size (mm) A)						
(m3/h)	Gross (kW)	Net (kW)	8 (6)	10 (8)	12 (10)	15 (13)	22 (19)	28 (25)	35 (32)
0.25	2.70	2.46	0.2675	0.0710	0.0255	0.0077	0.0014	0.0004	0.0001
0.50	5.40	4.91	0.8348	0.2188	0.0777	0.0231	0.0040	0.0011	0.0004
0.75	8.10	7.37		0.4285	0.1514	0.0447	0.0077	0.0022	0.0007
1.00	10.81	9.82		0.6940	0.2444	0.0719	0.0123	0.0035	0.0011
1.25	13.51	12.28			0.3553	0.1042	0.0178	0.0050	0.0016
1.50	16.21	14.73			0.4833	0.1414	0.0240	0.0067	0.0021
1.75	18.91	17.19			0.6276	0.1832	0.0311	0.0086	0.0027
2.00	21.61	19.65			0.7877	0.2296	0.0388	0.0108	0.0034
2.25	24.31	22.10			0.9630	0.2804	0.0473	0.0131	0.0042
2.50	27.01	24.56				0.3353	0.0565	0.0156	0.0049
2.75	29.72	27.01				0.3945	0.0663	0.0183	0.0058
3.00	32.42	29.47				0.4577	0.0769	0.0212	0.0067
3.25	35.12	31.93				0.5249	0.0880	0.0243	0.0077
3.50	37.82	34.38				0.5960	0.0998	0.0275	0.0087
3.75	40.52	36.84				0.6709	0.1123	0.0309	0.0097
4.00	43.22	39.29				0.7496	0.1253	0.0345	0.0108
4.25	45.92	41.75				0.8321	0.1390	0.0382	0.0120
4.50	48.63	44.20				0.9182	0.1533	0.0421	0.0132
4.75	51.33	46.66					0.1681	0.0462	0.0145
5.00	54.03	49.12					0.1836	0.0504	0.0158
5.25	56.73	51.57					0.1996	0.0548	0.0172
5.50	59.43	54.03					0.2162	0.0593	0.0186
5.75	62.13	56.48					0.2334	0.0640	0.0200

Pressure loss to the appliance must be lower then 1mb in total pipe route.
Incorrect sized pipe can lead too poor combustion readings

Pipe section	Gas rate M3/h	Pipe length	Estimated Pipe dia	Fitting allowance		Corrected length	Pressure loss Mb/pm	Calculated pressure loss
				Type	length			
A – B	3.1	3	22	Elbow x 2	1.2	4.2	0.0880	0.37
B – C	0.5	4	15	Elbow x 3 Tee(exit) x 1(22m)	3	7	0.0231	0.1617



System design

Heating

Pipe sizing.

Fact

Flow rate for heating should be 1m/s, lower sludge can settle, 1.5 can be disruptive, 2.5 can erode pipes, Part L, states flow temperatures should be 55° with a DT of 20°

Pipe Dia (mm)	Watts
8	1500
10	2500
15	6000
22	13000
28	22000
35	34000

Reference;

BS 5449
BS EN 806

Pipe Flow rates

H = Rad Watts
TD = Temp diff
SHC = Specific Heat

$$\frac{H}{TD \times 4.186} =$$

Low loss header sizing (m/s)

Kw = Boiler output
SHC = Specific heat
DT = Temperature diff

$$\frac{Kw \times 3600 \div 1000}{SHC \times DT}$$

Bypass setting

KW / Dt x 4.20

Manufacturers guidelines mini flow & system head

Radiator Sizing

Ventilation heatloss

V = Room volume m²
N = Air change p/hour
0.33 = Specific heat of air
TD = Temp diff, between -3° + desired room temp
i.e;
living room 1980 3m x 3m x 4m @21
0.33 x 36 x 1.5 x 24 = 427.68

0.33 x V x N x TD = heat loss

In Coastal areas -5 can be used for outside

Room	Category A (Pre 2000)	Category B (2000)	Category C (New build)
Lounge/living room	1.5	1	0.5
Dining/breakfast room	1.5	1	0.5

U-Valves for new build	
Room	U-Value
Pitched insulated roof	0.20
Flat roof	0.20
Walls	0.30
Internal walls	1.6
Floors	0.25
Windows & doors	2

Correction factors

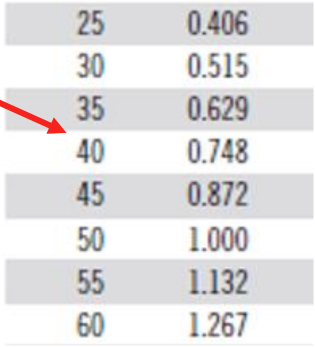
Htg flow – htg return = water temp
Water temp – desired room temp =

Boiler flow is 70 return temperature is 50, Water mean temperature is 60
Deduct room temperature of 21, equals 39.
39 falls between figures so accurate
Calculations are needed.

0.748 – 0.629 = 0.119

$\frac{0.119}{5}$ = 0.024 – the figure per ºC difference

0.748 – 0.024 = 0.748



25	0.406
30	0.515
35	0.629
40	0.748
45	0.872
50	1.000
55	1.132
60	1.267

Further details in Glossary

Room heat loss

Surface element	area (m2)	X	U Valve (W/m2k)	X	Temp dif (oC)	=	Design heat loss watts	Totals
		x		x		=		
		x		x		=		
		x		x		=		
		x		x		=		
		x		x		=		
		x		x		=		
		x		x		=		

Air heat loss

Air changes (1.5)	x	Room volume (m3)	x	Temp/diff (21 + -3°)	x	Vent factor 0.33	=		
			x		x		=		

Fabric heat loss	+	Air heat loss		+ 15%	=	
	+				=	
Total design heat loss Add boxes 1 & 2 = 3					=	

Heat emitter size

Flow 70	+	Return 55	÷ 2	– Room temp 21	=	MWT
	+		÷2		=	

MWT	x	CF correct factor	=	Radiator size
	x		=	

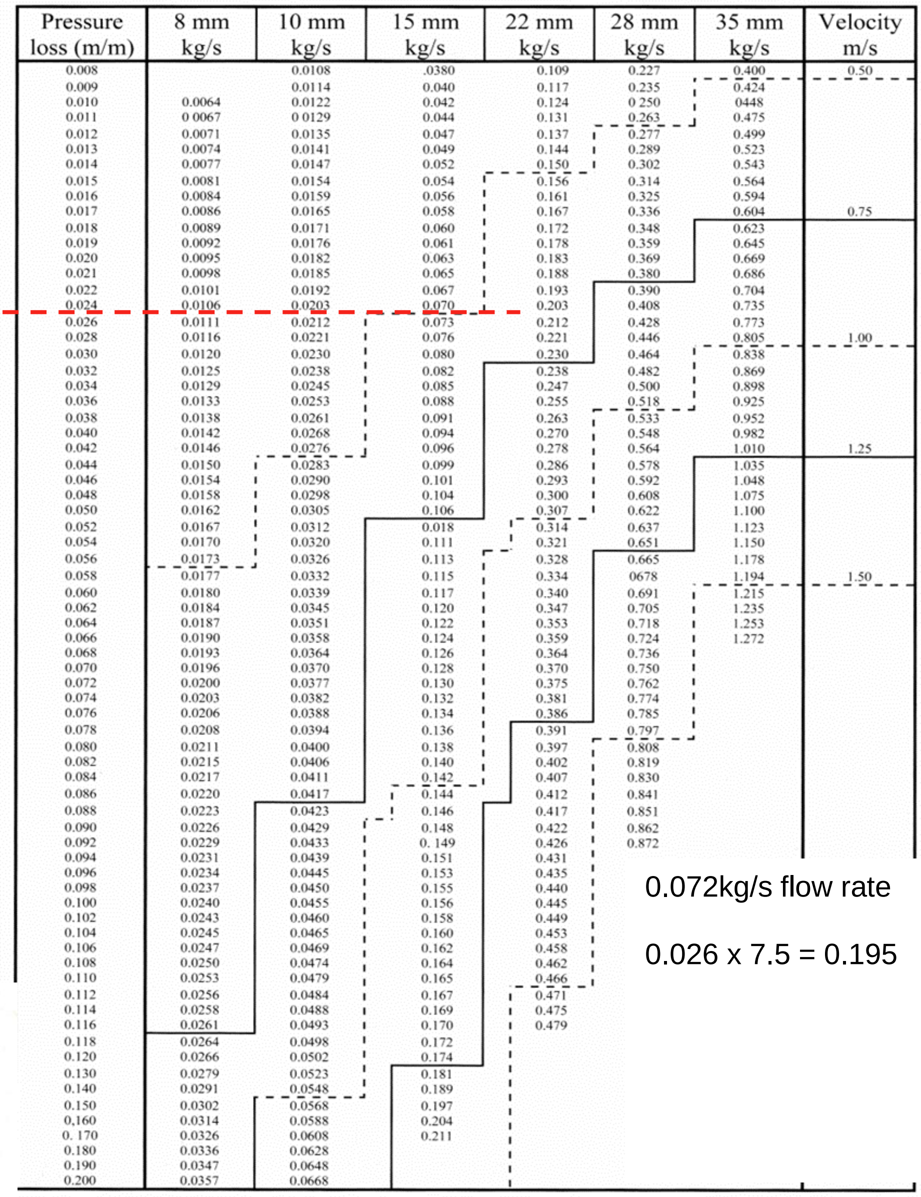
Part L now states all heating systems should be design for a 55° flow temperature

Heating Pipe sizing

$$\text{Flow rates} = \frac{\text{Flow rate kw}}{\text{TD x 4.187}}$$

6.05Kw	0.072kg/s
Dia	15mm
Pressure loss P/m	0.026
Effective length (m)	7.5
Pressure required	0.195m

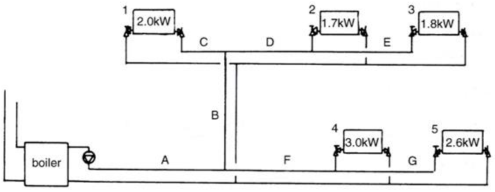
Always design heating with 0.5 – 1.5m/s Velocity



Pressure loss (m/m)	8 mm kg/s	10 mm kg/s	15 mm kg/s	22 mm kg/s	28 mm kg/s	35 mm kg/s	Velocity m/s
0.008		0.0108	.0380	0.109	0.227	0.400	0.50
0.009		0.0114	0.040	0.117	0.235	0.424	
0.010	0.0064	0.0122	0.042	0.124	0 250	0448	
0.011	0 0067	0 0129	0.044	0.131	0.263	0.475	
0.012	0.0071	0.0135	0.047	0.137	0.277	0.499	
0.013	0.0074	0.0141	0.049	0.144	0.289	0.523	
0.014	0.0077	0.0147	0.052	0.150	0.302	0.543	
0.015	0.0081	0.0154	0.054	0.156	0.314	0.564	
0.016	0.0084	0.0159	0.056	0.161	0.325	0.594	
0.017	0.0086	0.0165	0.058	0.167	0.336	0.604	0.75
0.018	0.0089	0.0171	0.060	0.172	0.348	0.623	
0.019	0.0092	0.0176	0.061	0.178	0.359	0.645	
0.020	0.0095	0.0182	0.063	0.183	0.369	0.669	
0.021	0.0098	0.0185	0.065	0.188	0.380	0.686	
0.022	0.0101	0.0192	0.067	0.193	0.390	0.704	
0.024	0.0106	0.0203	0.070	0.203	0.408	0.735	
0.026	0.0111	0.0212	0.073	0.212	0.428	0.773	
0.028	0.0116	0.0221	0.076	0.221	0.446	0.805	1.00
0.030	0.0120	0.0230	0.080	0.230	0.464	0.838	
0.032	0.0125	0.0238	0.082	0.238	0.482	0.869	
0.034	0.0129	0.0245	0.085	0.247	0.500	0.898	
0.036	0.0133	0.0253	0.088	0.255	0.518	0.925	
0.038	0.0138	0.0261	0.091	0.263	0.533	0.952	
0.040	0.0142	0.0268	0.094	0.270	0.548	0.982	
0.042	0.0146	0.0276	0.096	0.278	0.564	1.010	1.25
0.044	0.0150	0.0283	0.099	0.286	0.578	1.035	
0.046	0.0154	0.0290	0.101	0.293	0.592	1.048	
0.048	0.0158	0.0298	0.104	0.300	0.608	1.075	
0.050	0.0162	0.0305	0.106	0.307	0.622	1.100	
0.052	0.0167	0.0312	0.018	0.314	0.637	1.123	
0.054	0.0170	0.0320	0.111	0.321	0.651	1.150	
0.056	0.0173	0.0326	0.113	0.328	0.665	1.178	
0.058	0.0177	0.0332	0.115	0.334	0678	1.194	1.50
0.060	0.0180	0.0339	0.117	0.340	0.691	1.215	
0.062	0.0184	0.0345	0.120	0.347	0.705	1.235	
0.064	0.0187	0.0351	0.122	0.353	0.718	1.253	
0.066	0.0190	0.0358	0.124	0.359	0.724	1.272	
0.068	0.0193	0.0364	0.126	0.364	0.736		
0.070	0.0196	0.0370	0.128	0.370	0.750		
0.072	0.0200	0.0377	0.130	0.375	0.762		
0.074	0.0203	0.0382	0.132	0.381	0.774		
0.076	0.0206	0.0388	0.134	0.386	0.785		
0.078	0.0208	0.0394	0.136	0.391	0.797		
0.080	0.0211	0.0400	0.138	0.397	0.808		
0.082	0.0215	0.0406	0.140	0.402	0.819		
0.084	0.0217	0.0411	0.142	0.407	0.830		
0.086	0.0220	0.0417	0.144	0.412	0.841		
0.088	0.0223	0.0423	0.146	0.417	0.851		
0.090	0.0226	0.0429	0.148	0.422	0.862		
0.092	0.0229	0.0433	0. 149	0.426	0.872		
0.094	0.0231	0.0439	0.151	0.431			
0.096	0.0234	0.0445	0.153	0.435			
0.098	0.0237	0.0450	0.155	0.440			
0.100	0.0240	0.0455	0.156	0.445			
0.102	0.0243	0.0460	0.158	0.449			
0.104	0.0245	0.0465	0.160	0.453			
0.106	0.0247	0.0469	0.162	0.458			
0.108	0.0250	0.0474	0.164	0.462			
0.110	0.0253	0.0479	0.165	0.466			
0.112	0.0256	0.0484	0.167	0.471			
0.114	0.0258	0.0488	0.169	0.475			
0.116	0.0261	0.0493	0.170	0.479			
0.118	0.0264	0.0498	0.172				
0.120	0.0266	0.0502	0.174				
0.130	0.0279	0.0523	0.181				
0.140	0.0291	0.0548	0.189				
0.150	0.0302	0.0568	0.197				
0,160	0.0314	0.0588	0.204				
0. 170	0.0326	0.0608	0.211				
0.180	0.0336	0.0628					
0.190	0.0347	0.0648					
0.200	0.0357	0.0668					

0.072kg/s flow rate

0.026 x 7.5 = 0.195



Pipe section	A	B	C	D	E	F	G
Measured length (m)	9	7.5	6	9	8	6	9

1	2	3	4	5	6	7	8	9	10	11
Pipe Section	Total heat emitter value	10% addition for heat loss from pipes	Total heat requirements	Specific Heat x temperature drop	Flow rate (l/s)	Pipe size (mm)	Pressure loss (m/m)	Effective Pipe length (m)	Pressure required(m)	Remarks
A	11.1	1.11	12.21	84	0.145	15	0.088	11.8	1.038	
B	5.5	0.55	6.05	84	0.072	15	0.026	7.5	0.195	
C	2.0	0.2	2.2	84	0.026	8	0.116	15.4	1.786	
D	3.5	0.35	3.85	84	0.045	10	0.098	16	1.568	
E	1.8	0.18	1.98	84	0.023	8	0.094	17.2	1.616	
F	5.6	0.56	6.16	84	0.073	15	0.026	14.4	0.374	
G	2.6	0.26	2.86	84	0.034	8	0.19			

Pipe resistances are in glossary

UFH facts

Pipe Centres	Conversation factor
100	10
150	6.6
200	5

Pipe lengths

RA = Area of room
PC = Pipe centre
DfM = Distance from manifold x 2
Add 5%

ie;

RA – 12M2   PC - 150MM   DfM - 6

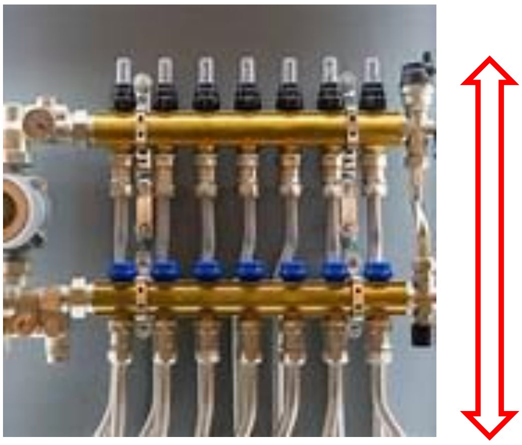
12 x 6.6   = 79.2m
DfM   = 12m
Sub total = 91.2m + 5%(4.5)
Total   = 95.7m

Ie;

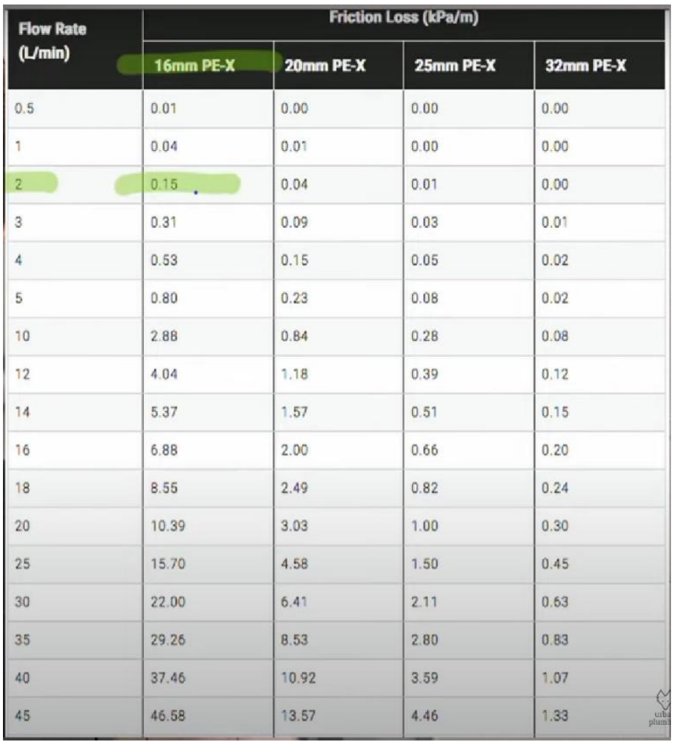
RA – 24m2   PC 150mm   DfM – 6m

24 x 6.6 = 158
158/2 = 79.50
6 x 2 = 12
91.5 + 5% = 95.8m

Below is the W/m2 produced from the pipe centres, as you can see 100mm centres provides more heatput



DFM;
Distance from manifold



Flow Rate (L/min)	Friction Loss (kPa/m)			
	16mm PE-X	20mm PE-X	25mm PE-X	32mm PE-X
0.5	0.01	0.00	0.00	0.00
1	0.04	0.01	0.00	0.00
2	0.15	0.04	0.01	0.00
3	0.31	0.09	0.03	0.01
4	0.53	0.15	0.05	0.02
5	0.80	0.23	0.08	0.02
10	2.88	0.84	0.28	0.08
12	4.04	1.18	0.39	0.12
14	5.37	1.57	0.51	0.15
16	6.88	2.00	0.66	0.20
18	8.55	2.49	0.82	0.24
20	10.39	3.03	1.00	0.30
25	15.70	4.58	1.50	0.45
30	22.00	6.41	2.11	0.63
35	29.26	8.53	2.80	0.83
40	37.46	10.92	3.59	1.07
45	46.58	13.57	4.46	1.33

30 MWT 18 rtemp	100	150	200	250	300
30	37	34	31	29	26

Ie,
80 x 0.15 = 1.2

Pipe centres(mm)	Heat output W/m.^{2}
100	91.4
150	82
200	74
250	66.4
300	60

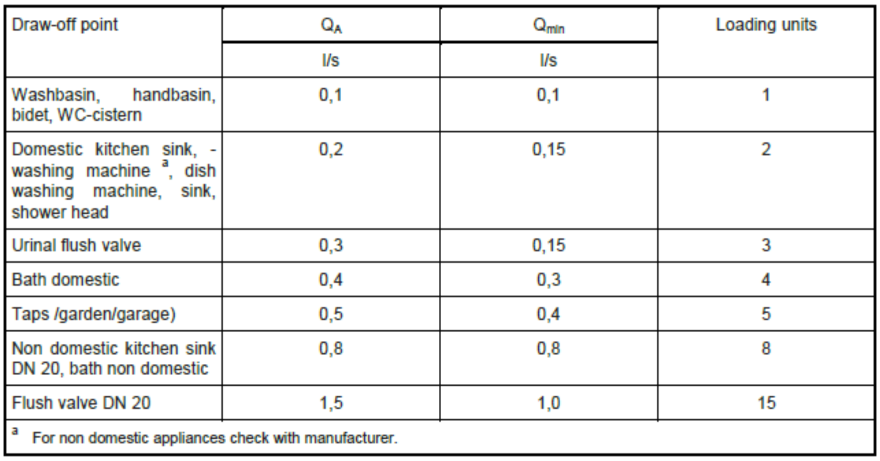
Based on 75mm screed & 45° mean temp

More UFH Outputs in Glossary

Hot & Cold Pipe Sizing

Below example

Garden tap x 2	10
Bath x 2	8
Sink	2
Shower	2
Wash basin	1
W/machine	2
D washer	2



Draw-off point	Q_A	Q_{min}	Loading units
	l/s	l/s	
Washbasin, handbasin, bidet, WC-cistern	0,1	0,1	1
Domestic kitchen sink, washing machine [a], dish washing machine, sink, shower head	0,2	0,15	2
Urinal flush valve	0,3	0,15	3
Bath domestic	0,4	0,3	4
Taps /garden/garage)	0,5	0,4	5
Non domestic kitchen sink DN 20, bath non domestic	0,8	0,8	8
Flush valve DN 20	1,5	1,0	15

[a] For non domestic appliances check with manufacturer.

Maximum flow rate velocity 3m/s this prevents water hammer, 27 LU against he chart equals too 5.5l/s & flow rate of 1.7ls which points to 22mm pipe

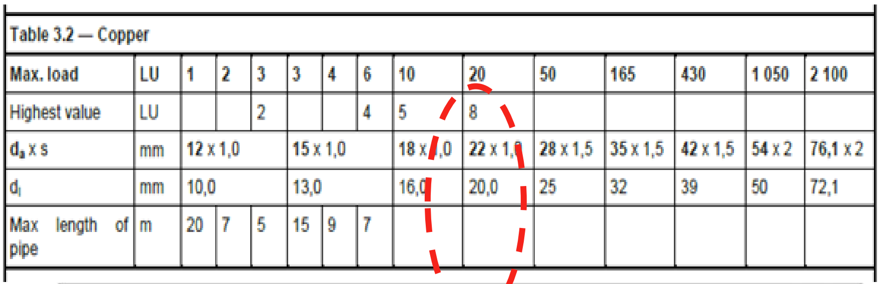


Table 3.2 — Copper

Max. load	LU	1	2	3	3	4	6	10	20	50	165	430	1 050	2 100
Highest value	LU			2			4	5	8					
d_a x s	mm	12 x 1,0			15 x 1,0			18 x 1,0	22 x 1,0	28 x 1,5	35 x 1,5	42 x 1,5	54 x 2	76,1 x 2
d_i	mm	10,0			13,0			16,0	20,0	25	32	39	50	72,1
Max length of pipe	m	20	7	5	15	9	7							

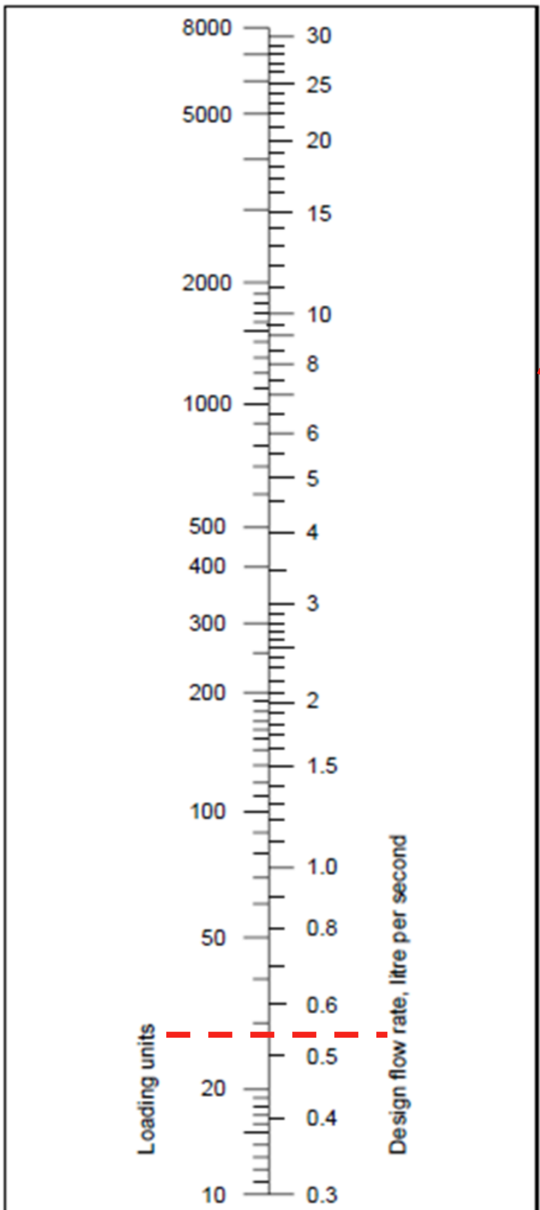


Figure D.1 Conversion of loading units to design flow rate

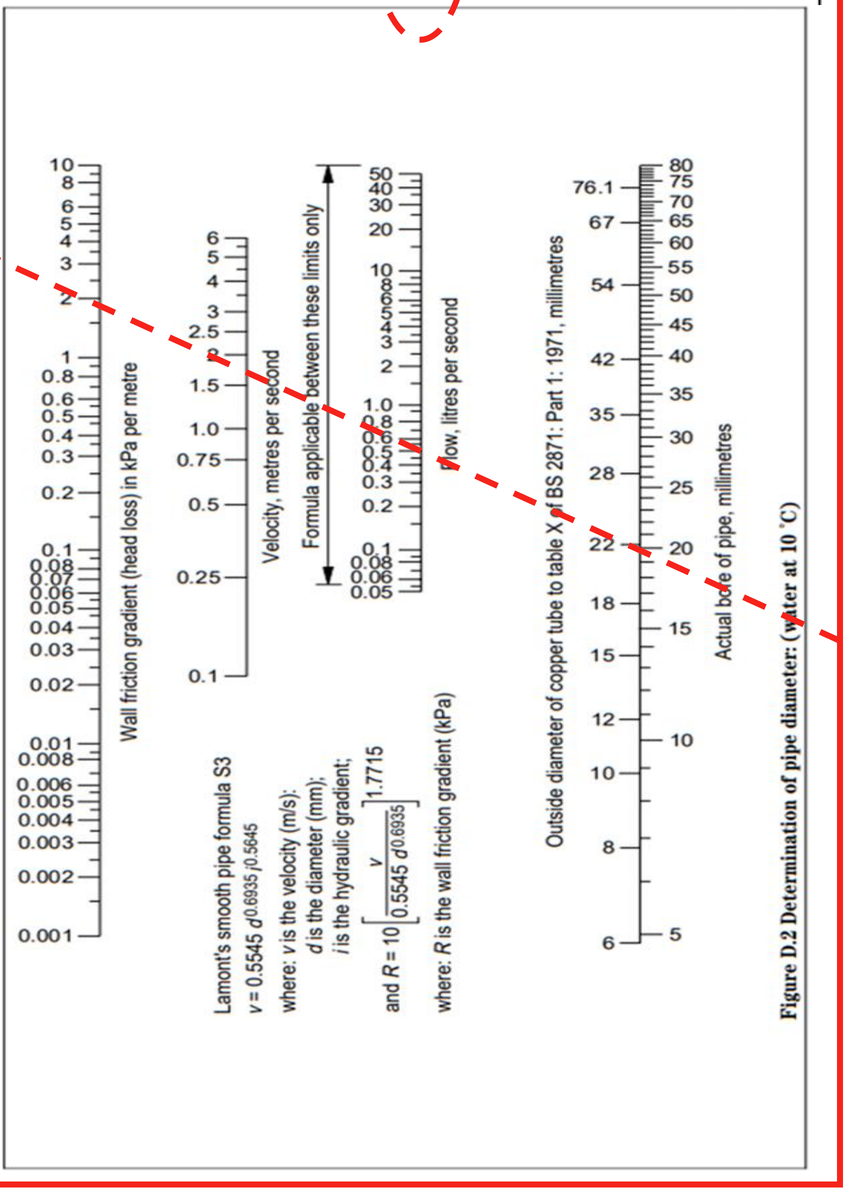


Figure D.2 Determination of pipe diameter: (water at 10 °C)

Hot water demand

Hot water Demand

Basic

Demand	Cylinder size	Kw req	Boiler allowed
2 bed, 1 bath	125	7.2	2
3 bed, 1 bath	145	8.4	2.5
4 bed, 1 bath	165	8.4	2.5
4 bed, 1 bath + 1 shower	175	10	2.5
4 bed, 2 bath	225	13	3.0

Calculated formula

Heat required

SHC x Kg x Tr =

SHC =

Kg = litres of water

Tr = Temperature rise

Period

$$\frac{\text{SHC x Kg x Tr =}}{\text{Secs}}$$

Hot & Cold Pipe sizing (unvented DHW)

Loading units

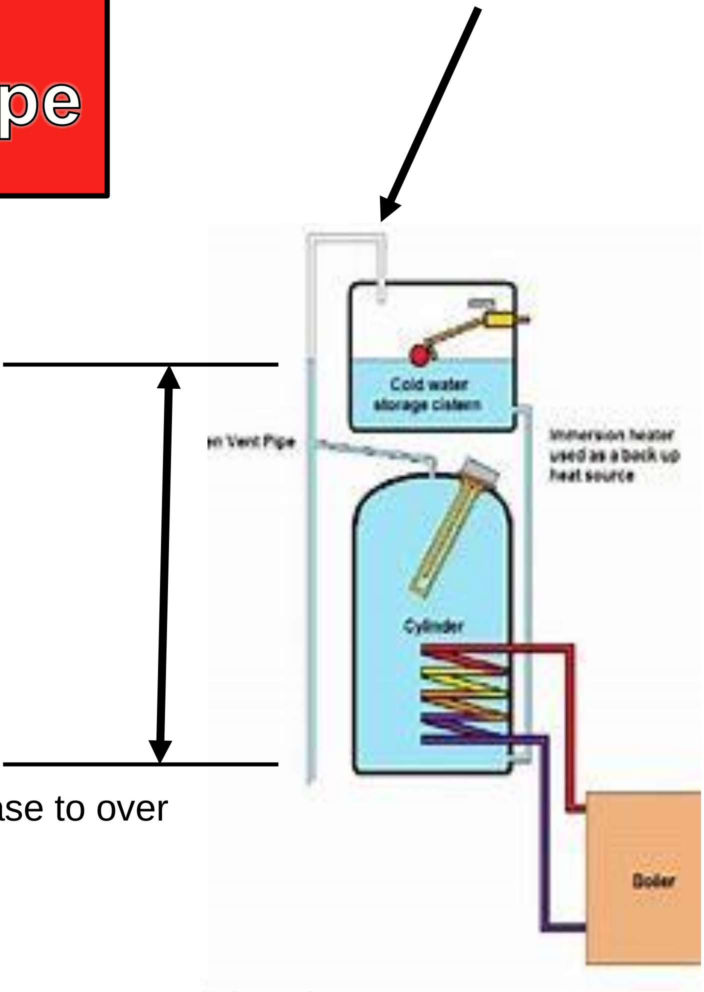
Appliance	Loading units
Basin/WC	1
Sink/Shower/W.machine	2
Urinal	3
Bath	5
Non domestic	8
Taps/Garden	5

Diameter per Units

LU	**1**	**2**	**3**	**3**	**4**	**6**	**10**	**20**	**50**	**165**	**430**
Dia (mm)	15	15	15	15	15	15	22	22	28	35	42

Hot water ventilation pipe

How to calculate vent pipe height?



150mm standard number
40mm per metre height

150 + 40 = vent height

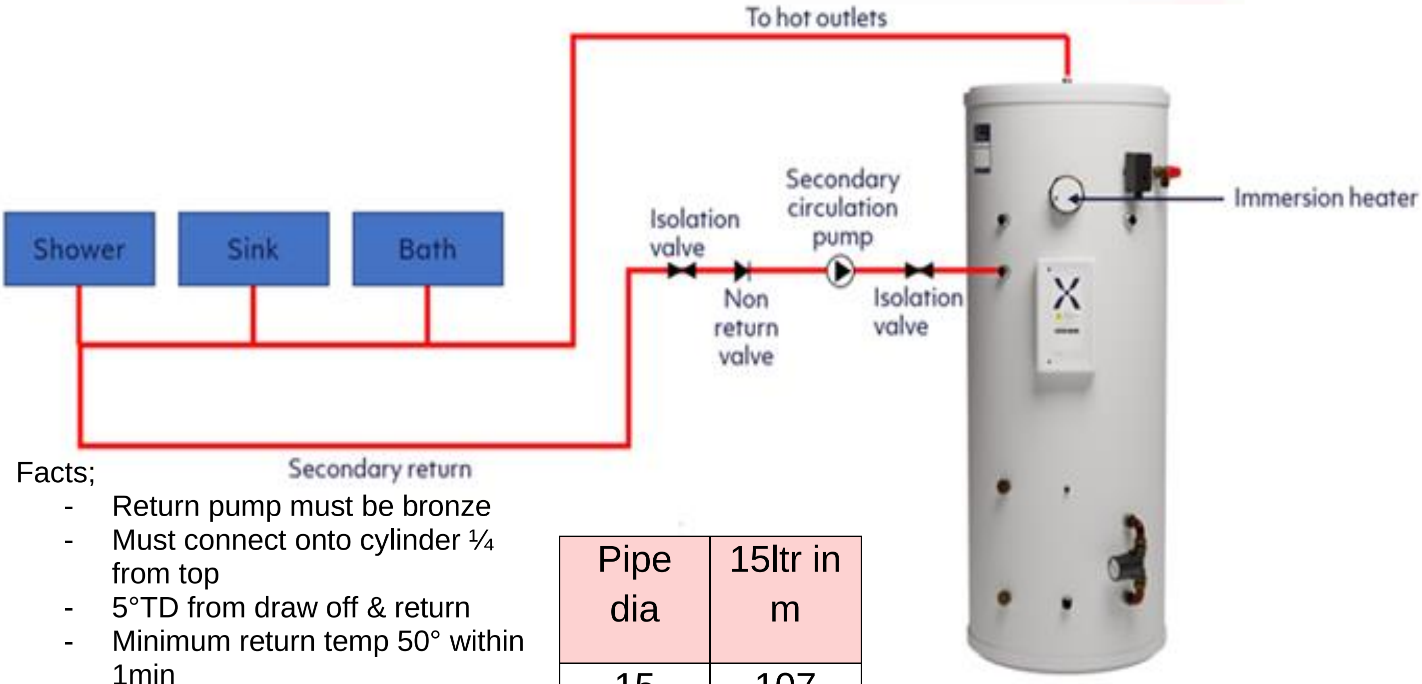
Height from cylinder base
to over pipe level

ı.e

4m height from cylinder base to over flow pipe

4 x 40 + 150 = 310mm

Secondary circulation



Facts;

- Return pump must be bronze
- Must connect onto cylinder ¼ from top
- 5°TD from draw off & return
- Minimum return temp 50° within 1min
- Minimum 0.5l/s
- Secondary return must be a minimum 2 x dia smaller then distruption
- Return with more than 15ltres needs expansion vessel
- Pump works on timer

Pipe dia	15ltr in m
15	107
22	48
28	30

Unvented Hot water

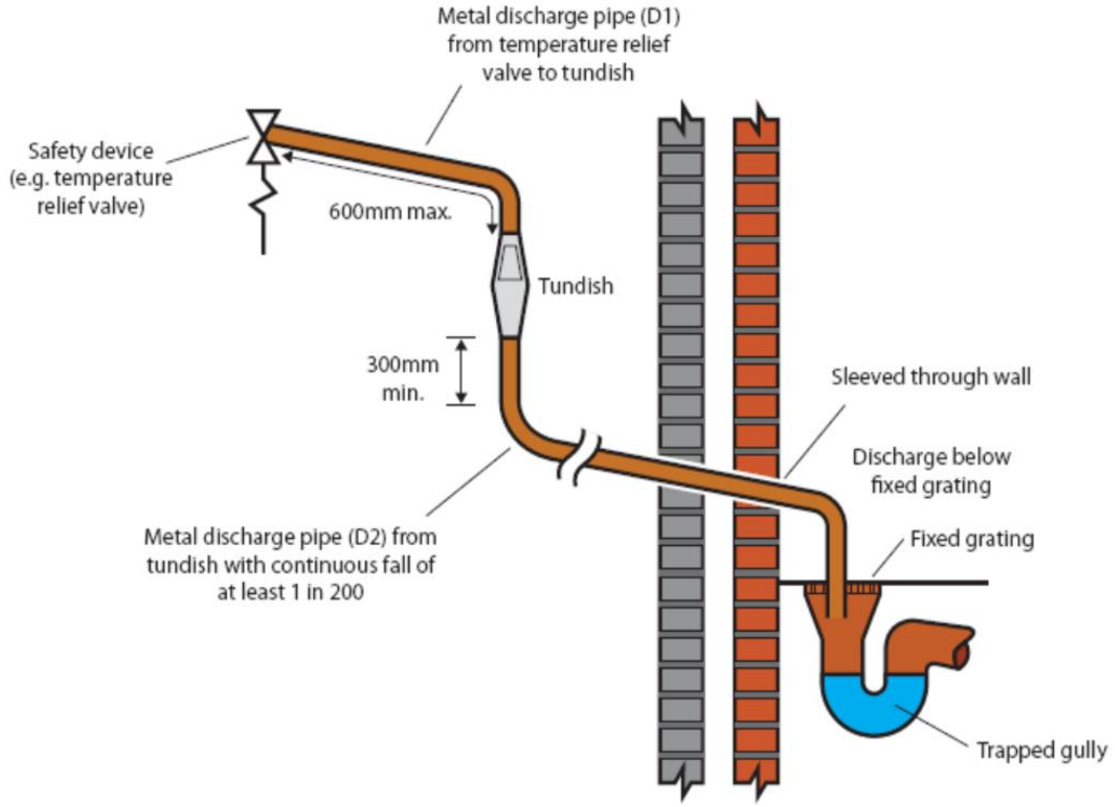
20lpm
1.5 – 3.5 bar

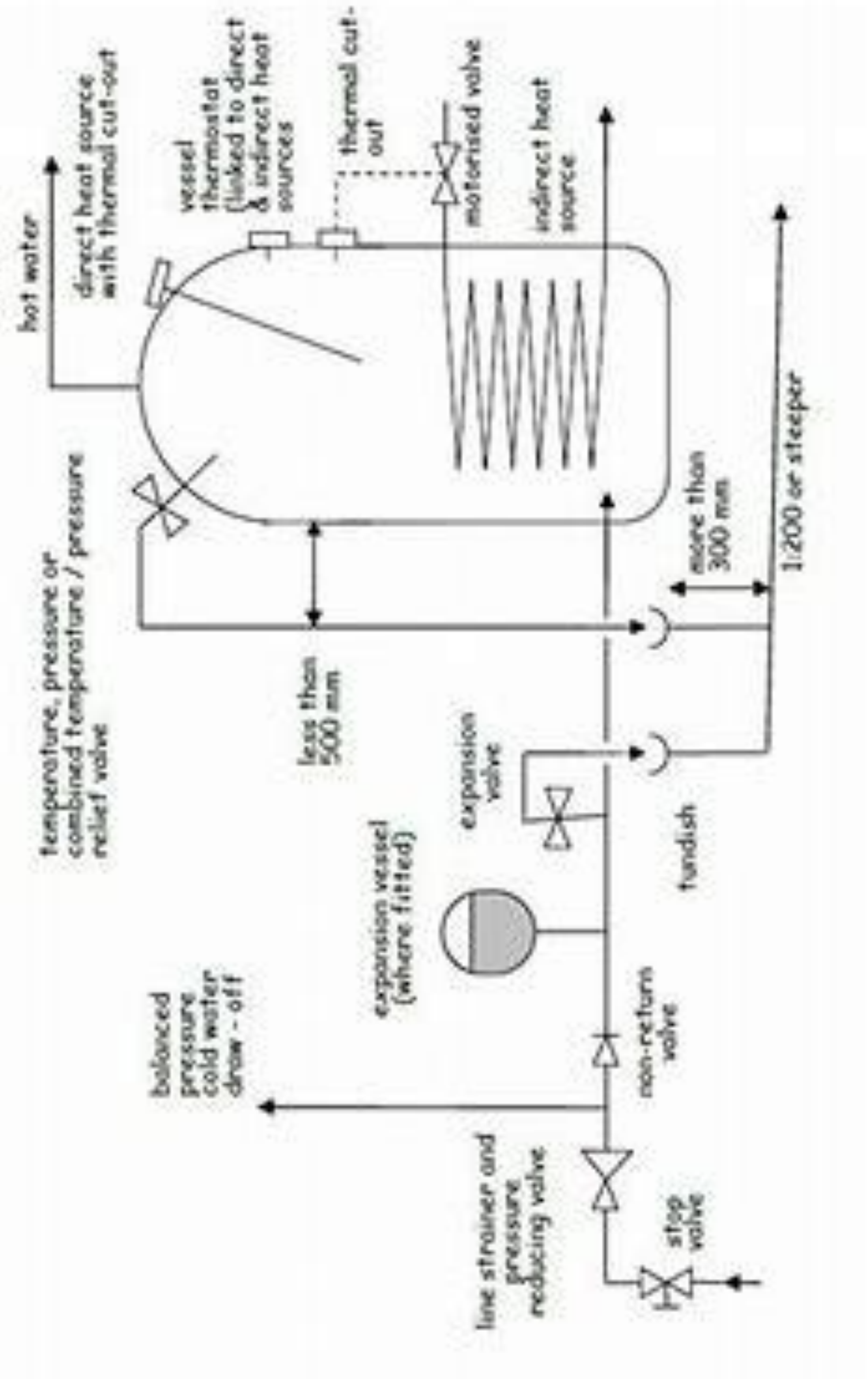
- D2 next dia above D1
- Discharge should be copper
- Terminate 100mm above ground with cage
- Must terminate 3m from plastic surface (gutter/roof sheeting)
- D2 discharges in solvent weld must be clipped every 300mm/labelled with a HepVo valve
- Warning audio light device for disable tennats

Valve Outlet size	**Minimum size of discharge D1**	**Minimum size of discharge D2** (From tundish)	**Maximum resistance, expressed as a length of straight pipe**	**Resistance created by each bend or elbow**
G1/2``	15mm	22mm	Up to 9m	0.8m
		28mm	Up to 18m	1m
		35mm	Up to 27m	1.4m
G3/4``	22mm	28mm	Up to 9m	1m
		35mm	Up to 18m	1.4m
		42mm	Up to 27m	1.7m
G1``	28mm	35mm	Up to 9m	1.4
		42mm	Up to 18m	1.7m
		54mm	Up to 27m	2.3m

Example:
Current install, cylinder has G1/2`` exit, 6 bends on D2 route which is 8m long

Two options follow;
D2 -- 22mm
D1 = 15mm -- D2 22mm 6 x 0.8 + 8 = 12.8m incorrect too long for 22mm
D2 – 28mm
D1 = 15mm – D2 28mm 6 x 1 + 8 = 14m correct for 28mm as actual lenght is under 18m





Temperature guidelines

60° daily for 60mins

Showers 43°

Care home 43°

Basin 38 – 41°

Sinks 46 – 48°

Bath 44°

Unvented Cylinder safety temperatures

Thermostat	**60°**
ECO Energy cut off (switches electric off to boiler)	**85°**
Temperature relief valve (Poopet valve)	**95°**

Booster pumps

Pump pressure adjustment

Pressure on/off adjustment switch

Run time

Pump run times

L/m x Run time = flow rate

66l/m x 10 = 660litres

Operating pressures:

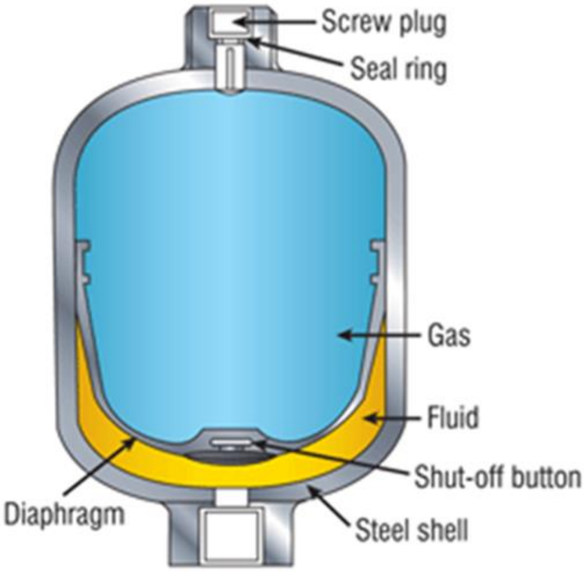
Accumulator operates between P1 and P2

P1 = minimum operating pressure

P2 = maximum operating pressure

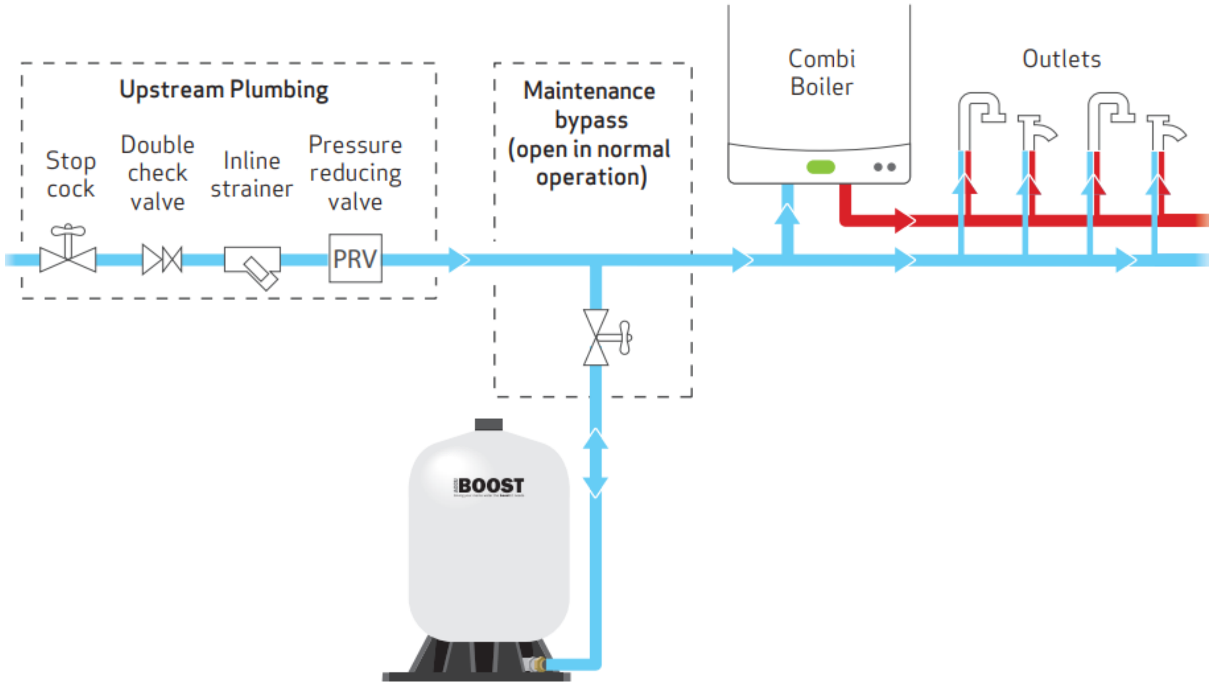
PO = pre-charge pressure (normally 90% of P1)

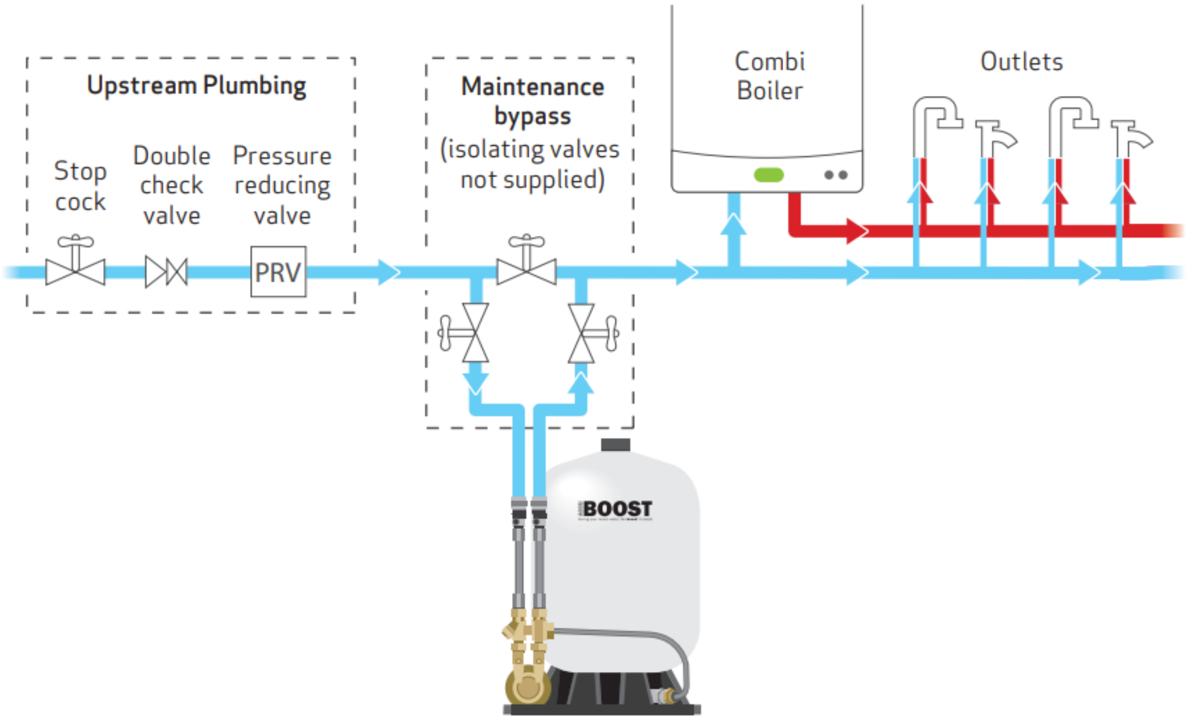
- allows a small amount of water to remain in the vessel at all times
- prevents the bladder collapsing completely during each operating cycle.



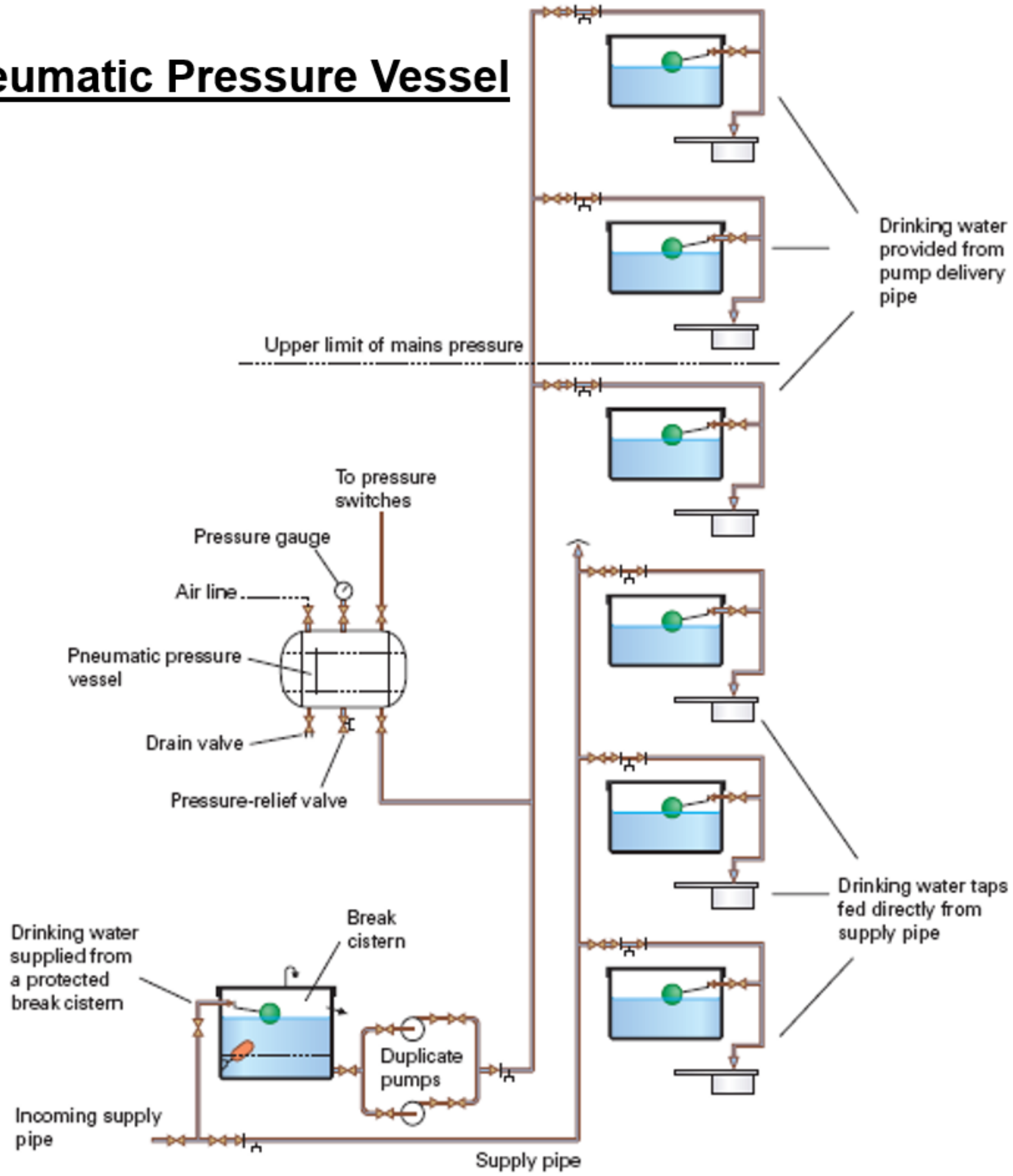
Pre charge in some vessels simulate charging pump

Unpumped


Upstream Plumbing
Stop cock
Double check valve
Inline strainer
Pressure reducing valve
PRV
Maintenance bypass (open in normal operation)
Combi Boiler
Outlets
BOOST


Upstream Plumbing
Stop cock
Double check valve
Pressure reducing valve
PRV
Maintenance bypass (isolating valves not supplied)
Combi Boiler
Outlets
BOOST

Pneumatic Pressure Vessel



Header Pipe System

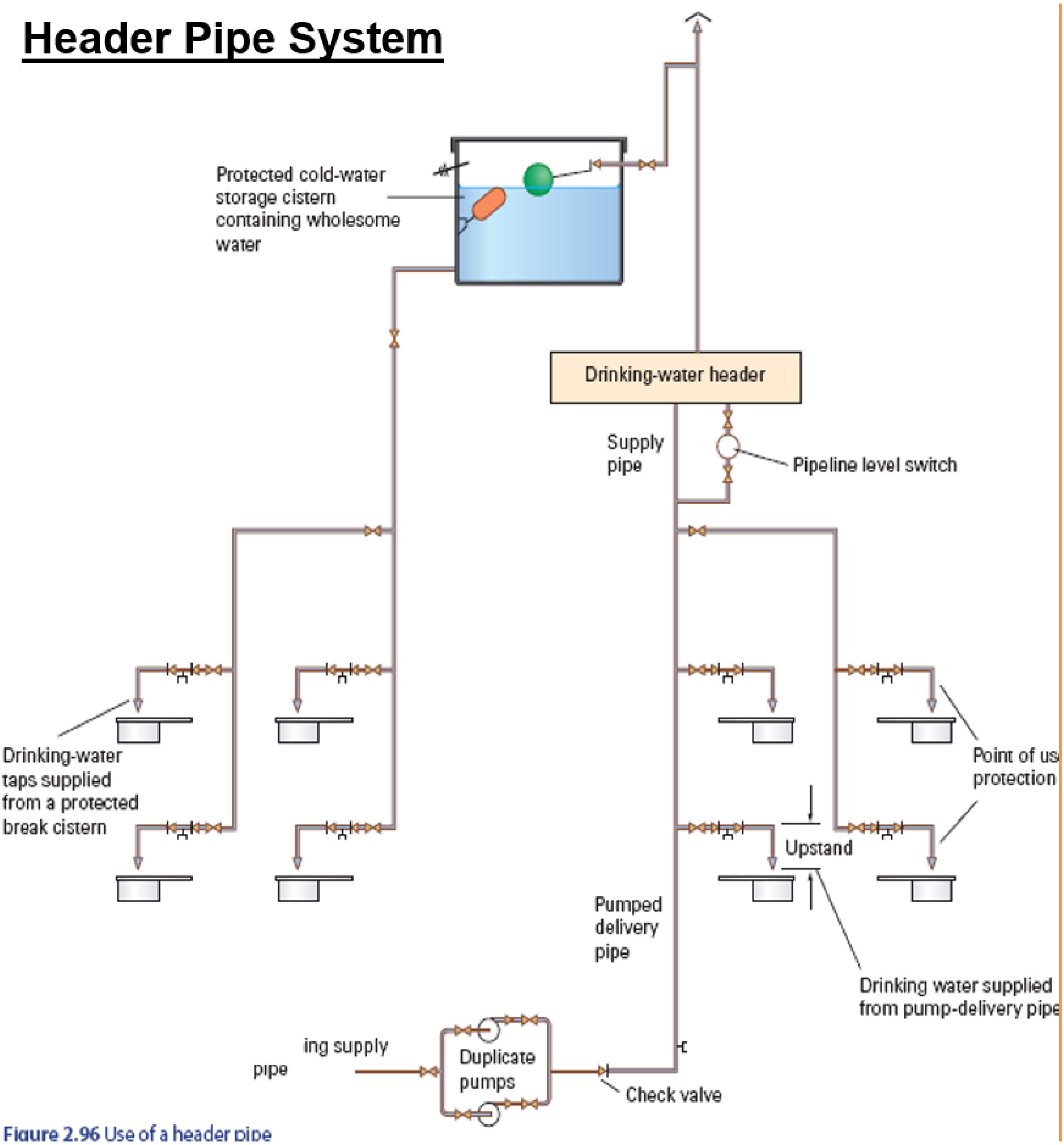


Figure 2.96 Use of a header pipe

Fig 1

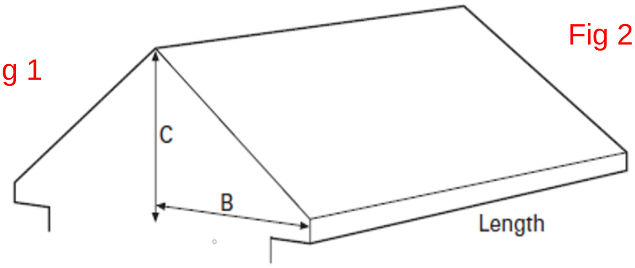


Fig 2

Type of surface		Effective design area
1	Flat roof	plan area of relevant portion
2	Pitched roof at 30° Pitched roof at 45° Pitched roof at 60°	plan area of portion x 1.29 plan area of portion x 1.50 plan area of portion x 1.87
3	Pitched roof over 70° or any wall	elevational area x 0.5

For roofs between 10° and 50° pitch, this can be calculated by using the following formula:

$$\left[\frac{C + B}{2}\right] \times \text{length of roof} = \text{effective roof area in m}^2$$

Gutter sizing

Fig 3

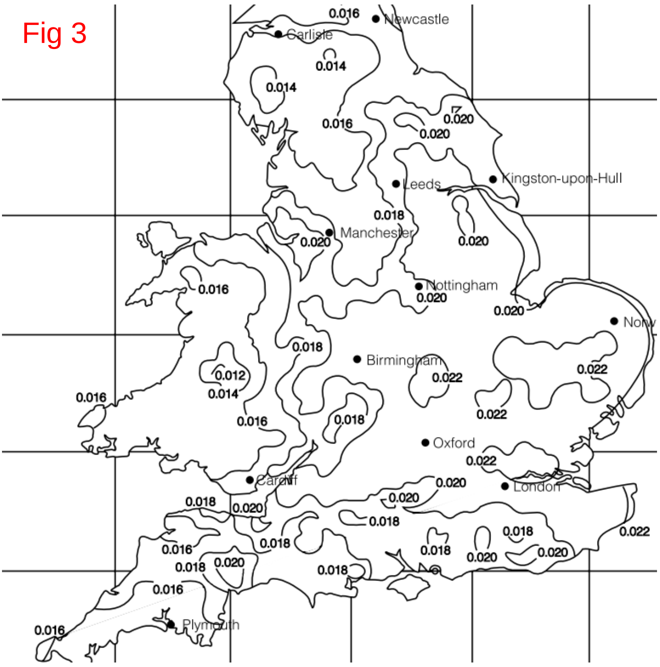


Fig 4

Situation	Risk factor
Eaves gutters	1,0
Eaves gutters where water overflowing would cause particular inconvenience, e.g. over entrances to public buildings	1,5
Non-eaves gutters and in all other circumstances where abnormally heavy rain or blockage in the roof drainage system could cause water to spillover into the building	2,0
For non-eaves gutters in buildings where an exceptional degree of protection is necessary, e.g. - hospital operating theatres - critical communications facilities - storage for substances that give off toxic or flammable fumes when wet - buildings housing outstanding works of art	3,0

Q = Fall (dia 2)
R = Rain fall intensity (dia 3)
C = Risk factor of dwelling (dia 4)
A = area (dia 1)

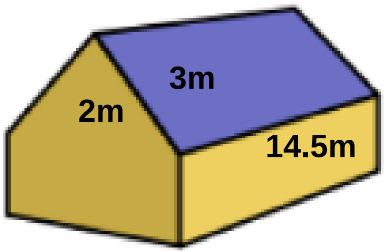
A x Q x R x C =

1+3 x 14.5 x 1.5(fall) = 87

87 x 0.020(rain intensity) = 1.74

1.74 x 1(Risk factor) = 1.74

Location	Nottingham
Pitch	45
Dwelling	House no risk factor



Max. effective roof area (m²)	Gutter size (mm diam.)	Outlet size (mm diam.)	Flow capacity (litres/sec)
6.0	–	–	–
18.0	75	50	0.38
37.0	100	63	0.78
53.0	115	63	1.11
65.0	125	75	1.37
103.0	150	89	2.16

Distance from outlet & stop end.
Gutter depth x 50 =

Distance between outlets.
Gutter depth x 100 =

100m gutter 50mm depth

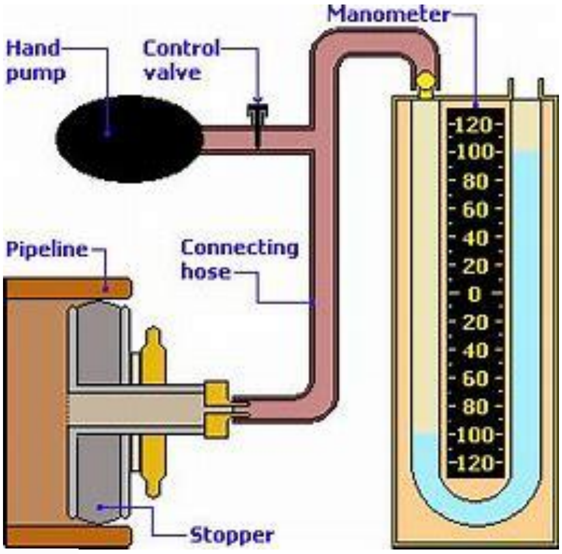
100 x 50 = 5m

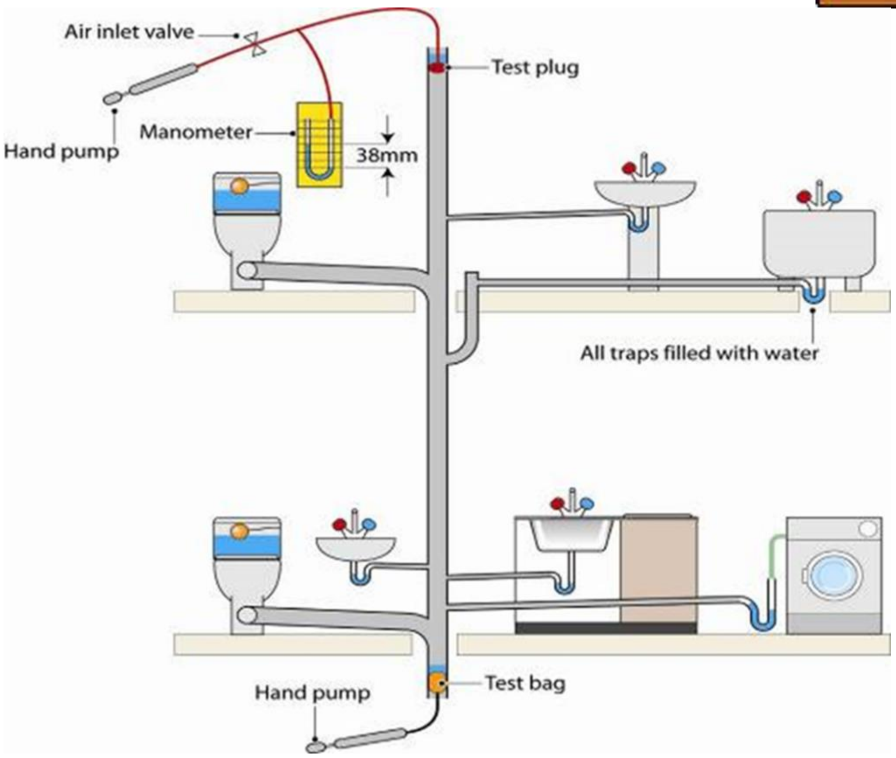
Areas greater than 25m_2 needs a Shoe exit

Ref: Reg H BS 12056

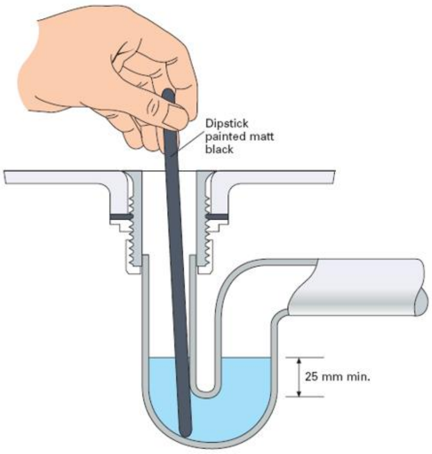
Drainage testing

- Fill trap seals with water
- Bung ventilation pipe with stop
- Using hand pump charge to 38mm
- Should be no drop after 3minutes



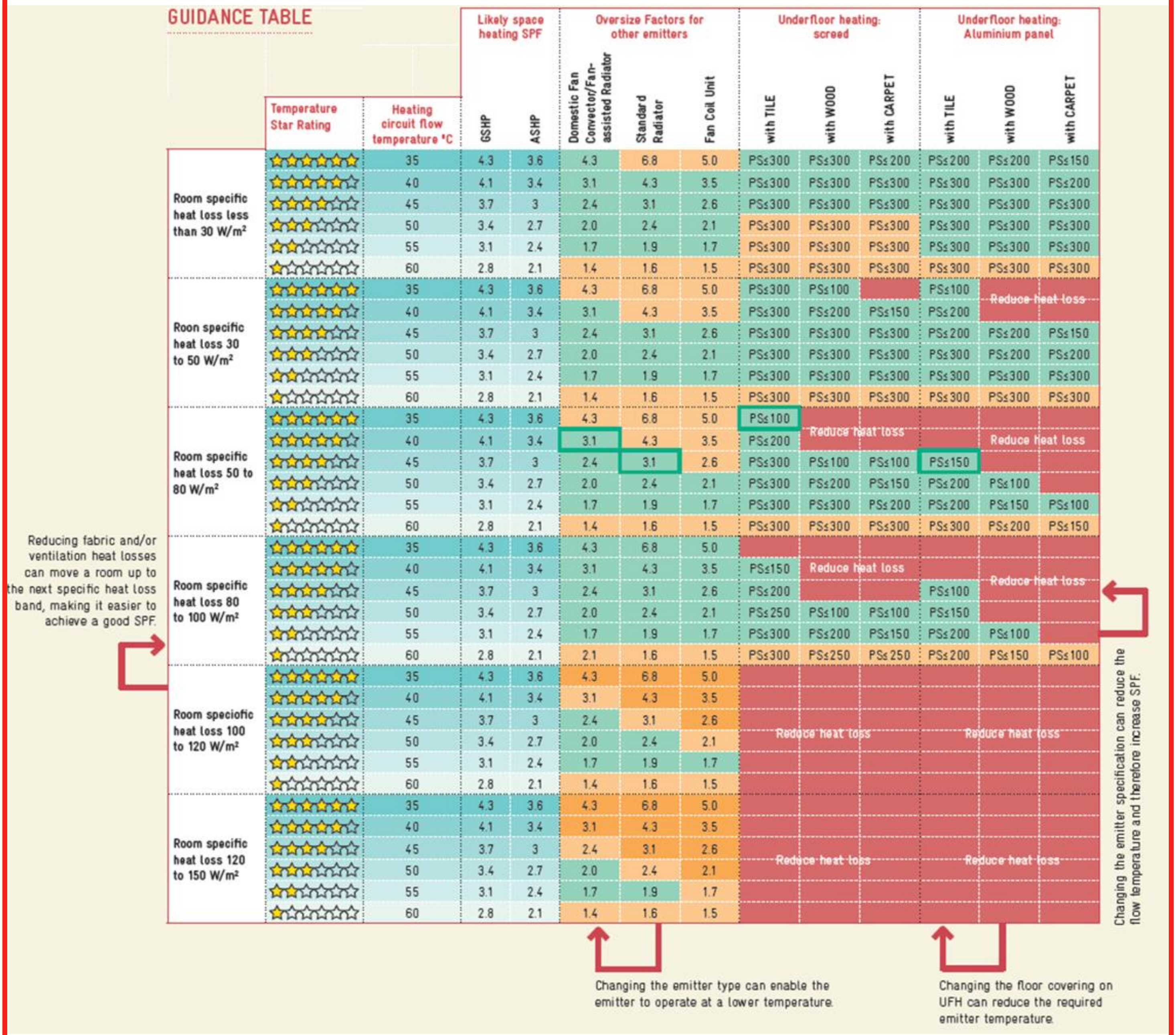


Drainage performance testing



To performance test sanitation, run at least 3 – 4 appliances WC, bath, basin and sink. Once water has drained away, using a dipstick check the trap seals must have at least 25mm water depth, this process should be carried out 3 times

Heat Pump design



GUIDANCE TABLE			Likely space heating SPF		Oversize Factors for other emitters			Underfloor heating: screed			Underfloor heating: Aluminium panel		
	Temperature Star Rating	Heating circuit flow temperature °C	GSHP	ASHP	Domestic Fan Convector/Fan-assisted Radiator	Standard Radiator	Fan Coil Unit	with TILE	with WOOD	with CARPET	with TILE	with WOOD	with CARPET
Room specific heat loss less than 30 W/m^2	★★★★★★	35	4.3	3.6	4.3	6.8	5.0	PS≤300	PS≤300	PS≤200	PS≤200	PS≤200	PS≤150
	★★★★★☆	40	4.1	3.4	3.1	4.3	3.5	PS≤300	PS≤300	PS≤300	PS≤300	PS≤300	PS≤200
	★★★★☆☆	45	3.7	3	2.4	3.1	2.6	PS≤300	PS≤300	PS≤300	PS≤300	PS≤300	PS≤300
	★★★☆☆☆	50	3.4	2.7	2.0	2.4	2.1	PS≤300	PS≤300	PS≤300	PS≤300	PS≤300	PS≤300
	★★☆☆☆☆	55	3.1	2.4	1.7	1.9	1.7	PS≤300	PS≤300	PS≤300	PS≤300	PS≤300	PS≤300
	★☆☆☆☆☆	60	2.8	2.1	1.4	1.6	1.5	PS≤300	PS≤300	PS≤300	PS≤300	PS≤300	PS≤300
Roon specific heat loss 30 to 50 W/m^2	★★★★★★	35	4.3	3.6	4.3	6.8	5.0	PS≤300	PS≤100		PS≤100	Reduce heat loss	
	★★★★★☆	40	4.1	3.4	3.1	4.3	3.5	PS≤300	PS≤200	PS≤150	PS≤200		
	★★★★☆☆	45	3.7	3	2.4	3.1	2.6	PS≤300	PS≤300	PS≤300	PS≤200	PS≤200	PS≤150
	★★★☆☆☆	50	3.4	2.7	2.0	2.4	2.1	PS≤300	PS≤300	PS≤300	PS≤300	PS≤200	PS≤200
	★★☆☆☆☆	55	3.1	2.4	1.7	1.9	1.7	PS≤300	PS≤300	PS≤300	PS≤300	PS≤300	PS≤300
	★☆☆☆☆☆	60	2.8	2.1	1.4	1.6	1.5	PS≤300	PS≤300	PS≤300	PS≤300	PS≤300	PS≤300
Room specific heat loss 50 to 80 W/m^2	★★★★★★	35	4.3	3.6	4.3	6.8	5.0	PS≤100	Reduce heat loss			Reduce heat loss	
	★★★★★☆	40	4.1	3.4	3.1	4.3	3.5	PS≤200					
	★★★★☆☆	45	3.7	3	2.4	3.1	2.6	PS≤300	PS≤100	PS≤100	PS≤150		
	★★★☆☆☆	50	3.4	2.7	2.0	2.4	2.1	PS≤300	PS≤200	PS≤150	PS≤200	PS≤100	
	★★☆☆☆☆	55	3.1	2.4	1.7	1.9	1.7	PS≤300	PS≤300	PS≤200	PS≤200	PS≤150	PS≤100
	★☆☆☆☆☆	60	2.8	2.1	1.4	1.6	1.5	PS≤300	PS≤300	PS≤300	PS≤300	PS≤200	PS≤150
Room specific heat loss 80 to 100 W/m^2	★★★★★★	35	4.3	3.6	4.3	6.8	5.0		Reduce heat loss			Reduce heat loss	
	★★★★★☆	40	4.1	3.4	3.1	4.3	3.5	PS≤150					
	★★★★☆☆	45	3.7	3	2.4	3.1	2.6	PS≤200			PS≤100		
	★★★☆☆☆	50	3.4	2.7	2.0	2.4	2.1	PS≤250	PS≤100	PS≤100	PS≤150		
	★★☆☆☆☆	55	3.1	2.4	1.7	1.9	1.7	PS≤300	PS≤200	PS≤150	PS≤200	PS≤100	
	★☆☆☆☆☆	60	2.8	2.1	2.1	1.6	1.5	PS≤300	PS≤250	PS≤250	PS≤200	PS≤150	PS≤100
Room speciofic heat loss 100 to 120 W/m^2	★★★★★★	35	4.3	3.6	4.3	6.8	5.0		Reduce heat loss			Reduce heat loss	
	★★★★★☆	40	4.1	3.4	3.1	4.3	3.5						
	★★★★☆☆	45	3.7	3	2.4	3.1	2.6						
	★★★☆☆☆	50	3.4	2.7	2.0	2.4	2.1						
	★★☆☆☆☆	55	3.1	2.4	1.7	1.9	1.7						
	★☆☆☆☆☆	60	2.8	2.1	1.4	1.6	1.5						
Room specific heat loss 120 to 150 W/m^2	★★★★★★	35	4.3	3.6	4.3	6.8	5.0		Reduce heat loss			Reduce heat loss	
	★★★★★☆	40	4.1	3.4	3.1	4.3	3.5						
	★★★★☆☆	45	3.7	3	2.4	3.1	2.6						
	★★★☆☆☆	50	3.4	2.7	2.0	2.4	2.1						
	★★☆☆☆☆	55	3.1	2.4	1.7	1.9	1.7						
	★☆☆☆☆☆	60	2.8	2.1	1.4	1.6	1.5						

Reducing fabric and/or ventilation heat losses can move a room up to the next specific heat loss band, making it easier to achieve a good SPF.

Changing the emitter specification can reduce the flow temperature and therefore increase SPF.

Changing the emitter type can enable the emitter to operate at a lower temperature.

Changing the floor covering on UFH can reduce the required emitter temperature.

Buffer Sizing

$$V = \frac{Q \times t \times 60}{4.18 \times DT}$$

i.e

$$\frac{5 \times 15 \times 60}{4.18 \times 5}$$

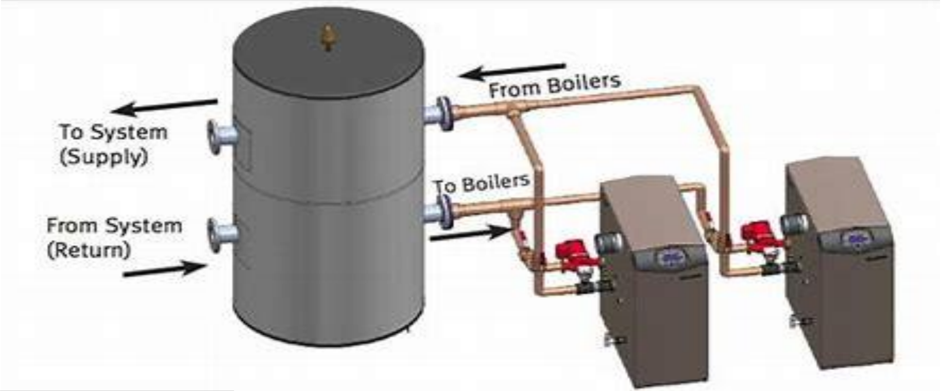
V = tank volume

Q = heat load *(5kw)*

DT = Delta T *(rads 10° / Udfr 5°)*

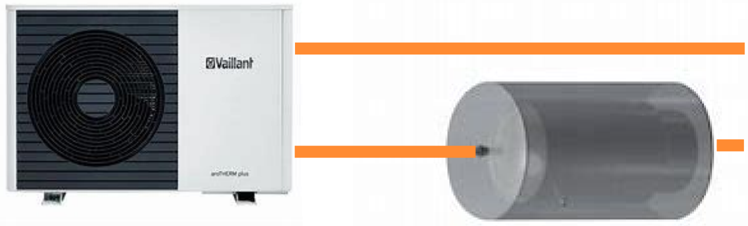
60 = 60 seconds

T = HP compressor starts in hour



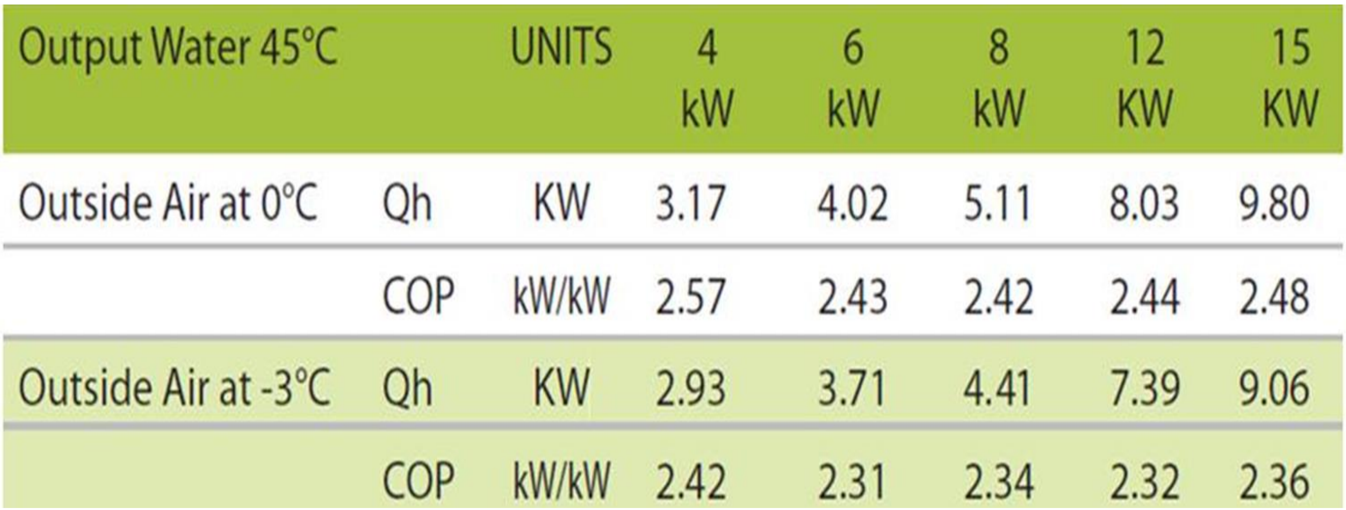
Sizing Volumizers

Volumisers are installed to prevent systems freezing, should the primary pipework be lower than 20l then a volumiser should be installed



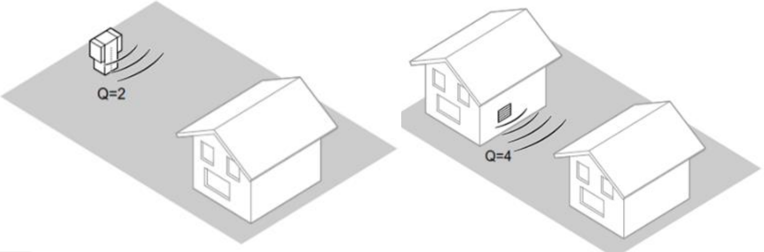
0.14l	15mm copper
0.31l	22mm copper
0.5l	28mm copper
600 x 1000 rad	6l

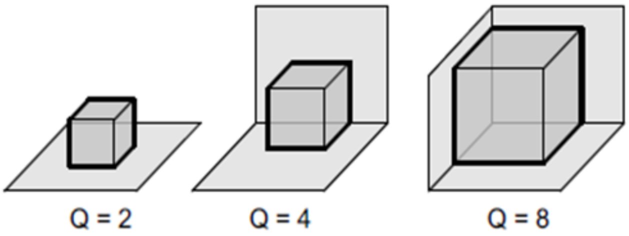
Heat pump performances with outside temperatures



Output Water 45°C		UNITS	4 kW	6 kW	8 kW	12 KW	15 KW
Outside Air at 0°C	Qh	KW	3.17	4.02	5.11	8.03	9.80
	COP	kW/kW	2.57	2.43	2.42	2.44	2.48
Outside Air at -3°C	Qh	KW	2.93	3.71	4.41	7.39	9.06
	COP	kW/kW	2.42	2.31	2.34	2.32	2.36

Heat Pump location





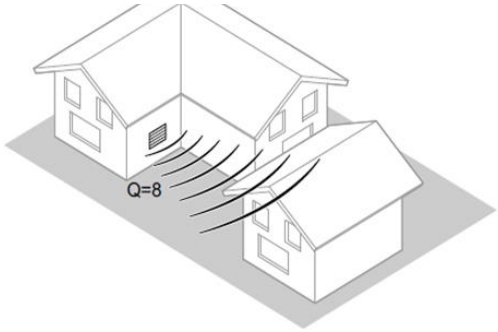


Table 1:

Q rating	4	5	6	8	10	12	15	20	25
2	-20	-21	-23	-26	-28	-29	-31	-34	-36
4	-17	-19	-20	-23	-25	-26	-28	-31	-33
8	-14	-16	-17	-20	-22	-23	-25	-28	-30

Table 2:

Restriction	db reduction
Solid barrier between assessment position	-10
Move HP 25cm to be seen from assessment position	-5

Table 3:

Difference between two noise levels	Correction factor
5	**1.2**
6	**1**
7	**0.8**
8	**0.6**

Scenario; ASHP installed against wall, manufacturers data states 55db, this install is partially covered with wall and the assessment position is 4metres away

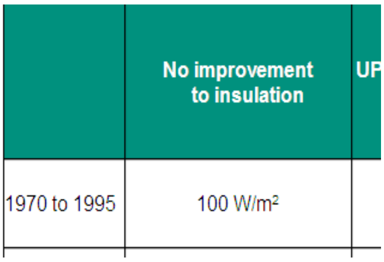
Description	Result
1 Manufacturers db	55db
2 Installed against single wall	Q4
3 Distance from wall	4m
4 Db reduction 4m @Q4 (table 1)	-17
5 Brick wall between assessment (table 2)	-5
5 55 + -17 + -5 =	33db
6 MCS approval guide (table 3) 40 – 33 = 7	0.8
7 Final 40 + 0.8 =	41
8 figure is below 42	Permitted

Heat Pump Sizing

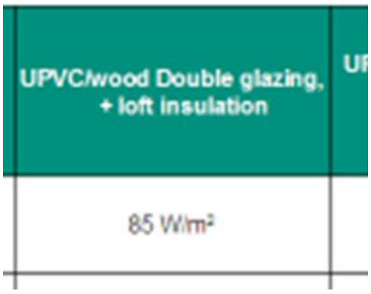
Dwelling 1970 no improvements

	No improvement to insulation	UPVC/wood Double glazing, + loft insulation	UPVC/wood Double glazing, + loft & cavity wall insulation
1970 to 1995	100 W/m²	85 W/m²	70 W/m²
1996 to 2005	80 W/m²	70 W/m²	60 W/m²
2006 to 2010	50 W/m²	50 W/m²	50 W/m²
New build	40 W/m²	40 W/m²	40 W/m²

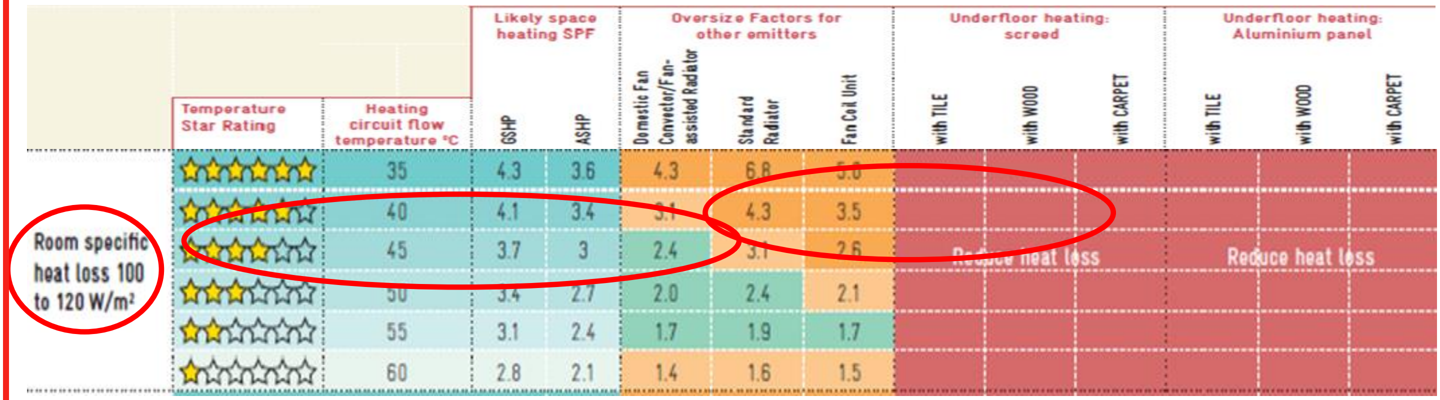
Ground floor 45m² + f/floor 45m² = 90m²
90 x 100 = 9Kw
After adding improvements
Loft insulation & glazing
90 x 85 = 7.65Kw



	No improvement to insulation
1970 to 1995	100 W/m²



UPVC/wood Double glazing, + loft insulation
85 W/m²



Room specific heat loss 100 to 120 W/m²

		Likely space heating SPF		Oversize Factors for other emitters			Underfloor heating: screed			Underfloor heating: Aluminium panel		
Temperature Star Rating	Heating circuit flow temperature °C	GSHP	ASHP	Domestic Fan Convector/Fan-assisted Radiator	Standard Radiator	Fan Coil Unit	with TILE	with WOOD	with CARPET	with TILE	with WOOD	with CARPET
★★★★★★	35	4.3	3.6	4.3	6.8	5.0	Reduce heat loss			Reduce heat loss		
★★★★★☆	40	4.1	3.4	3.1	4.3	3.5						
★★★★☆☆	45	3.7	3	2.4	3.1	2.6						
★★★☆☆☆	50	3.4	2.7	2.0	2.4	2.1						
★★☆☆☆☆	55	3.1	2.4	1.7	1.9	1.7						
★☆☆☆☆☆	60	2.8	2.1	1.4	1.6	1.5						

Scenario
Bungalow with 90m² floor area, dwelling heat loss of 10500kw 1980 built located in Humberside.
Heating system 35 ℃ under floor heating system incorporating HPC cylinder

$$\frac{10500}{90} = 117\text{w/m}^2 \text{ heat loss}$$

Solar sizing

Sap Calculation methods

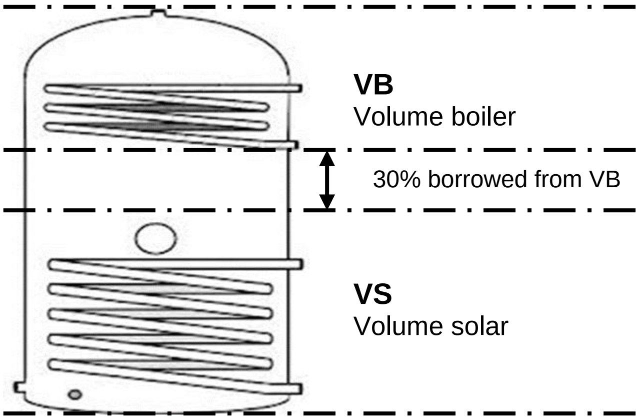
Below table is for new build properties where number of people is unknown

For example 120m^2 TFA equals 111litres VD

The solar VS must be able to hold 80% of the VD

110 x 0.8 = 88.8

88.8litres is lower than the VS volume of 105litres so therefore the cylinder is correct



BSRIA method

46 + (26 x number of occupants)

For example 3 people

46 + 78 = 124

124 x 0.8 = 99.2

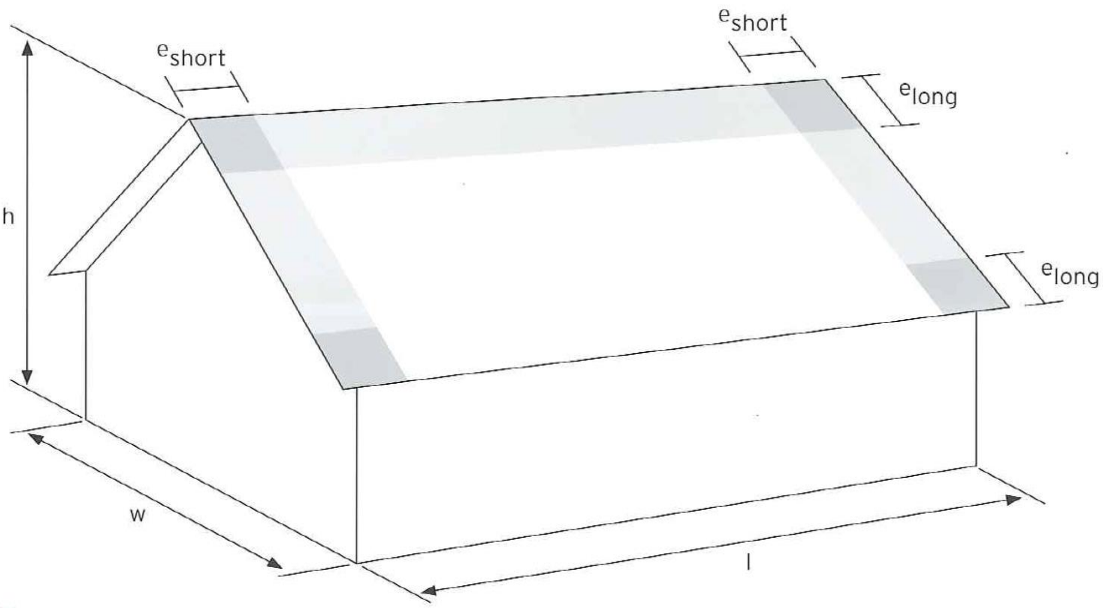
99.2 VS

Total Floor area TFA (m2)	Assumed Occupancy	Hot water demand (litre/day)
40	1.4	72
80	2.5	100
120	3.0	111
200	3.2	116
300	3.4	121
400	3.6	127

Solar panel sizing

50 litres per panel
South facing
30°
Purge for 30mins remove air

Fact



Key:

w. Building width
h. Building height
l. Building length

Calculate the building width w, building height h and building length l.

The values for the edge clearances to be observed, ^{e}short and ^{e}long can be found in the following tables.

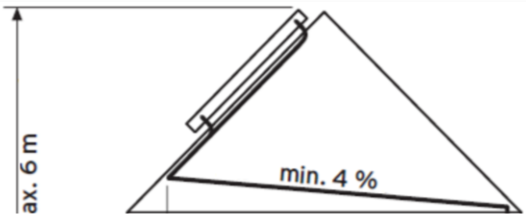
	w (m)	Building height h (m)										
		5	6	7	8	9	10	11	12	13	14	15
Building width w (m)	8	1.0										
	9	1.0										
	10	1.0										
	11	1.0	1.1									
	12	1.0	1.2									
	13	1.0	1.2	1.3								
	14	1.0	1.2	1.4								
	15	1.0	1.2	1.4	1.5							
	16	1.0	1.2	1.4	1.6							
	17	1.0	1.2	1.4	1.6	1.7						
	18	1.0	1.2	1.4	1.6	1.8						

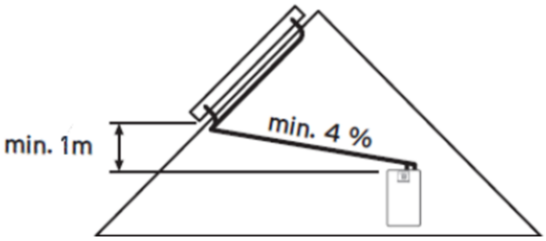
Edge clearances: ^{e}short (m)

	l (m)	Building height h (m)										
		5	6	7	8	9	10	11	12	13	14	15
Building length l (m)	10	1.0										
	11	1.0	1.1									
	12	1.0	1.2									
	13	1.0	1.2	1.3								
	14	1.0	1.2	1.4								
	15	1.0	1.2	1.4	1.5							
	16	1.0	1.2	1.4	1.6							
	17	1.0	1.2	1.4	1.6	1.7						
	18	1.0	1.2	1.4	1.6	1.8						
	19	1.0	1.2	1.4	1.6	1.8	1.9					
	20	1.0	1.2	1.4	1.6	1.8	2.0					

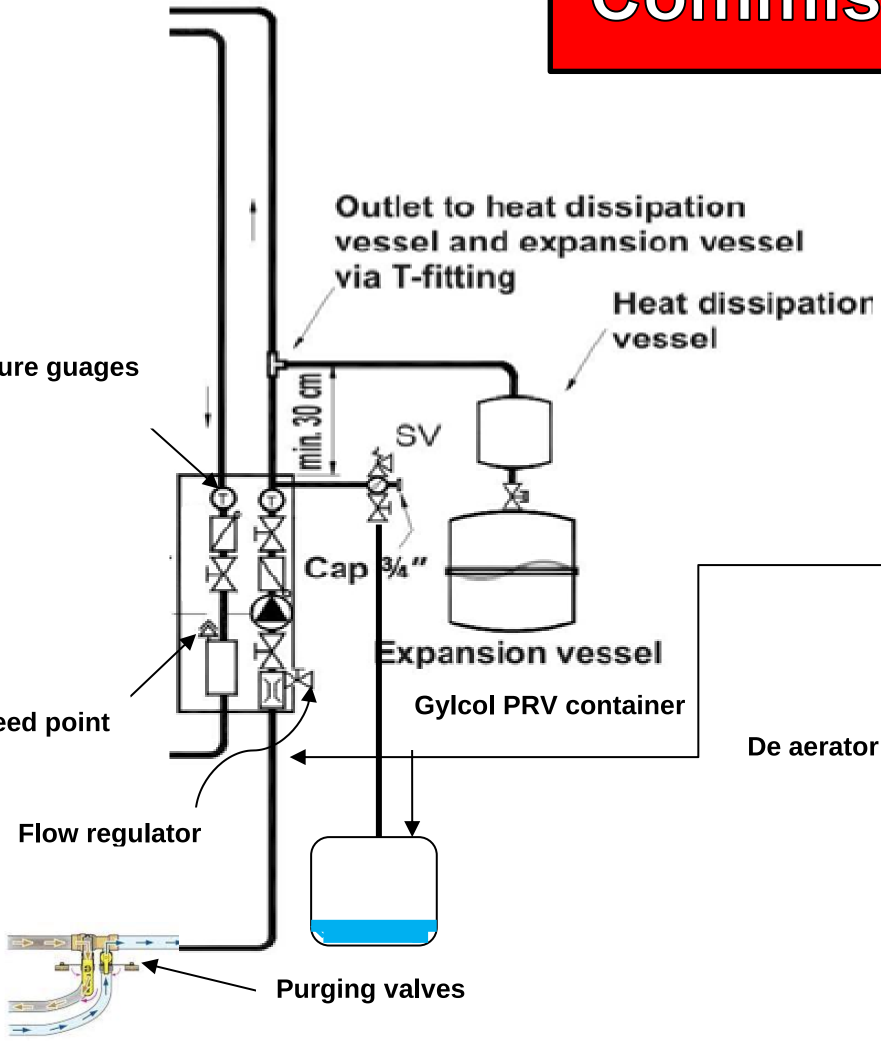
Edge clearances: ^{e}long (m)

NTC black / external - Grey / Internal
Pump installed on the return
Insulation must be 150°
Coil hex should be 10% of collector
No PTFE, No solder, No plastic, Metal clips only, Brass olives
Higher than 4m planning needed
5m from boundary
Rafters at least 50mm
Trac pipe 10m max 4cm fall





Solar Commissioning




De aerator to remove air bubbles on return

Servicing

Comissioning	min	max
Flow rate	2l/m	3l/m
Ph levels	7	9
Refractometer	-16	-26
Sanitise	30mins	retest
Flush	30mins	Assess no air bubbles
Pressure	2bar	6bar

How to calculate flow rates for solar

$$\frac{Kw \times T}{SHC \times TD}$$

Kw amount of energy collector can absorb,
Time 1sec
SHC fluid gycol 3.9
Temperature difference 6

Sizing
air conditioning units

Calculating air conditiioning required to meet demands,

allow 0.15 per Kw

elements to consider;

- Deduct by 10% if room in shaded area
- Add 10% if in high sun light exposure
- If oven in room incase by 1.15Kw
- If more than 2 individuals add 0.18kw pp
-

(Floor width x Floor length) x 0.15 =

Example room 5.5m by 7.5m, 20 people inside

5.5 x 7.5 = 41.25
41.25 x 0.15 = 6.19
20 – 2 = 18
18 x 0.18 = 3.24
9.42 Kw

Temperature Conversion

Celsius to Kelvin

Celsius Kelvin

+ 273

Conversation for Fahrenheit

Celsius Fahrenheit

(°c x 1.8) + 32 =

Fahrenheit Celsius

F -32 ÷ 1.8 =

Boyes Law

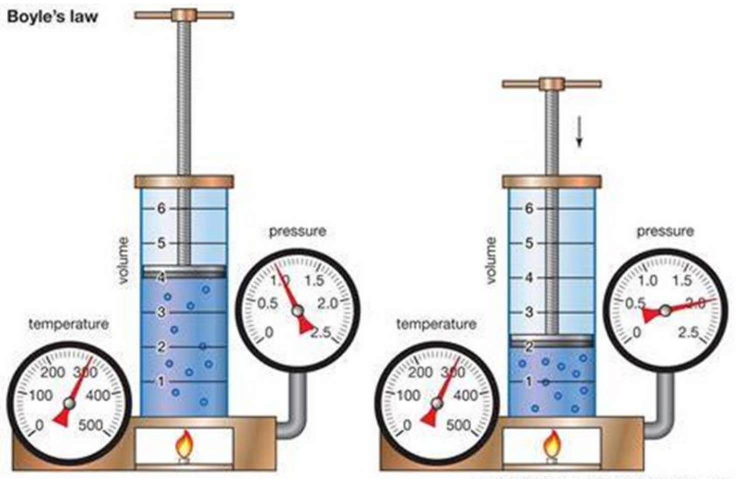
Example

Tyre pressure is 11.41l @44psi,

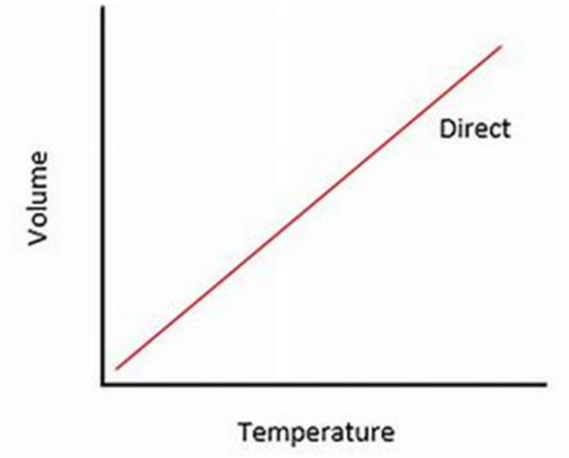
What will the pressure be at 10.66l?

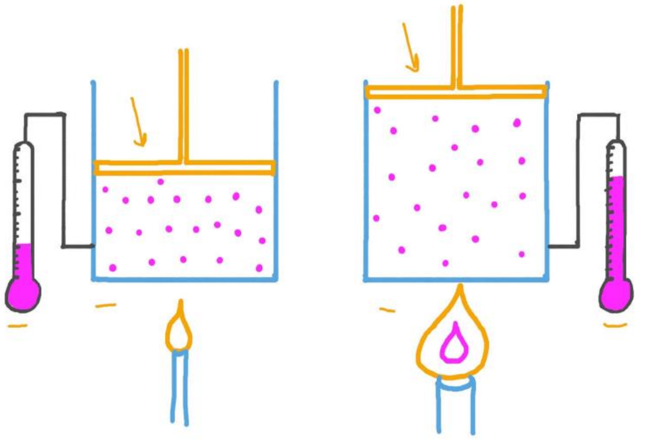
P1 x V2 ÷ V1 = P2

$$\frac{44 \times 11.41}{10.6} = 47.36$$



CHARLES' LAW





Example

275ml @ 25°c what will be the volume at 50°c

Always concert to Kelvin

25 + 273 = 298
50 + 273 = 323

275 = ??? = 88.825 divide by lower T1 for new V1 = 298
298 Multiply 323

Example

A vessel is 250k in temperature with volume of 3.5l, when the vessel temperature is increased to 400k what will be the new volume?

$$\frac{V1}{T1} = \frac{V2}{T2} \qquad \frac{3.5}{250} \overset{x}{=} \frac{?}{400} = 3.5 \times 400 = 1400$$

Ans: 1400 ÷ 250 = 5,6

Chillers

Calculate the amount of heat that must be removed from 500 kg of poultry that is to be stored at -18°C if it is to enter the refrigerated space at 7°c.

Specific heat of poultry before freezing = 3.18 kj/kg K
Specific heat of poultry after freezing = 1.55 kj/kg K
Latent heat of fusion (hfg) = 246 kj/kg
Freezing temperature of poultry = -2.75°c

QT = hSB+ hSA + hL

Where:- QT = Total heat.
hSB = sensible heat before freezing
hSA = sensible heat after freezing
hL = Latent heat

QSB = sensible heat before freezing
QSB = m x sp.ht x td
QSB = 500 x 3.18 x (7 – (-2.75))
QSB = 5L00 x 3.18 x 9.75
QSB = kg x kj/kg K x K
QSB = 500 X 3.18 X 9.75 = 15502.5 kj

QSA = sensible heat after freezing (sensible heat is adding heat)
QSA = m x sp. ht. x td
QSA = 500 x 1.55 x (-2.75(-18))
QSA = 500 x 1.55 x 15.25
QSA = kg x kj/kg K x K
QSA = 500 x 1.55 x 15.25 = 11818,75 kj

QL = Latent heat after freezing (heat that doesnt change)
QL = m x hfg
QL = kg x kj/kg
QL = 500 X 246 = 123000 kj

QT = QSB + QSA + QLT =

QT = 15502.5 + 11818.75 + 123000 = 150321.25 kj

Air conditioning

Solar gain = radiation

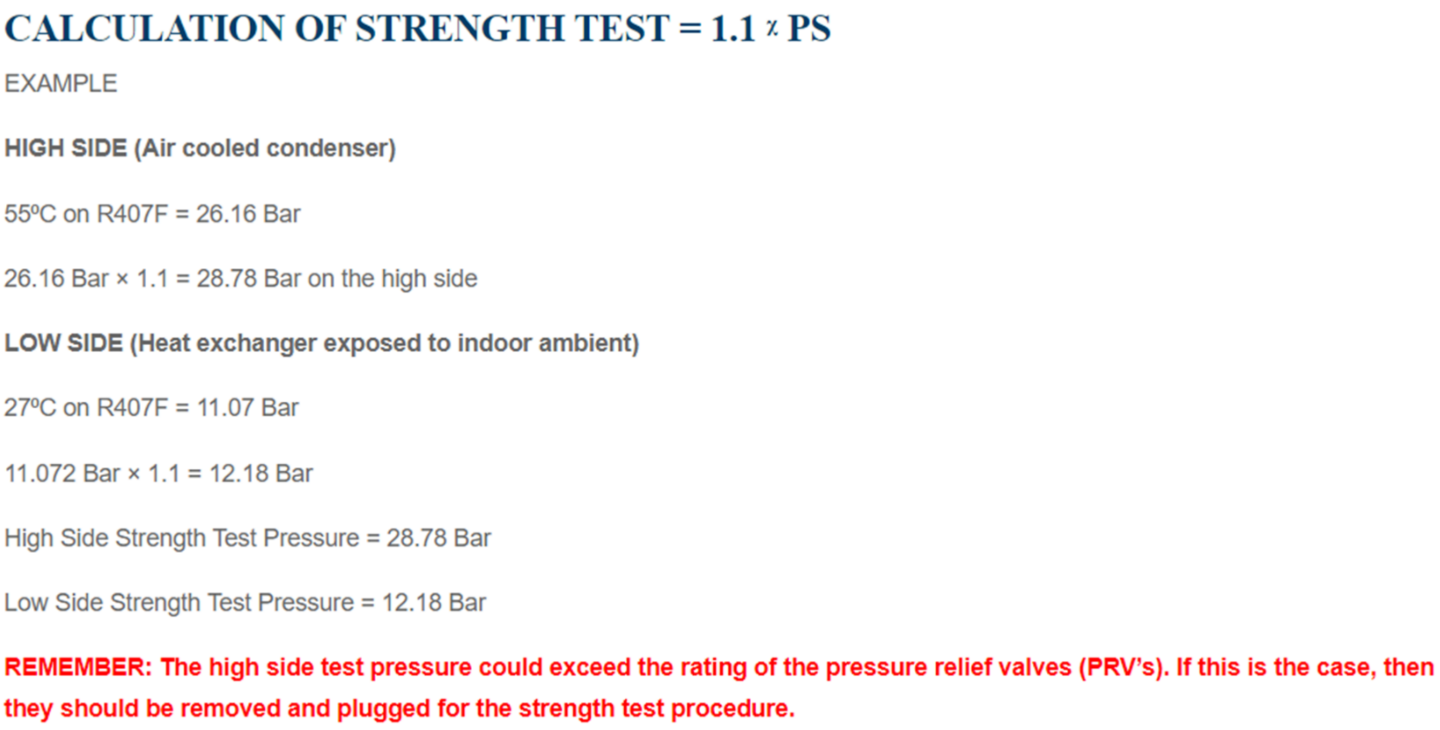
Heat gain = room generated

Heat gain (w) = (Area m_2) x (U valve W/m_2 K) x (Sat – Int temp)

Testing

- *All testing should confirm with BSEN 378*
- *New or old system*
- *Refrigeration type*
- *New systems x 1.43*
- *Old systems x 1.1*
- *LP temperature 320*
- *HP temperature 550 (water cooled 430)*
- *If needed remove drier*
- *Nitrogen can cause suffocation*

Existing (c)	New (c)	Side
1.1 x 55	1.43 x 55	HP
1.1 x 32	1.43 x 32	LP
1.1 x 32	1.43 x 43	Water cooled



CALCULATION OF STRENGTH TEST = 1.1 x PS

EXAMPLE

HIGH SIDE (Air cooled condenser)

55ºC on R407F = 26.16 Bar

26.16 Bar × 1.1 = 28.78 Bar on the high side

LOW SIDE (Heat exchanger exposed to indoor ambient)

27ºC on R407F = 11.07 Bar

11.072 Bar × 1.1 = 12.18 Bar

High Side Strength Test Pressure = 28.78 Bar

Low Side Strength Test Pressure = 12.18 Bar

REMEMBER: The high side test pressure could exceed the rating of the pressure relief valves (PRV's). If this is the case, then they should be removed and plugged for the strength test procedure.

Leak Check Report

Site Name and address			Date	
			Leak checked by	
			Company Name	
Location of plant			Equipment Model	
Refrigerant Type		Single / Blend	Refrigerant Qty (kg)	

Condenser

Calculated Discharge Pressure (bar)	
Calculated Discharge Temperature (°c) (using pressure readings)	

Discharge Pressure (bar)	Condensing Temperature (°c)	Liquid Line Temperature (°c)	Air On Temperature	Air Off Temperature
Temperature Difference				

Evaporator

Calculated Suction Pressure (bar)	
Calculated Suction Temperature (°c) (using pressure readings)	

Suction Pressure (bar)	Evaporating Temperature (°c)	Suction Line Temperature (°c)	Air On Temperature (°c)	Air Off Temperature (°c)
Temperature Difference				

	Safety group	
Higher Flammability	A3	B3
Lower Flammability	A2 A2L*	B2 B2L*
No flame Propagation	A1	B1
	Lower Toxicity	Higher Toxicity

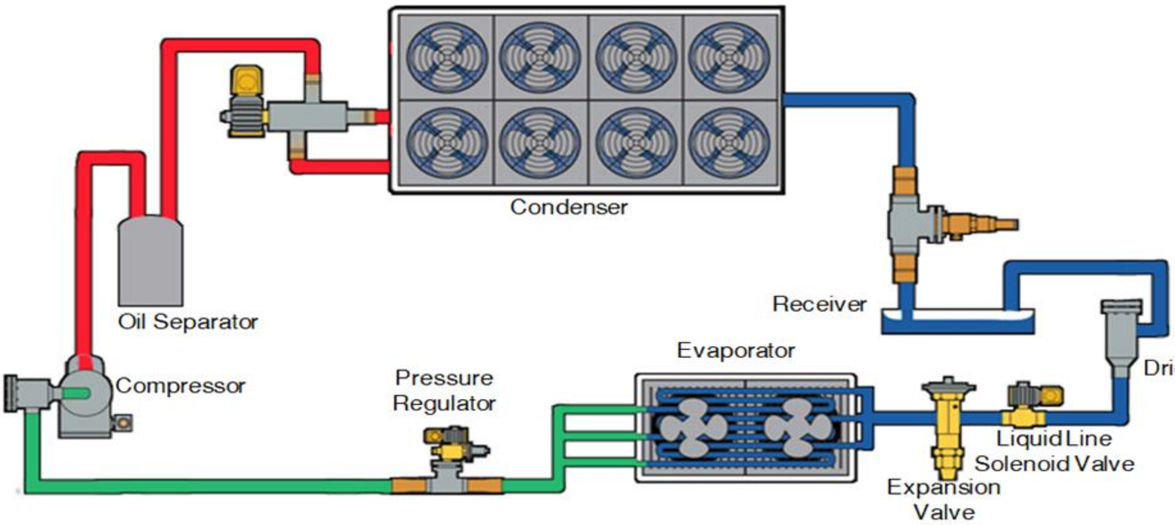
*A2L and B2L are lower flammability refrigerants with a maximum burning velocity of ≤ 10 cm/s

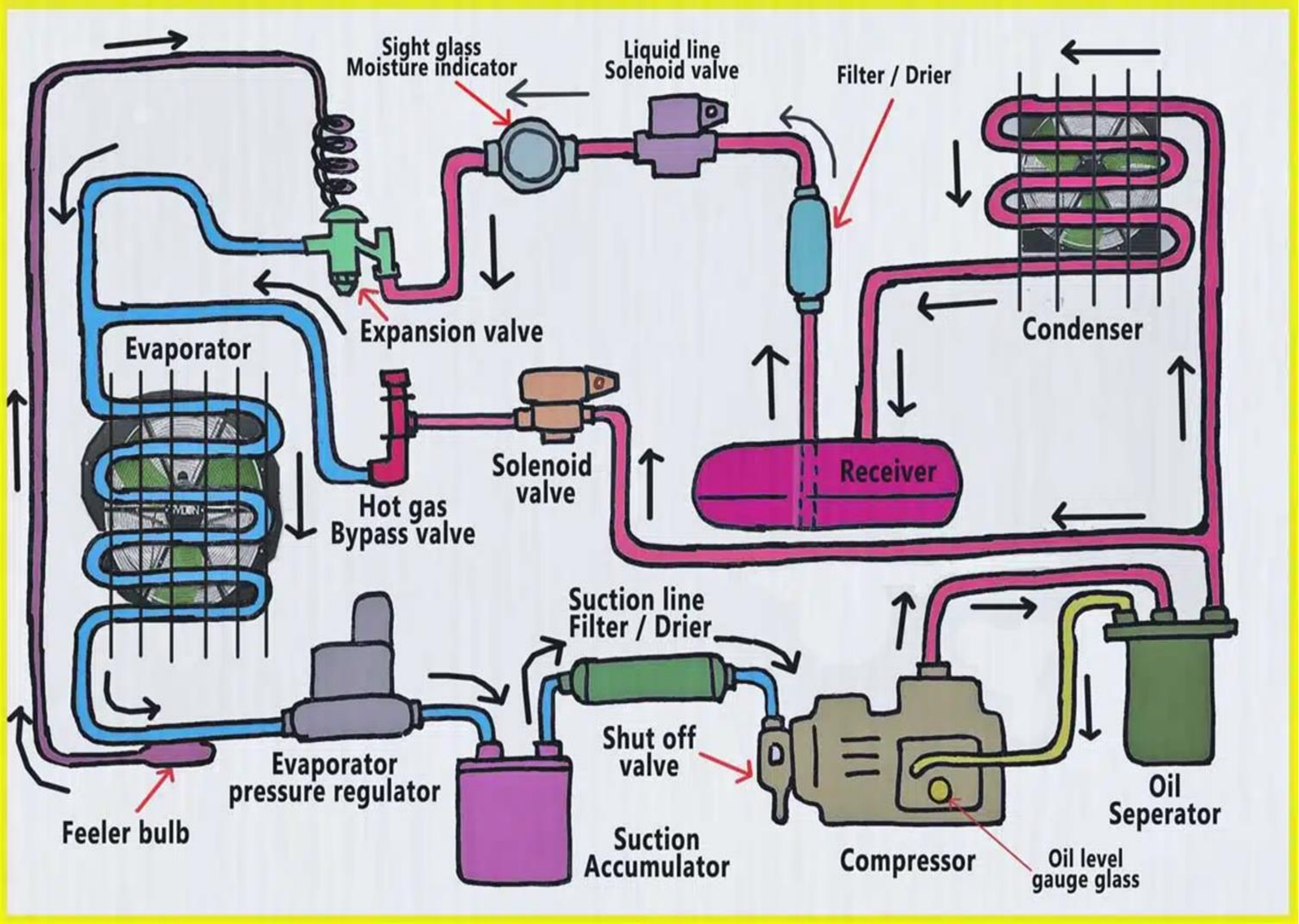
Refrigerants Safety Data

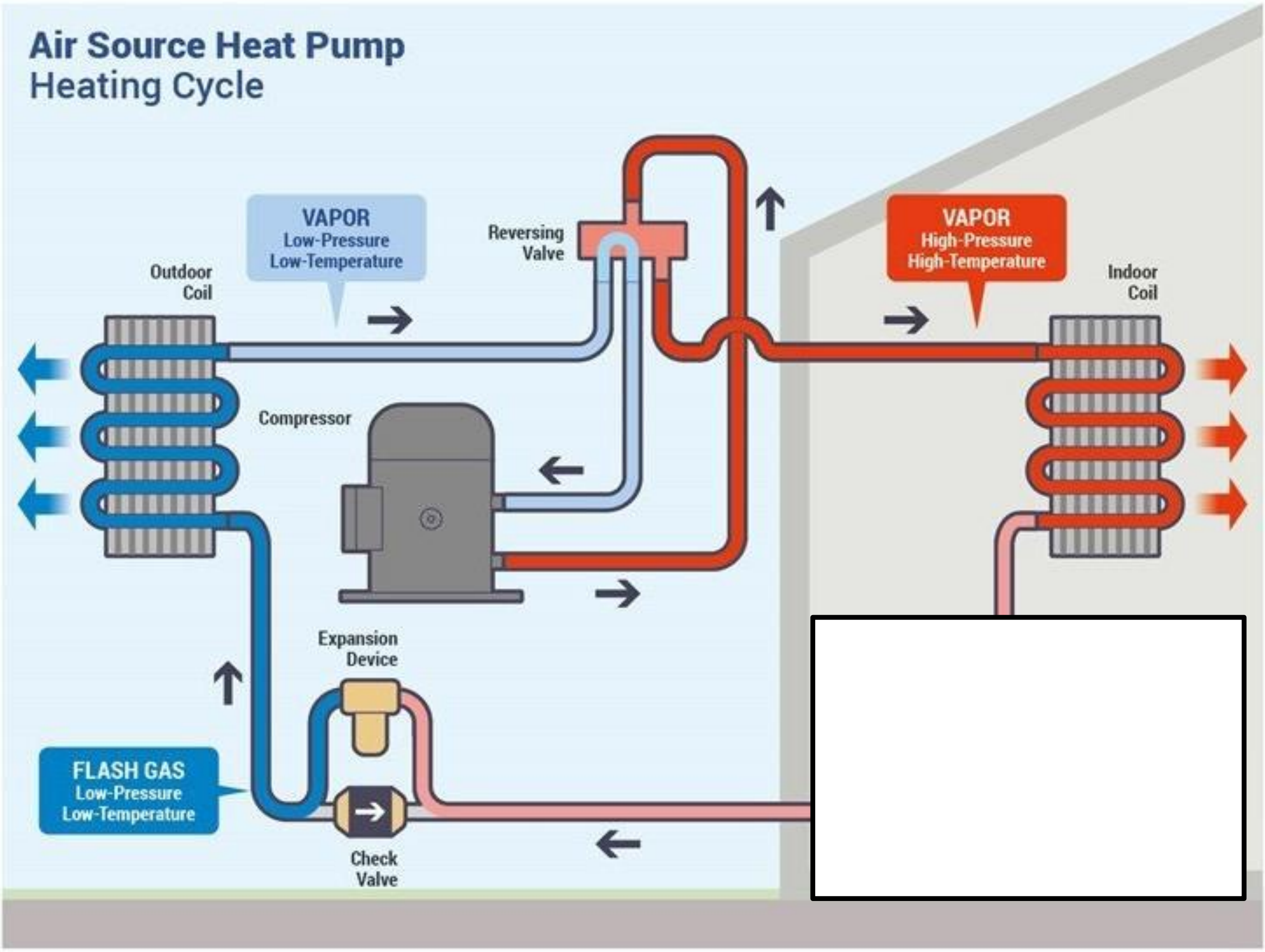
Products and equipment	**Minimum Frequency**
Hermetic System with GWP< 10 of CO2	Not Required
System with GWP = 5 TONES of CO2	Once every 12 months
System with GWP = 50 TONES of CO2	Twice every 12 month
System with GWP = 500 TONES of CO2	Four Times every 12 month
◦ Leak Testing	
System Below 3 kg Semi Hermetic and 6 kg Hermetic (If labelled correctly) do not require leakage testing under this article until 1/1/2017	

Products and equipment	**Minimum Frequency**
System with GWP = 5 TONES of CO2	Once every 24 months
System with GWP = 50 TONES of CO2	Once every 12 months
System with GWP = 500 TONES of CO2	Once every 6 months
◦ Leak Testing with leak detection system installed	
Operators of the equipment containing fluorinated greenhouse gases in quantities of 500 tonnes of CO2 equivalent or more, shall ensure that the equipment is provided with a leakage detection system which alerts the operator or a service company of any leakage. Leak Check Minimum Mass of Refrigerant	

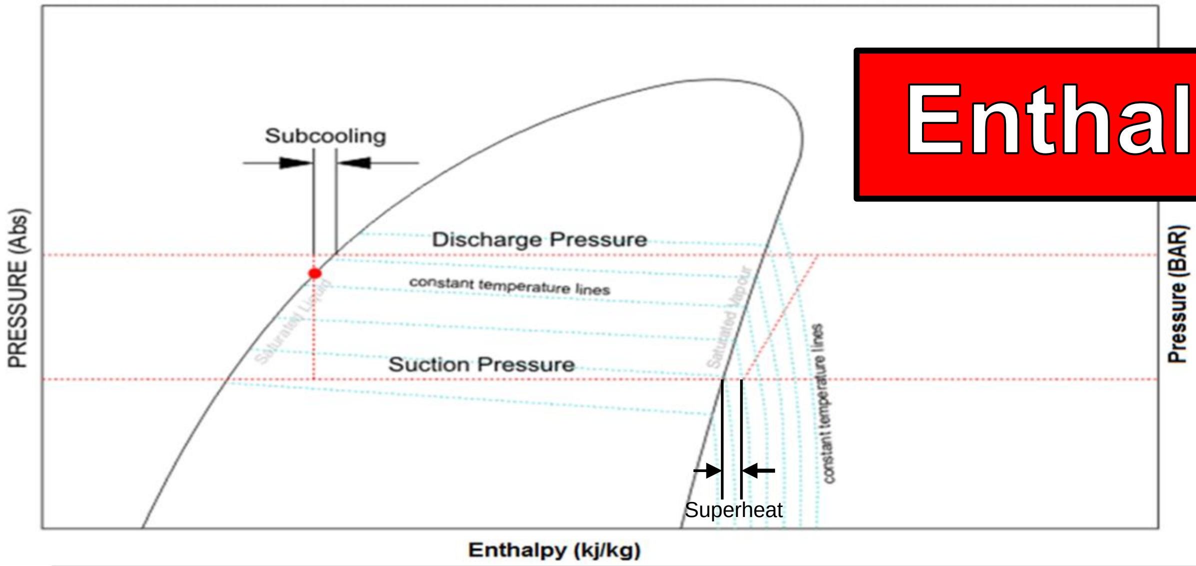
A REFRIGERATION CIRCUIT

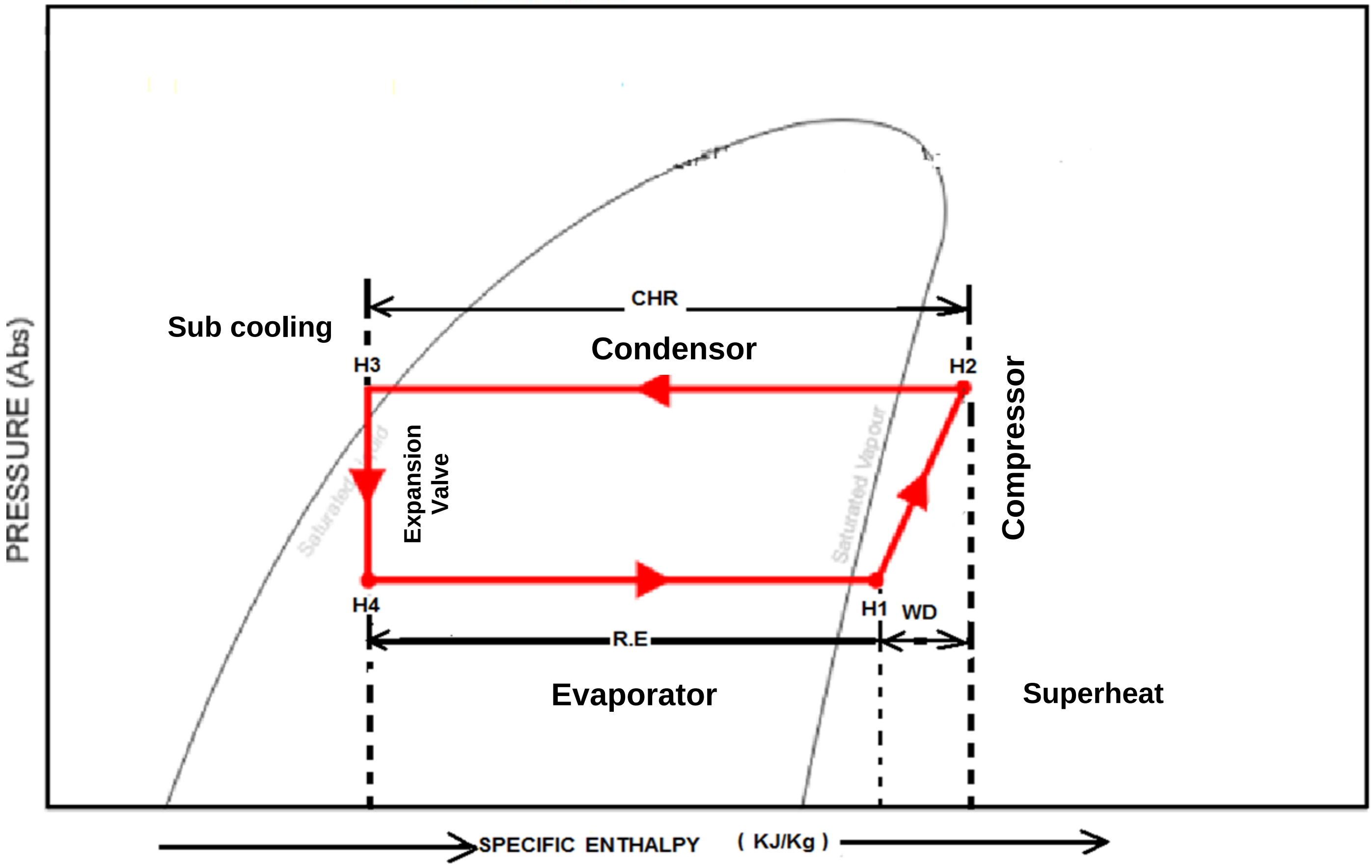


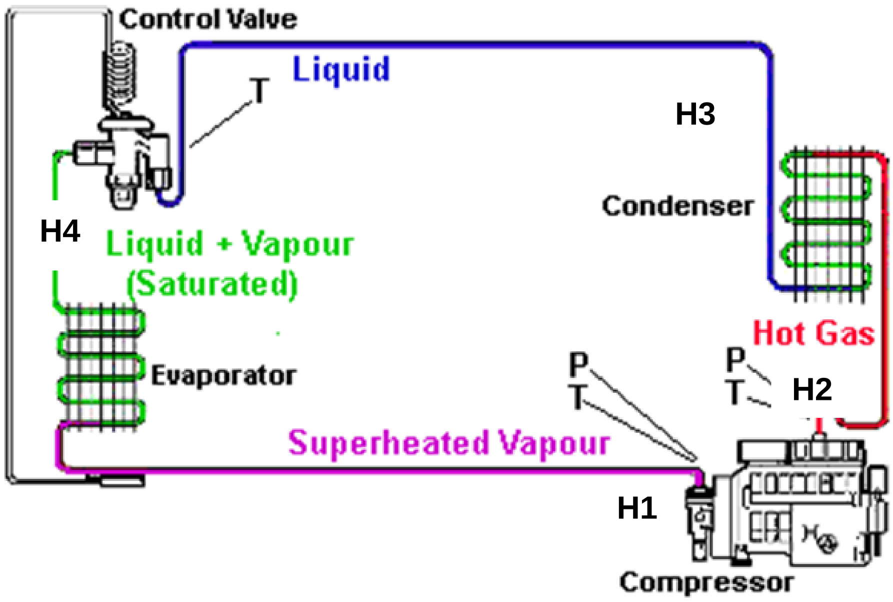



Air Source Heat Pump
Heating Cycle
VAPOR
Low-Pressure
Low-Temperature
Reversing
Valve
VAPOR
High-Pressure
High-Temperature
Outdoor
Coil
Indoor
Coil
Compressor
Expansion
Device
FLASH GAS
Low-Pressure
Low-Temperature
Check
Valve

Enthalpy


Subcooling
Discharge Pressure
constant temperature lines
Saturated Liquid
Saturated Vapour
Suction Pressure
constant temperature lines
Superheat
PRESSURE (Abs)
Pressure (BAR)
Enthalpy (kj/kg)


CHR
Sub cooling
Condensor
H3
H2
Compressor
Expansion Valve
Saturated Liquid
Saturated Vapour
H4
H1
WD
R.E
Evaporator
Superheat
PRESSURE (Abs)
SPECIFIC ENTHALPY (KJ/Kg)


Control Valve
Liquid
T
H3
Condenser
H4
Liquid + Vapour (Saturated)
Hot Gas
P
T
H2
Evaporator
P
T
Superheated Vapour
H1
Compressor

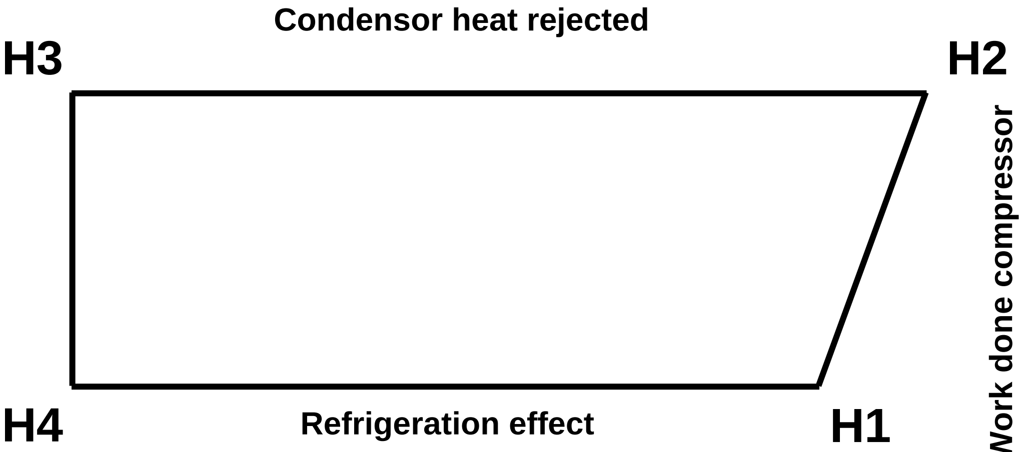
Enthalpy

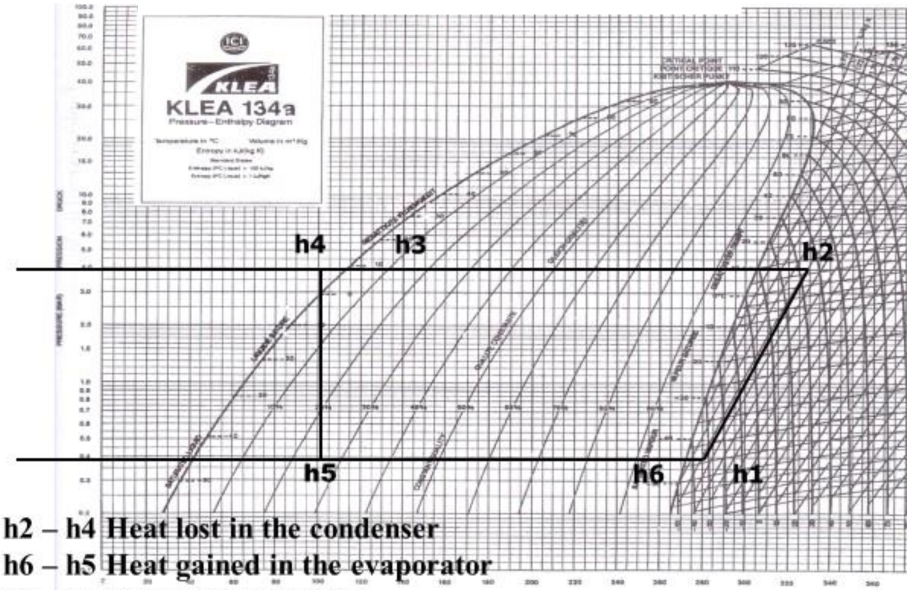
Mass Flow Rate of Refrigerant (m) = Cooling duty / (H1 – H4)
Measured in kg/s

Work Done by Compressor = (H2 – H1) x m
Measured In kw
Condenser capacity measured = (H2 – H3) x m
In kw
Refrigeration Effect measured = (H1 – H4) x m
In kw
Volume Flow Rate (v) measured = Specific volume x m
In m^3 / s
Coefficient of Performance (COP) = Refrigeration effect
No units(simply a ratio) (H1 – H4) / work done (H2 – H1)

Refrigerant flow rates

Kw = 10Kw = 0.05Kg/s
HRE 200kg



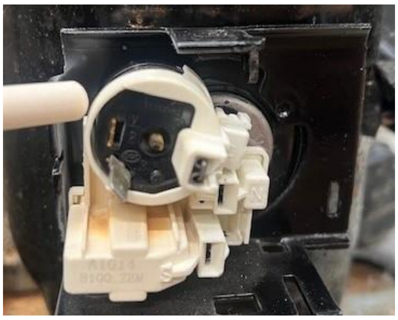


h2 – h4 Heat lost in the condenser
h6 – h5 Heat gained in the evaporator
h2 – h1 Heat of compression
h1 – h6 suction superheat
h3 – h4 liquid line sub-cooling

Compressor testing

Above: Remove compressor casing

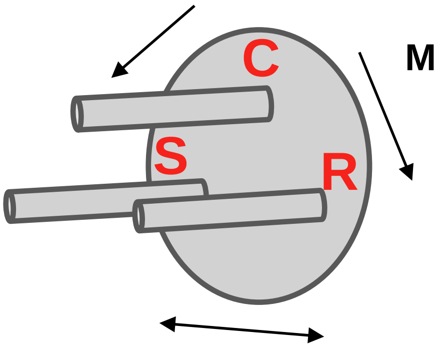
Left: Pull off wiring harness



Right: Thermal overload, reset may need pressing instances of overheating, the ohms reading should be lower than 0.3Ω

Left: Relay, soft compressor start, Resistance should be lower than 0.3Ω

Right: Behind the thermal overload is compressor winding pins for electrical supply Com, Start and Run. Run is usually on the right and Start usually has the higher Ω



Measure Ω C to S

Measure Ω C to R

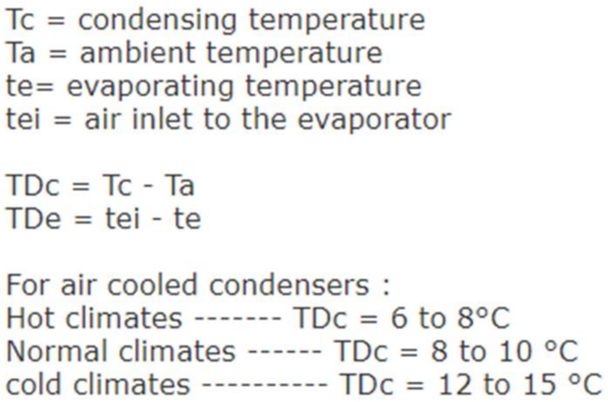
Measure Ω S to R which should be equal to CS + CR

Compressors can fail due to low oil levels, overheating from refrigeration pressures, lack of cooling water from condense and fan failure

TEV sizing formula

Ta 32

Te -35

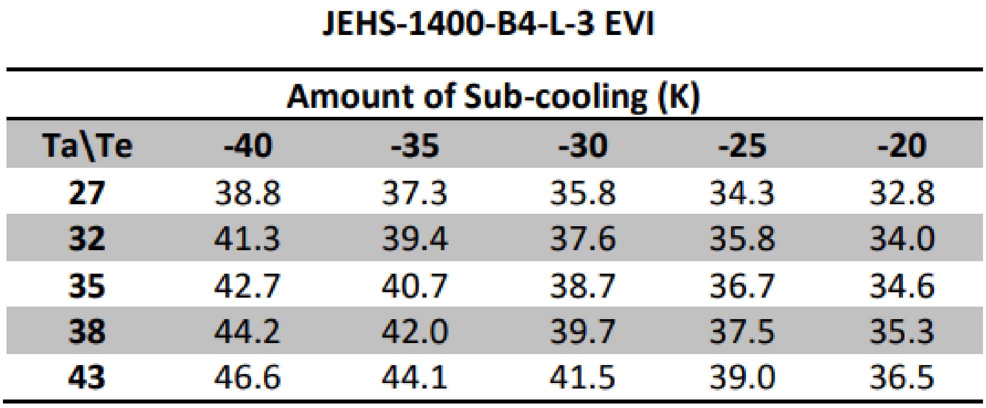


Tc = condensing temperature
Ta = ambient temperature
te= evaporating temperature
tei = air inlet to the evaporator

TDc = Tc - Ta
TDe = tei - te

For air cooled condensers :
Hot climates ------- TDc = 6 to 8°C
Normal climates ------ TDc = 8 to 10 °C
cold climates ---------- TDc = 12 to 15 °C

39.4k



JEHS-1400-B4-L-3 EVI

Amount of Sub-cooling (K)					
Ta\Te	**-40**	**-35**	**-30**	**-25**	**-20**
27	38.8	37.3	35.8	34.3	32.8
32	41.3	39.4	37.6	35.8	34.0
35	42.7	40.7	38.7	36.7	34.6
38	44.2	42.0	39.7	37.5	35.3
43	46.6	44.1	41.5	39.0	36.5

Glossary

Building Regs approved document J: Combustion appliances & fuel storage systems
Building Regs approved document F: Ventilation
The Water Supply (Water Fittings) Regulations 1999
The Gas Safety (Installation and Use) Regulations 1998
The IET 18th Edition Wiring Regulations BS 7671.
British Standards for designing central heating systems include:
*BS EN 12828:*Heating systems in buildings. Design water-based heating systems
*BS EN 12831:*Heating systems in buildings Method for calculation of design load.
BS EN 442: Radiators and convectors. Technical specifications and requirements.

Other correction factors for radiators

Radiator connection factor	**f2**
Top and bottom same end (TBSE)	1.00
Top and bottom opposite end (TBOE)	1.05
Bottom opposite end (BOE)	0.96

Enclosure factor	**F3**
Fixed on plain surface	1.00
Shelf over radiator	0.95
Fixed in open recess	0.90
Encased in cabinet with front or top grille	0.70 or 0.80

Paint finish factor	**F4**
Oil or water based paint	1.00
Metallic based paint	0.85

Desired room temperatures

Room	**Room Temperature ºC**
Living Room	21
Dining Room	21
Bedsitting room	21
Bedroom	21
Hall and Landing	21
Kitchen	21
Bathroom	22
Toilet	21
Unheated (including floor)	10

calculating ventilation heat loss:

Category A
Air change rates for older existing buildings (pre 2000)

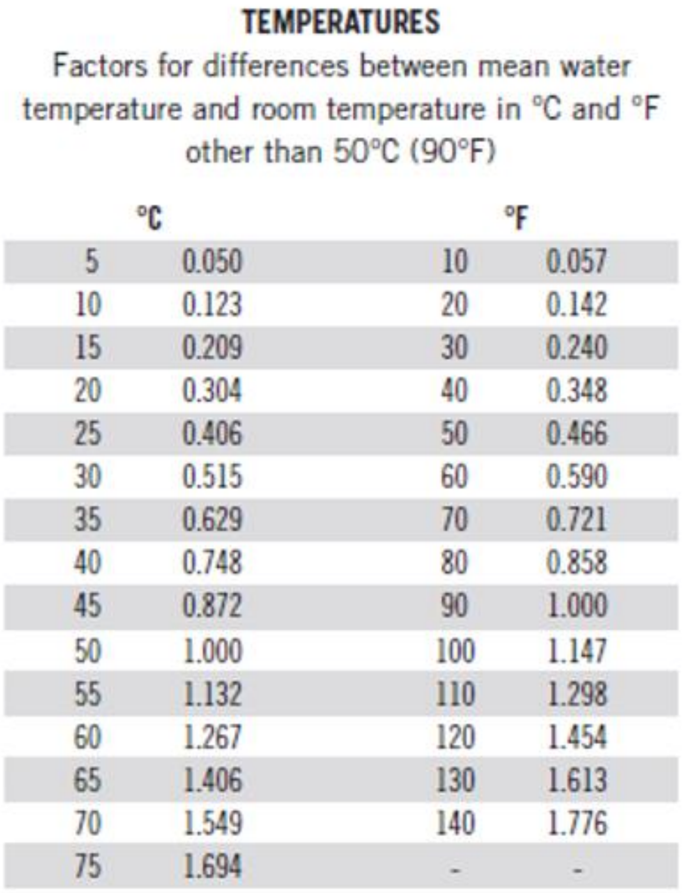
Category B
Air change rates for modern buildings (2000 or later) with double glazing and regulatory minimum insulation

Category C
New buildings (constructed after 2006) complying with all current Building Regulations

Room	Category A	Category B	Category C
Lounge/living room	1.5	1	0.5
Dining/breakfast room	1.5	1	0.5
Kitchen	2	1.5	1.5
Hall	2	1	0.5
Cloaks/WC	2	1.5	1.5
Utility room	3	2	0.5
Study	1.5	1.5	0.5
Bedroom	1	1	0.5
Bedroom with ensuite bath	2	1.5	1
Internal room or corridor	0	0	0
Landing	2	1	0.5
Bathroom/shower room	3	1.5	1.5
Storeroom	1	0.5	0.5

Taken from Domestic Heating Design Guide

Softline temperature table



TEMPERATURES

Factors for differences between mean water
temperature and room temperature in °C and °F
other than 50°C (90°F)

°C		°F	
5	0.050	10	0.057
10	0.123	20	0.142
15	0.209	30	0.240
20	0.304	40	0.348
25	0.406	50	0.466
30	0.515	60	0.590
35	0.629	70	0.721
40	0.748	80	0.858
45	0.872	90	1.000
50	1.000	100	1.147
55	1.132	110	1.298
60	1.267	120	1.454
65	1.406	130	1.613
70	1.549	140	1.776
75	1.694	-	-

Other correction factors for radiators

Radiator connection factor	f2
Top and bottom same end (TBSE)	1.00
Top and bottom opposite end (TBOE)	1.05
Bottom opposite end (BOE)	0.96

Enclosure factor	F3
Fixed on plain surface	1.00
Shelf over radiator	0.95
Fixed in open recess	0.90
Encased in cabinet with front or top grille	0.70 or 0.80

Paint finish factor	F4
Oil or water based paint	1.00
Metallic based paint	0.85

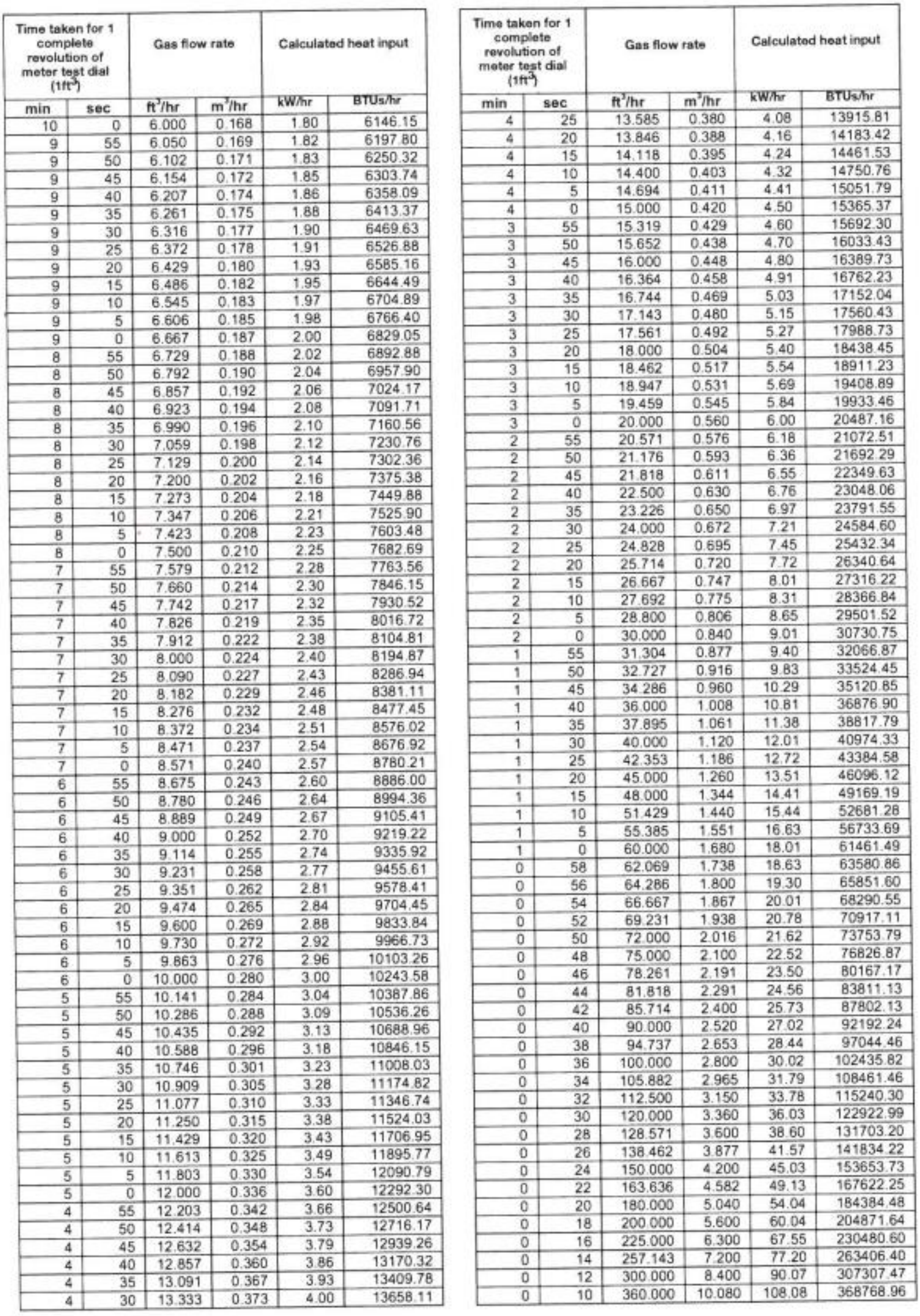
Heating pipe resistances

Fitting description	Equivalent length of straight pipe in metres				
Pipe diameter (copper)	10mm	15mm	22mm	28mm	35mm
Straight valves	0.5	0.5	0.6	0.6	0.8
Angle valves	2.0	2.0	4.5	6.0	N/A
Press fit/ capillary elbow	1.7	1.4	1.3	1.3	1.2
Tee branch (press fit)	1.7	1.5	1.5	1.7	2.0
Tee branch (capillary)	0.6	0.7	1.0	1.3	1.5
Radiator heat emitter	Assume 1 metre pipe per metre of radiator length				

Cylinder heat loss

Norminal Capacity (litres)	Standing heatloss	
	Per day (kwh/24hr)	Per year (kwh/365d)
120	1.24	453
150	1.43	522
170	1.54	562
210	1.89	690
250	2.07	756
300	2.36	961
Tested to BS EN 12897 : 2016 stored 20 heated to 60		

Gas rating chart

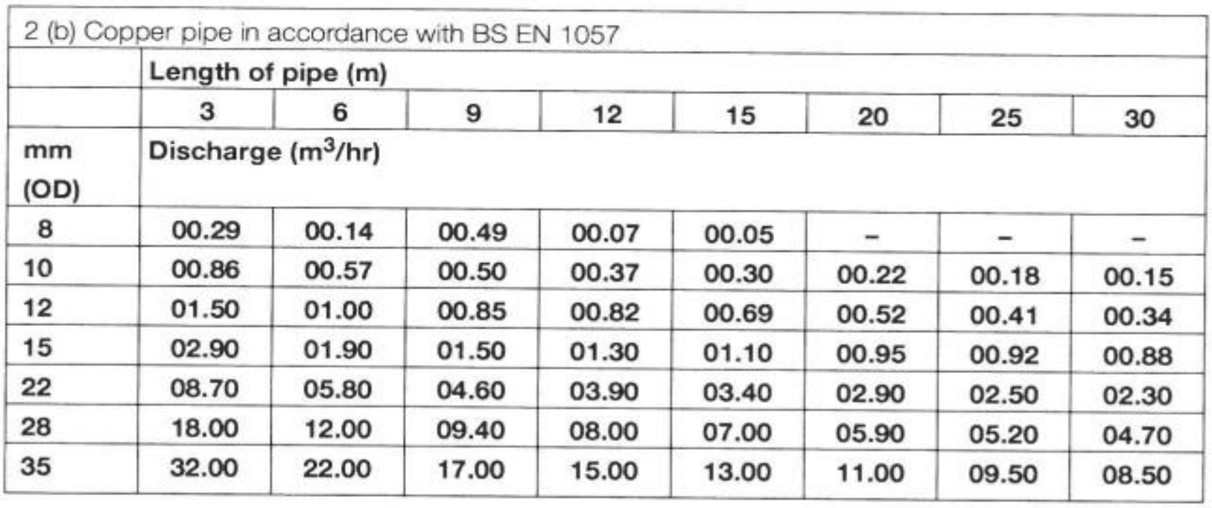


Time taken for 1 complete revolution of meter test dial (1ft^3)		Gas flow rate		Calculated heat input	
min	sec	ft^3/hr	m^3/hr	kW/hr	BTUs/hr
10	0	6.000	0.168	1.80	6146.15
9	55	6.050	0.169	1.82	6197.80
9	50	6.102	0.171	1.83	6250.32
9	45	6.154	0.172	1.85	6303.74
9	40	6.207	0.174	1.86	6358.09
9	35	6.261	0.175	1.88	6413.37
9	30	6.316	0.177	1.90	6469.63
9	25	6.372	0.178	1.91	6526.88
9	20	6.429	0.180	1.93	6585.16
9	15	6.486	0.182	1.95	6644.49
9	10	6.545	0.183	1.97	6704.89
9	5	6.606	0.185	1.98	6766.40
9	0	6.667	0.187	2.00	6829.05
8	55	6.729	0.188	2.02	6892.88
8	50	6.792	0.190	2.04	6957.90
8	45	6.857	0.192	2.06	7024.17
8	40	6.923	0.194	2.08	7091.71
8	35	6.990	0.196	2.10	7160.56
8	30	7.059	0.198	2.12	7230.76
8	25	7.129	0.200	2.14	7302.36
8	20	7.200	0.202	2.16	7375.38
8	15	7.273	0.204	2.18	7449.88
8	10	7.347	0.206	2.21	7525.90
8	5	7.423	0.208	2.23	7603.48
8	0	7.500	0.210	2.25	7682.69
7	55	7.579	0.212	2.28	7763.56
7	50	7.660	0.214	2.30	7846.15
7	45	7.742	0.217	2.32	7930.52
7	40	7.826	0.219	2.35	8016.72
7	35	7.912	0.222	2.38	8104.81
7	30	8.000	0.224	2.40	8194.87
7	25	8.090	0.227	2.43	8286.94
7	20	8.182	0.229	2.46	8381.11
7	15	8.276	0.232	2.48	8477.45
7	10	8.372	0.234	2.51	8576.02
7	5	8.471	0.237	2.54	8676.92
7	0	8.571	0.240	2.57	8780.21
6	55	8.675	0.243	2.60	8886.00
6	50	8.780	0.246	2.64	8994.36
6	45	8.889	0.249	2.67	9105.41
6	40	9.000	0.252	2.70	9219.22
6	35	9.114	0.255	2.74	9335.92
6	30	9.231	0.258	2.77	9455.61
6	25	9.351	0.262	2.81	9578.41
6	20	9.474	0.265	2.84	9704.45
6	15	9.600	0.269	2.88	9833.84
6	10	9.730	0.272	2.92	9966.73
6	5	9.863	0.276	2.96	10103.26
6	0	10.000	0.280	3.00	10243.58
5	55	10.141	0.284	3.04	10387.86
5	50	10.286	0.288	3.09	10536.26
5	45	10.435	0.292	3.13	10688.96
5	40	10.588	0.296	3.18	10846.15
5	35	10.746	0.301	3.23	11008.03
5	30	10.909	0.305	3.28	11174.82
5	25	11.077	0.310	3.33	11346.74
5	20	11.250	0.315	3.38	11524.03
5	15	11.429	0.320	3.43	11706.95
5	10	11.613	0.325	3.49	11895.77
5	5	11.803	0.330	3.54	12090.79
5	0	12.000	0.336	3.60	12292.30
4	55	12.203	0.342	3.66	12500.64
4	50	12.414	0.348	3.73	12716.17
4	45	12.632	0.354	3.79	12939.26
4	40	12.857	0.360	3.86	13170.32
4	35	13.091	0.367	3.93	13409.78
4	30	13.333	0.373	4.00	13658.11
4	25	13.585	0.380	4.08	13915.81
4	20	13.846	0.388	4.16	14183.42
4	15	14.118	0.395	4.24	14461.53
4	10	14.400	0.403	4.32	14750.76
4	5	14.694	0.411	4.41	15051.79
4	0	15.000	0.420	4.50	15365.37
3	55	15.319	0.429	4.60	15692.30
3	50	15.652	0.438	4.70	16033.43
3	45	16.000	0.448	4.80	16389.73
3	40	16.364	0.458	4.91	16762.23
3	35	16.744	0.469	5.03	17152.04
3	30	17.143	0.480	5.15	17560.43
3	25	17.561	0.492	5.27	17988.73
3	20	18.000	0.504	5.40	18438.45
3	15	18.462	0.517	5.54	18911.23
3	10	18.947	0.531	5.69	19408.89
3	5	19.459	0.545	5.84	19933.46
3	0	20.000	0.560	6.00	20487.16
2	55	20.571	0.576	6.18	21072.51
2	50	21.176	0.593	6.36	21692.29
2	45	21.818	0.611	6.55	22349.63
2	40	22.500	0.630	6.76	23048.06
2	35	23.226	0.650	6.97	23791.55
2	30	24.000	0.672	7.21	24584.60
2	25	24.828	0.695	7.45	25432.34
2	20	25.714	0.720	7.72	26340.64
2	15	26.667	0.747	8.01	27316.22
2	10	27.692	0.775	8.31	28366.84
2	5	28.800	0.806	8.65	29501.52
2	0	30.000	0.840	9.01	30730.75
1	55	31.304	0.877	9.40	32066.87
1	50	32.727	0.916	9.83	33524.45
1	45	34.286	0.960	10.29	35120.85
1	40	36.000	1.008	10.81	36876.90
1	35	37.895	1.061	11.38	38817.79
1	30	40.000	1.120	12.01	40974.33
1	25	42.353	1.186	12.72	43384.58
1	20	45.000	1.260	13.51	46096.12
1	15	48.000	1.344	14.41	49169.19
1	10	51.429	1.440	15.44	52681.28
1	5	55.385	1.551	16.63	56733.69
1	0	60.000	1.680	18.01	61461.49
0	58	62.069	1.738	18.63	63580.86
0	56	64.286	1.800	19.30	65851.60
0	54	66.667	1.867	20.01	68290.55
0	52	69.231	1.938	20.78	70917.11
0	50	72.000	2.016	21.62	73753.79
0	48	75.000	2.100	22.52	76826.87
0	46	78.261	2.191	23.50	80167.17
0	44	81.818	2.291	24.56	83811.13
0	42	85.714	2.400	25.73	87802.13
0	40	90.000	2.520	27.02	92192.24
0	38	94.737	2.653	28.44	97044.46
0	36	100.000	2.800	30.02	102435.82
0	34	105.882	2.965	31.79	108461.46
0	32	112.500	3.150	33.78	115240.30
0	30	120.000	3.360	36.03	122922.99
0	28	128.571	3.600	38.60	131703.20
0	26	138.462	3.877	41.57	141834.22
0	24	150.000	4.200	45.03	153653.73
0	22	163.636	4.582	49.13	167622.25
0	20	180.000	5.040	54.04	184384.48
0	18	200.000	5.600	60.04	204871.64
0	16	225.000	6.300	67.55	230480.60
0	14	257.143	7.200	77.20	263406.40
0	12	300.000	8.400	90.07	307307.47
0	10	360.000	10.080	108.08	368768.96

Gas Pipe sizing chart

Based on straight actual length with 1mb droppage from both ends

use 0.5m for a bend & 0.3m for a machine bend

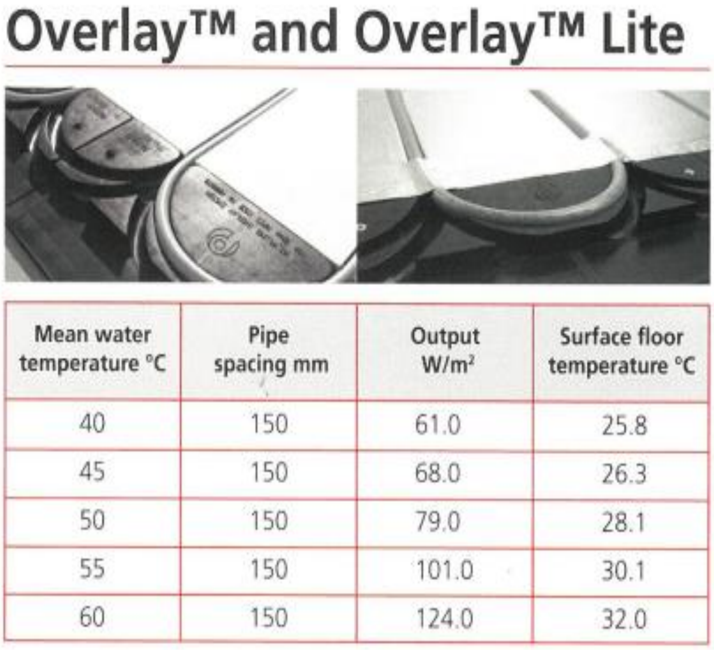


2 (b) Copper pipe in accordance with BS EN 1057

	Length of pipe (m)							
	3	6	9	12	15	20	25	30
mm (OD)	Discharge (m^3/hr)							
8	00.29	00.14	00.49	00.07	00.05	–	–	–
10	00.86	00.57	00.50	00.37	00.30	00.22	00.18	00.15
12	01.50	01.00	00.85	00.82	00.69	00.52	00.41	00.34
15	02.90	01.90	01.50	01.30	01.10	00.95	00.92	00.88
22	08.70	05.80	04.60	03.90	03.40	02.90	02.50	02.30
28	18.00	12.00	09.40	08.00	07.00	05.90	05.20	04.70
35	32.00	22.00	17.00	15.00	13.00	11.00	09.50	08.50

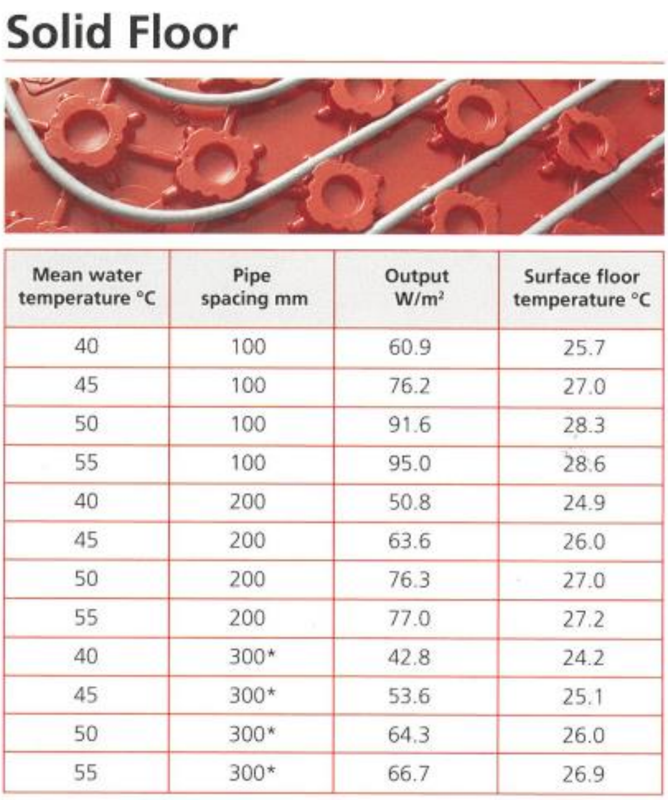
Underfloor heating

Underfloor heating Outputs W/m2



Overlay™ and Overlay™ Lite

Mean water temperature °C	Pipe spacing mm	Output W/m²	Surface floor temperature °C
40	150	61.0	25.8
45	150	68.0	26.3
50	150	79.0	28.1
55	150	101.0	30.1
60	150	124.0	32.0



Solid Floor

Mean water temperature °C	Pipe spacing mm	Output W/m²	Surface floor temperature °C
40	100	60.9	25.7
45	100	76.2	27.0
50	100	91.6	28.3
55	100	95.0	28.6
40	200	50.8	24.9
45	200	63.6	26.0
50	200	76.3	27.0
55	200	77.0	27.2
40	300*	42.8	24.2
45	300*	53.6	25.1
50	300*	64.3	26.0
55	300*	66.7	26.9

Suspended and Floating Floor

Mean water temperature °C	Pipe spacing mm	Output W/m²	Surface floor temperature °C
40	225/300	31.7	23.1
45	225/300	40.2	23.9
50	225/300	49.2	24.7
55	225/300	50.0	24.8
60	225/300	52.3	25.0

MHP System

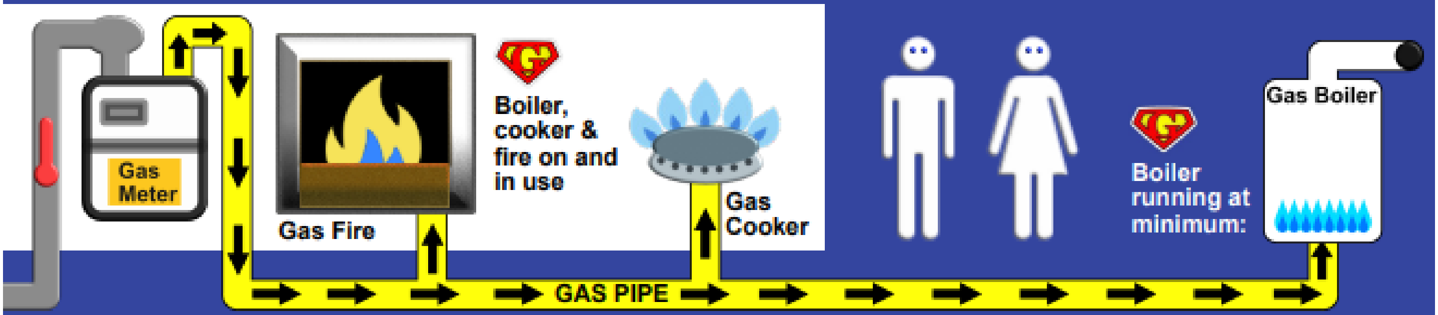
Mean water temperature °C	Pipe spacing mm	Output W/m²	Surface floor temperature °C
40	90	52.0	25.0
45	90	64.0	26.0
50	90	76.0	27.0
55	90	100.0	29.0
60	90	124.0	31.0

Credits: Paul Hull (founder of The Gas Safety Superheroes)

THE GAS SAFETY SUPERHEROES

THE DANGERS OF AN UNDERSIZED GAS PIPE:

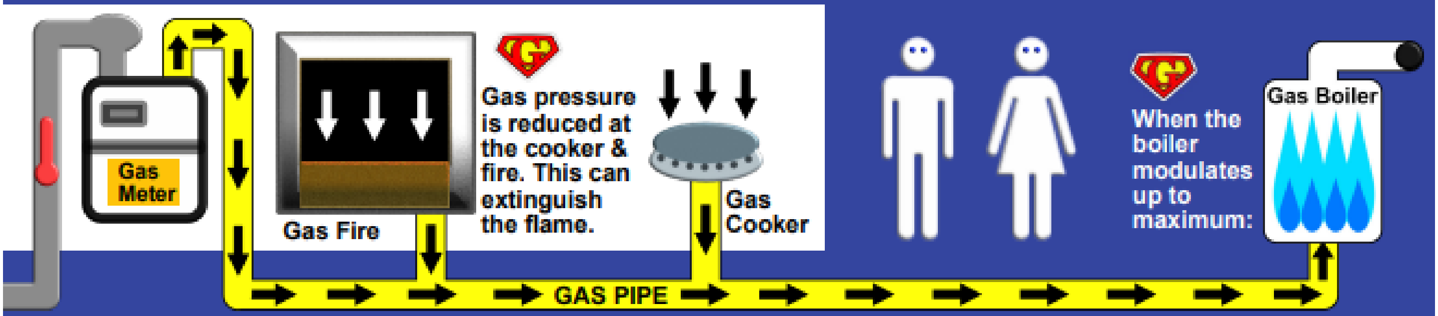
If a gas pipe is undersized, the way a new boiler draws gas through the gas pipe from the gas meter can lead to problems with the boiler and other gas appliances in the property. Undersized gas pipes can contribute to incomplete combustion that can produce carbon monoxide.



Boiler, cooker & fire on and in use

Boiler running at minimum:

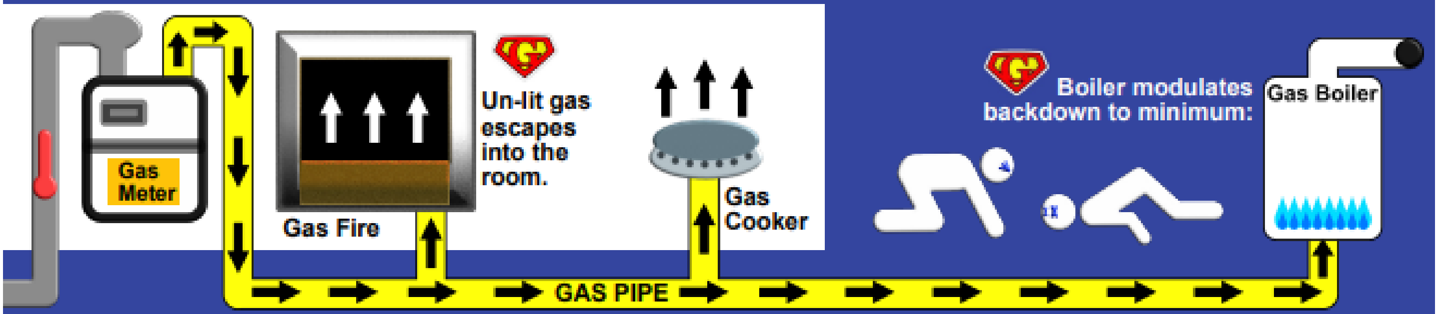
If the gas pipe is not large enough, you could draw the flame off the cooker, fire or both through reduced pressure, and then end up with un-lit gas escaping from the cooker burners & gas fire when the boiler modulates down again.



Gas pressure is reduced at the cooker & fire. This can extinguish the flame.

When the boiler modulates up to maximum:

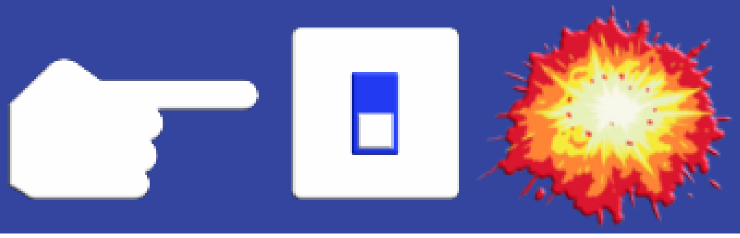
Exposure to extremely high levels of natural gas can cause loss of consciousness or even death. if a natural gas leak has occurred and is severe, oxygen can be reduced, causing dizziness, fatigue, nausea, headache, and irregular breathing.



Un-lit gas escapes into the room.

Boiler modulates backdown to minimum:

When natural gas fills a room, it just takes one spark for an explosion that can destroy a home and end lives. Smell Gas? To report a gas or carbon monoxide emergency call the National Gas Emergency Service 24 hours a day on 0800 111 999



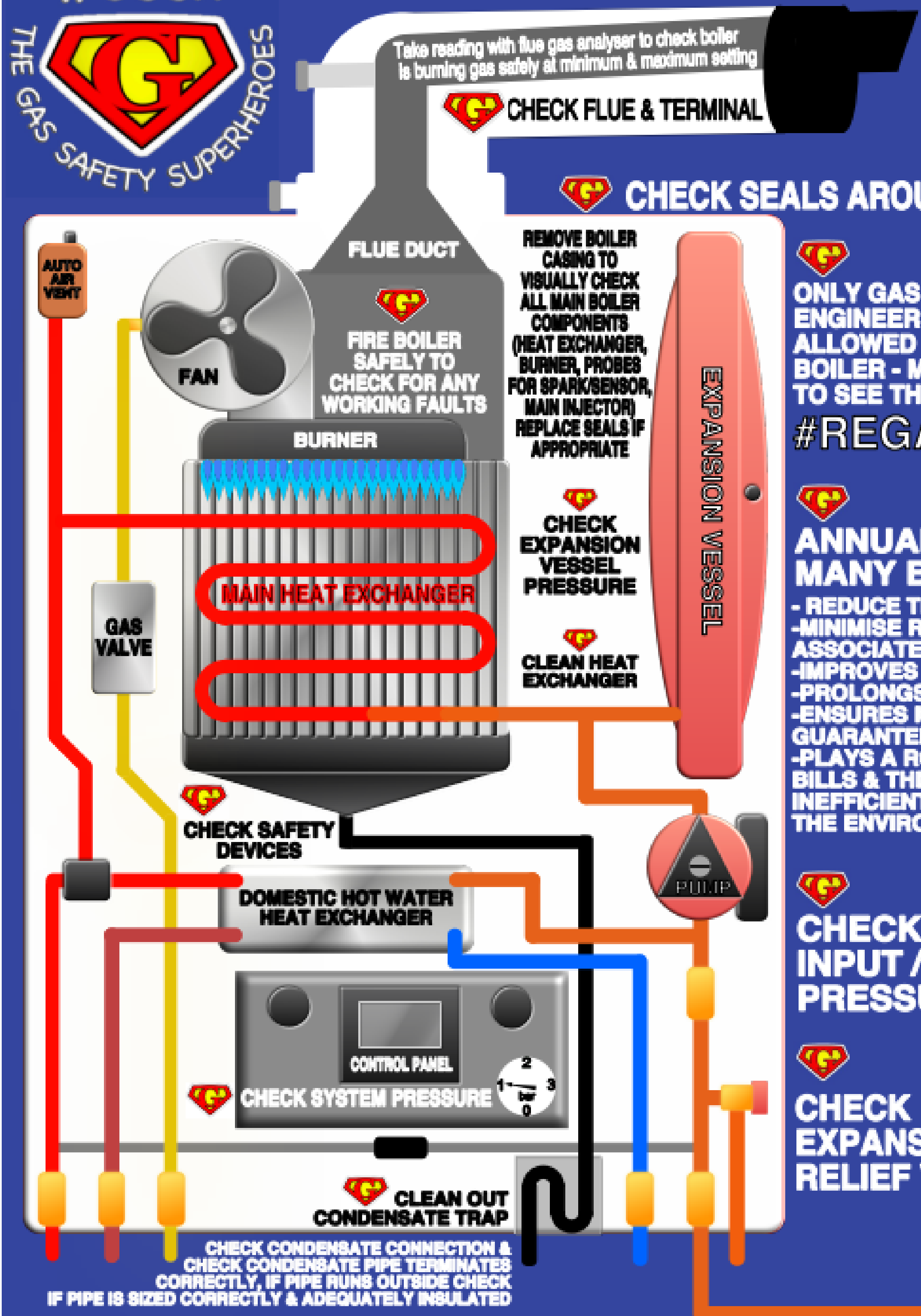
If your gas pipe has only 15mm diameter pipe coming straight off your gas meter or is a long distance in 15mm pipe to your gas appliances then it is possible you need to upgrade your gas pipe. If you are unsure if you actually need to upgrade your gas pipes, contact your local Gas Safe Registered engineer to carry out an assessment (and quote if necessary).

THE GAS SAFETY SUPERHEROES GUIDE TO BOILER SERVICING

*BEST PRACTICE FOR A BOILER SERVICE FROM A GAS SAFE REGISTERED ENGINEER INCLUDING THE FOLLOWING:

#GSSH

THE GAS SAFETY SUPERHEROES



Take reading with flue gas analyser to check boiler is burning gas safely at minimum & maximum setting

CHECK FLUE & TERMINAL

VISUALLY CHECK THE BOILER

CHECK SEALS AROUND BOILER CASING

FIRE BOILER SAFELY TO CHECK FOR ANY WORKING FAULTS

REMOVE BOILER CASING TO VISUALLY CHECK ALL MAIN BOILER COMPONENTS (HEAT EXCHANGER, BURNER, PROBES FOR SPARK/SENSOR, MAIN INJECTOR) REPLACE SEALS IF APPROPRIATE

CHECK EXPANSION VESSEL PRESSURE

CLEAN HEAT EXCHANGER

CHECK SAFETY DEVICES

CHECK SYSTEM PRESSURE

CLEAN OUT CONDENSATE TRAP

CHECK CONDENSATE CONNECTION & CHECK CONDENSATE PIPE TERMINATES CORRECTLY, IF PIPE RUNS OUTSIDE CHECK IF PIPE IS SIZED CORRECTLY & ADEQUATELY INSULATED

ONLY GAS SAFE REGISTERED ENGINEERS ARE LEGALLY ALLOWED TO SERVICE YOUR BOILER - MAKE SURE YOU ASK TO SEE THEIR GAS SAFE I.D. CARD

#REGARDTHECARD

ANNUAL SERVICING HAS MANY BENEFITS:

- REDUCE THE RISK OF BREAKDOWNS
- MINIMISE RISK OF GAS LEAK & ASSOCIATED ISSUES
- IMPROVES BOILER EFFICIENCY
- PROLONGS THE LIFE OF THE BOILER
- ENSURES MANUFACTURERS GUARANTEE IS VALID
- PLAYS A ROLE IN REDUCING ENERGY BILLS & THE NEGATIVE IMPACT AN INEFFICIENT BOILER CAN HAVE ON THE ENVIRONMENT

CHECK THE HEAT INPUT / OPERATING PRESSURE OF BOILER

CHECK EXPANSION / PRESSURE RELIEF VALVE

IF SYSTEM HAS FILTER CHECK & CLEAN

AFTER THE GAS SAFE REGISTERED ENGINEER HAS SERVICED YOUR BOILER YOU SHOULD RECEIVE A SERVICE REPORT SHOWING YOU EVERYTHING THAT HAS BEEN DONE

THIS IS AN ILLUSTRATION OF A BASIC CONDENSING GAS COMBI BOILER

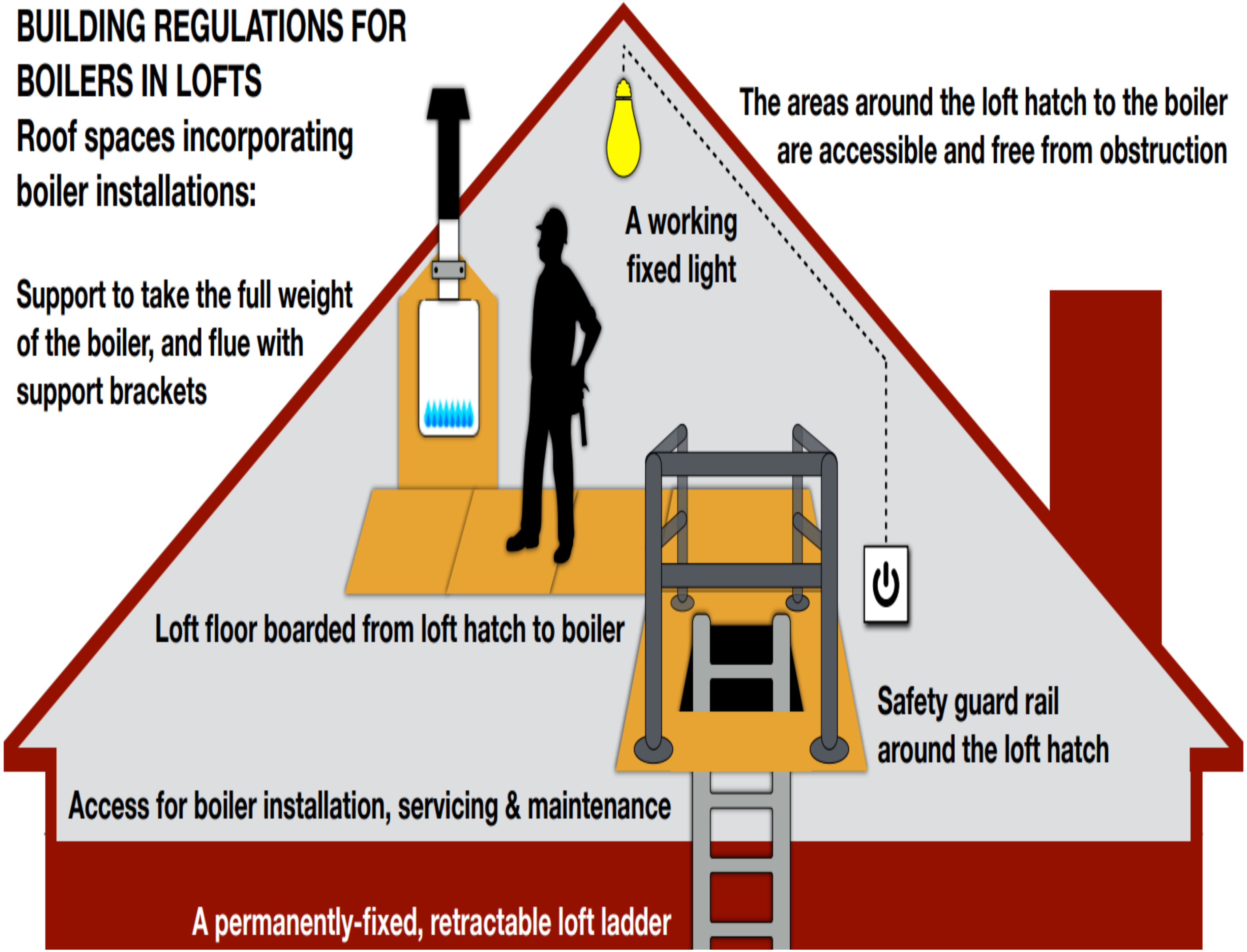
*ALWAYS CHECK MANUFACTURERS INSTRUCTIONS

THE GAS SAFETY SUPERHEROES

25th ANNIVERSARY H&Vnews AWARDS 2019 WINNER
HEADLINE SPONSOR WOLSELEY

BUILDING REGULATIONS FOR BOILERS IN LOFTS

Roof spaces incorporating boiler installations:



Support to take the full weight of the boiler, and flue with support brackets

A working fixed light

The areas around the loft hatch to the boiler are accessible and free from obstruction

Loft floor boarded from loft hatch to boiler

Safety guard rail around the loft hatch

Access for boiler installation, servicing & maintenance

A permanently-fixed, retractable loft ladder

THE GAS SAFETY SUPERHEROES

BOILER AND FLUE GAS ANALYSER TECHNICAL SUPPORT PHONE NUMBERS AND WEBSITES:

BOILER: **ALPHA HEATING INNOVATION**	**0344 871 8760**	https://www.alpha-innovation.co.uk/installers
BOILER: **ARISTON**	**0333 240 7777**	https://www.ariston.com/uk/
BOILER: **ATAG**	**0800 254 5065**	http://atagheating.co.uk/installer/
BOILER: **BAXI**	**0344 871 1545**	https://www.baxi.co.uk/trade
BOILER: **BIASI**	**01922 714 636**	http://www.biasi.co.uk/
BOILER: **FERROLI**	**0330 205 0005**	https://www.ferroli.co.uk/
BOILER: **GLOW-WORM**	**01773 828 300**	https://www.glow-worm.co.uk/trade/
BOILER: **IDEAL**	**01482 498 663**	http://idealboilers.com/installer/
BOILER: **INTERGAS**	**01527 888 000**	https://www.intergasheating.co.uk/installer/
BOILER: **KESTON**	**01482 443 005**	http://www.keston.co.uk/
BOILER: **MAIN**	**0344 871 1545**	https://www.mainheating.co.uk/
BOILER: **NAVIEN**	**020 3598 2020**	https://navienuk.com/
BOILER: **POTTERTON**	**0344 871 1545**	http://www.potterton.co.uk/
BOILER: **RAVENHEAT**	**0113 252 7007**	https://ravenheat.co.uk/
BOILER: **SIME**	**0345 901 1114**	http://sime.co.uk/installers/
BOILER: **VAILLANT**	**0344 693 3133**	https://www.vaillant.co.uk/for-installers/
BOILER: **VIESSMANN**	**01952 675 070**	https://www.viessmann.co.uk/
BOILER: **VOKERA**	**0844 391 0999**	http://www.vokera.co.uk/
BOILER: **WORCESTER BOSCH**	**0330 123 3366**	https://www.worcester-bosch.co.uk/

FLUE GAS ANALYSER: **ANTON**	**01923 274 730**	https://www.anton-group.com/index.htm
FLUE GAS ANALYSER: **KANE**	**0800 059 0800**	https://www.kane.co.uk/
FLUE GAS ANALYSER: **TESTO**	**01420 358 123**	https://www.testo.com/en-UK/
FLUE GAS ANALYSER: **T.P.I.**	**01293 530 196**	https://www.tpieurope.com/