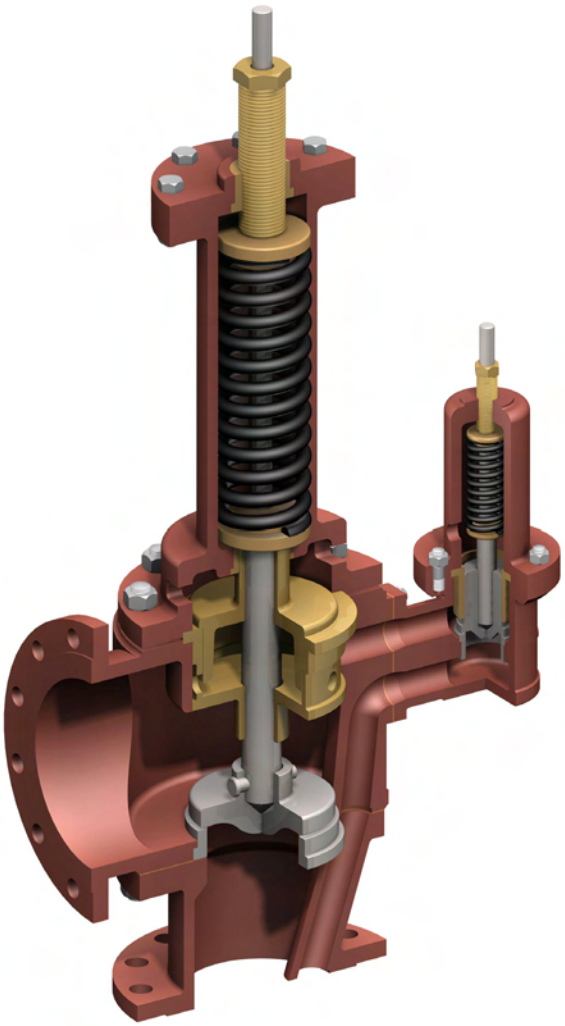
DA full lift safety valve



- Full Lift design to BS759
- Capacity certified by AOTC
- Full rated flow achieved within 10% overpressure
- Blowdown of 1% allows better utilisation of plant
- Linear characteristic gives clean opening, stable performance and positive closing
- Insensitive to back pressure of up to 25% during discharge
- Fail safe design used in nuclear reactors
- High temperature option
- Totally enclosed flow option
- Springs designed and stressed to BS1726 and BS759
- Fully guided, strongly constructed with stainless trim
- Suitable for steam, gas, water and other fluids

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Construction

The safety valve comprises a spring-loaded main valve, incorporation a cylinder with a loose-fitting piston, and a similar pilot valve mounted on the main valve chest. When the pilot valve is open, it discharges into the main valve cylinder, under the operating piston. Operating pressure for the main and pilot valves is set by adjusting screws on top of the valve spindles.

Principle of operation

The pilot valve is normally set between two and five psig above the pressure setting of the main valve. In the following example the main valve is set at 200 psig and the pilot valve at 202 psig.

Immediately the inlet pressure drops below 202 psig, the pilot valve will close and the pressure under the main valve piston is dissipated through the clearance between the main piston and the cylinder wall*. The main spring then returns the main valve to the normal discharge, where it will remain until the inlet pressure drops below 200 psig. At this point, the main spring will overcome the pressure under the main valve and the valve will firmly close.

The presence of full pressure under the main piston will not affect the action of the pilot valve. This is due to the pilot valve balancing piston having the same feature area as the pilot valve. Reaction thrusts are therefore balanced giving the correct degree of adjustment at either open or shut positions.

Immediately the inlet pressure rises above 200 psig the main valve overcomes the spring loading and opens with a clean action. If the inlet pressure continues to rise and reaches 202 psig, the pressure at the pilot valve overcomes its spring loading and opens the valve. The pilot valve discharge is directed by port to the underside of the main piston. This action will further compress the main valve spring thereby giving the main valve full lift discharge.

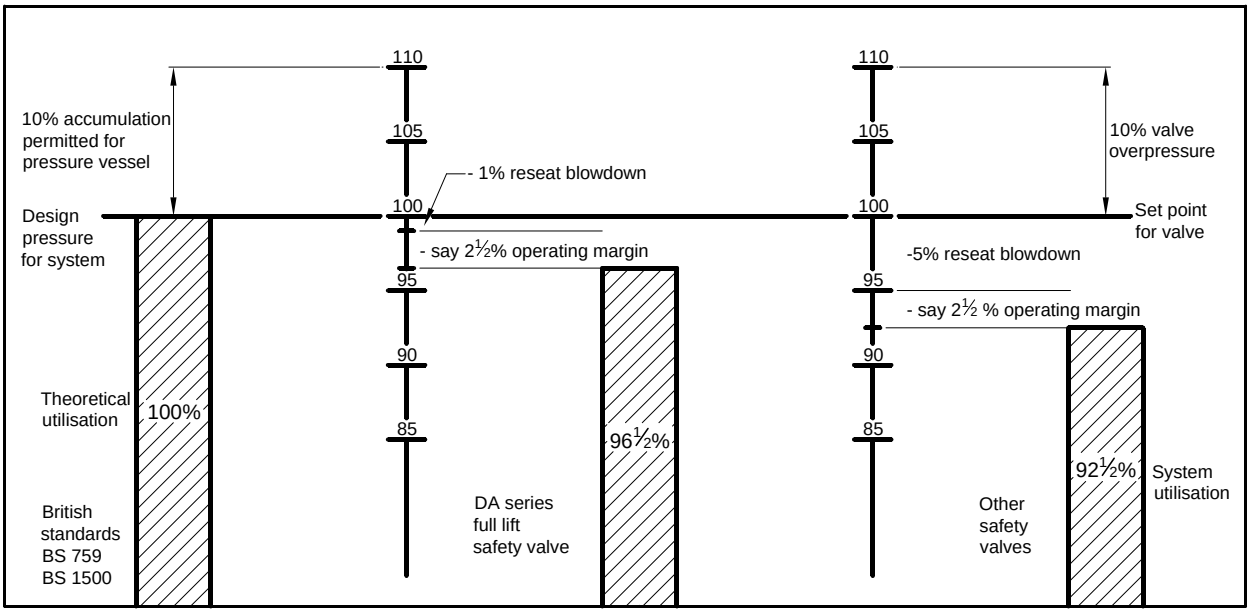
The lip around the pilot plug ensures rapid and accurate opening and closing of the valve. This fast action reduces any wire-drawing effected on the valve which could damage the valve.

*Not applicable to enclosed flow valves fitted with fluid seals.

Safety valve performance

The overpressure and blowdown performance is of increasing importance as designers seek to safely reduce the margin between operating and design pressure. The relationships and comparative performances between DA full lift safety valves and other safety valves are shown below. The performance should be readily repeatable without frequent attention.

Relative safety valve performance key terms



Other products

Auld Valves manufacture a range of products complementary to the DA full lift safety valve. A range catalogue is available from the company. Briefly, the products are:

- Standfast pressure regulators
- Vigilant safety valves
- A100 control valves
- A100 desuperheater valves

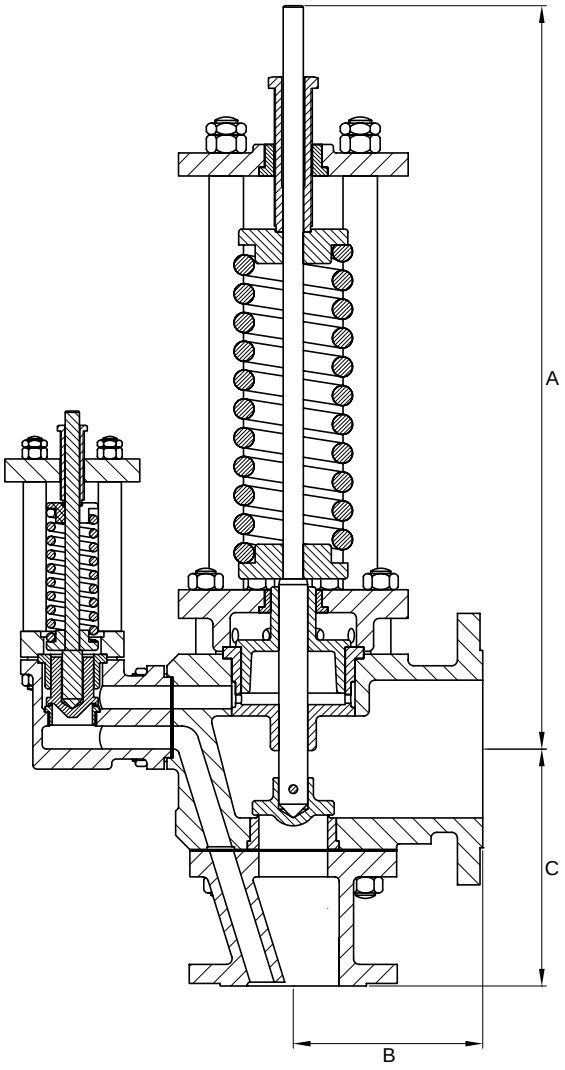
Application

DA full lift safety valves are available in a variety of sizes from 2 inch to 10 inch inlet diameter and with a range of body materials to suit the process conditions.

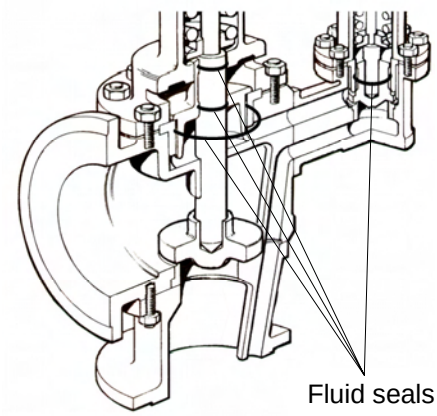
One of two basic patterns of the DA full lift safety valve may be supplied dependant on the combination of processed pressure and temperature. In the column type DA full lift safety valve, shown on the front page, the main and pilot valve spindles and operating springs are enclosed in a bolted bonnet, whereas, the high temperature version is fitted with pillars in place of the valve bonnets as shown below.
DA full lift safety valves are suitable for use with steam, gas, water and many other process fluids and gases. However, where toxic or inflammable fluids or gases are involved, fluid seals are fitted to the main and pilot valves to ensure that leakage to atmosphere cannot occur. The leakage hole in the main valve piston is also eliminated. This totally enclosed version is shown below.

Auld Valves will advise on the application of materials and suitability of the valves for special fluids.

High temperature option



Totally enclosed flow option



Valve size selection

The following table is intended to serve as a guide to the correct sizing for DA full lift safety valves. However, in order to ensure that the valve complies with insurance company requirements, it is recommended that the valve size selected is confirmed with Auld. Confirmation is dependent on the following information being supplied:

- Type of fluid, gas or vapour
- Line or operating pressure
- Set pressure required for safety valve
- Maximum discharge capacity
- Operating temperature
- Total temperature, if superheated

Allowing for superheat

Due to increased volume where steam is superheated, a correction has to be made to obtain the capacity rating associated with the larger volume. The correction formula is:

$$C_s = C(1 + 0.0015T)^{-\frac{1}{2}}$$

C = capacity
C_s = corrected capacity
T = degree of superheat

Choosing set point

For convenient plant operation, it is advisable to have the set pressure at least 5% above the operating pressure or 3 psi above, which ever is the greater.

Flange connections

BS 10 or BS 4504 are preferred flanges. Most other flanges, including ASA and DIN can be supplied. The outlet flange is normally supplied to a lighter table.

Saturated steam capacities in lb/h – based on 10% overpressure

Set pressure psig	2" x 3"				4" x 6"					6" x 8"							Chest size
	2" x 4"	2½" x 3"	3" x 4"		4" x 5"	5" x 6"	5" x 6"	6" x 8"		8" x 10"	8" x 10"		10" x 12"				
	1½"	1¾"	2"	2½"	3"	3½"	4"	4½"	5"	5½"	6"	6½"	7"	7½"	8"	8½"	Seat size
15	1985	2701	3529	5514	7940	10806	14114	17863	22054	26685	31757	37271	43226	49622	56458	63736	
20	2335	3117	4151	6486	9340	12711	16602	21012	25942	31389	37356	43841	50846	58369	66410	74971	
25	2684	3654	4773	7458	10739	14616	19090	24161	29829	36093	42954	50412	58466	67117	76363	86207	
30	3034	4130	5395	8430	12139	16521	21578	27310	33717	40797	48552	56982	66086	75864	86315	97443	Column
35	3384	4606	6017	9402	13538	18426	24066	30459	37605	45501	54150	63552	73706	84612	96267	108678	
40	3734	5082	6639	10374	14938	20331	26554	33608	41493	50205	59749	70122	81326	93359	106220	119914	
45	4084	5558	7261	11346	16338	22236	29043	36757	45380	54909	65347	76693	88947	102107	116172	131149	Pillar
50	4434	6035	7883	12318	17738	24141	31531	39906	49268	59614	70945	83263	96567	110854	126125	142385	
60	5133	6987	9127	14262	20537	27951	36507	46204	57044	69022	84142	96403	111807	128349	146030	164856	
70	5833	7939	10371	16206	23336	31761	41483	52502	64819	74830	93338	109544	127047	145844	165935	187327	Iron limit
80	6533	8892	11615	18150	26136	35571	46459	58800	72595	87838	104535	122684	142287	163338	185840	209798	
90	7232	9844	12859	20093	28934	39380	51435	65098	80369	97246	115731	135824	157526	180833	205745	232268	
100	7932	10797	14103	22037	31734	43191	56411	71396	88145	106654	126928	148963	172767	198328	225650	254739	
110	8632	11749	15347	23981	34533	47000	61387	77694	95921	116063	138124	162106	188007	215823	245554	277211	
120	9332	12701	16591	25925	37333	50810	66364	83992	103693	125471	149321	175246	203247	233318	265460	299682	
130	10032	13654	17835	27870	40132	54620	71340	90290	111472	134879	160517	188387	218487	250813	285364	-	
140	10731	14606	19080	29813	42931	58430	76316	96588	119247	144287	171714	201527	233727	268308	305269	-	
150	11431	15558	20324	31757	45731	62240	81292	102886	127023	153695	182910	214667	248967	285803	325174	-	
160	12131	16511	21568	33701	48530	66050	86268	109184	134798	163103	194107	227808	264807	303298	345079	-	
170	12831	17463	22812	35645	51329	69860	91244	115482	142574	172512	205303	240948	279447	320793	364984	-	
180	13530	18416	24056	37589	54129	73670	96220	121780	150349	181920	216500	254089	294687	338287	-	-	
190	14230	19368	25300	39533	56928	77480	101197	128078	158125	191328	227696	267229	309927	355782	-	-	
200	14930	20320	26544	41477	59727	81290	106173	134376	165900	200736	238893	-	325167	373277	-	-	
210	15629	21273	27788	43421	62527	85100	111149	140674	173675	210144	250089	-	340408	390772	-	-	
220	16329	22225	29032	45365	65326	88910	116125	146972	181451	219552	261286	-	355648	408267	-	-	
230	17029	23177	30276	47309	68125	92719	121101	153270	-	228961	272482	-	370888	425762	-	-	
240	17729	24130	31520	49253	70925	96529	126077	159568	-	238369	283679	-	386128	443257	-	-	
250	18428	25082	32764	51197	73724	100339	131053	165866	-	247777	294875	-	401368	460752	-	-	
260	19128	26035	34008	53141	76523	104149	136029	172164	-	257185	306072	-	416608	-	-	-	
270	19828	26987	35252	55085	79323	107979	141006	178462	-	266593	317268	-	431848	-	-	-	
280	20528	-	36496	57029	82122	111769	-	184760	-	276001	328465	-	447088	-	-	-	
290	21227	-	37741	58973	84921	115579	-	191058	-	285410	339661	-	462328	-	-	-	
300	21927	-	38985	60917	87721	119389	-	197356	-	294818	350858	-	477568	-	-	-	
310	22627	-	40229	62861	90520	123199	-	203654	-	304226	-	-	-	-	-	-	
320	23327	-	41473	64805	93319	127009	-	209952	-	313634	-	-	-	-	-	-	
330	24026	-	42717	66749	96119	130819	-	216250	-	323042	-	-	-	-	-	-	
340	24726	-	43961	68693	98918	134629	-	222548	-	332450	-	-	-	-	-	-	
350	25426	-	45205	70637	101717	138438	-	228846	-	341859	-	-	-	-	-	-	
360	26125	-	46449	-	104517	142248	-	235144	-	-	-	-	-	-	-	-	
370	26825	-	47693	-	107316	146058	-	241442	-	-	-	-	-	-	-	-	
380	27525	-	48937	-	110115	149868	-	247740	-	-	-	-	-	-	-	-	
390	28225	-	50181	-	112915	153678	-	254038	-	-	-	-	-	-	-	-	
400	28924	-	51425	-	115714	157468	-	260336	-	-	-	-	-	-	-	-	
410	29624	-	52669	-	118513	161298	-	-	-	-	-	-	-	-	-	-	
420	30324	-	53913	-	121313	165108	-	-	-	-	-	-	-	-	-	-	
430	31024	-	55158	-	124112	168918	-	-	-	-	-	-	-	-	-	-	
440	31723	-	56402	-	126911	172728	-	-	-	-	-	-	-	-	-	-	
450	32423	-	57646	-	129710	176538	-	-	-	-	-	-	-	-	-	-	
460	33123	-	58890	-	132510	180348	-	-	-	-	-	-	-	-	-	-	
470	33822	-	60134	-	135309	184157	-	-	-	-	-	-	-	-	-	-	
480	34522	-	61378	-	138108	187967	-	-	-	-	-	-	-	-	-	-	
490	35222	-	62622	-	140908	191777	-	-	-	-	-	-	-	-	-	-	
500	35922	-	63866	-	143707	195587	-	-	-	-	-	-	-	-	-	-	

Materials and limiting factors

The following tables show the maximum pressure and temperature for the various valve sizes and for different body materials. Auld can supply specially designed valves to suit process conditions other than those shown.

Body size	Seat bore	Body material		
		Cast iron Max. temp 425°F	Cast steel Max. temp 850°F	Cast molysteel Max. temp 950°F
2" x 3"	1½"	180 psig	500 psig	500 psig
2½" x 3"	1¾"	180	275	275
2" x 4"	1½"	-	1100	1100
3" x 4"	2" & 2½"	180	750	750
4" x 5"	3"	150	150	150
4" x 6"	3"	-	800	800
5" x 6"	3½" & 4"	180	450	450
6" x 8"	4½", 5" & 5½"	180	400	400
8" x 10"	5½", 6" & 6½"	180	350	350
10" x 12"	7", 7½", 8" & 8½"	125	300	300

All other wetted parts are manufactured from stainless steel.

Overall dimensions and weights

Inlet and outlet size	A	B	C	Weight
	C/L to top	C/L to outlet flange	C/L to inlet flange	kg (approx)
2" x 3"	17"	5½"	7"	55
2½" x 3"	17"	5½"	7"	57
2" x 4"	21"	6½"	7½"	77
3" x 4"	21"	6½"	7½"	80
4" x 5"	21¼"	8"	8¾"	110
4" x 6"	32½"	8¼"	10¼"	165
5" x 6"	32½"	8¼"	10¼"	170
6" x 8"	42¾"	10"	14"	250
8" x 10"	42¾"	10"	14"	355
10" x 12"	54"	12¾"	12"	443

Parts list

Part Name	Drg Ref	Material
Body	1	Carbon steel / iron
Inlet piece	2	Carbon steel / iron
Bonnet / (pillars)	3	Iron / (steel)
Bonnet cover / (crosshead)	4	Iron / (steel)
Spindle	5	Stainless steel
Valve seat	6	Stainless steel
Internal valve lid	7	Stainless steel
Valve pin	8	Stainless steel
Piston	9	Bronze / stainless steel
Cylinder	10	Bronze / stainless steel
Spring	11	Steel
Spring caps top & bottom	12 & 13	Bronze / mild steel
Piston bush	14	Bronze
Adjusting screw bush	15	Bronze
Adjusting screw	16	Bronze
Column to cover bolts & nuts	19 & 20	Steel
Chest to column studs nuts	21 & 22	Steel
Chest to inlet piece studs & nuts	23 & 24	Steel
Chest to inlet piece joint	25	Proprietary
PV body	26	Carbon steel / iron
PV bonnet / crosshead	27	Cast iron / steel
PV spindle	28	Stainless steel
PV seat	29	Stainless steel
PV seat pin	30	Steel
PV valve plug	31	Stainless steel
PV guide	33	Bronze
PV spring	34	Steel
PV spring cap top & bottom	35 & 36	Bronze / steel
PV adjusting screw	37	Brass
PV split pin	39	Brass
PV dome to chest stud & nuts	40 & 41	Steel
PV to MV stud & nuts	42 & 43	Steel
PV to MV joint	44	Proprietary

Installation

The DA full lift safety valve should be installed in a vertical position with the main spring above the inlet flange. On steam duties, it is advisable to keep the valve free of condensate by installing it at a 'high point' in the main and fitting adequately sized steam traps on the inlet. On water or similar liquid duties, the safety valve should be installed at a 'low point' in the main, with appropriate air vents at a 'high point'; trapped air in the valve could cause erratic performance. Where possible, adequate clearance on top of the valve to ease adjustment and servicing.

Handling

Appropriate slings should be fitted around the body of the valve when lifting.

Pipeline cleanliness

Welding slag, scale or foreign matter which is allowed to enter the valve immediately after installation is very likely to damage the seat of the safety valve, thereby causing it to malfunction usually by leaking. It is therefore imperative to ensure that the pipeline is completely clean before installing the valve in position.

General

Safety valves are critical items of plant safety, it is therefore important that they are installed by experienced and competent personnel.

Setting the safety valve

The safety valve may be set on line if convenient or on a test rig. Firstly, remove the locking ferrules from the main valve and pilot valve then proceed as follows:

Setting the main valve

- 'Gag' the pilot valve by screwing down the spring adjusting screw (37) to substantially beyond its set point.
- Increase the inlet pressure until a light discharge occurs at the main valve. Note the pressure and adjust the main spring compression screw (16) as necessary.
- **Caution** - take care not to rotate the main valve spindle and lid when turning the adjusting screw.

Setting the pilot valve

- Lower the inlet pressure to just below the set pressure of the main valve
- Relax the pressure on the pilot valve spring by turning the adjusting screw in an anti-clockwise direction until the pilot valve starts to operate, indicated by the commencement of lift of the main valve piston (9).
- **Caution -** avoid rotation of the pilot valve spindle and lid during adjustment.
- Slightly increase the pilot valve spring compression until the pilot valve operates when the inlet pressure is slightly above the set point of the main valve (approximately 1.0 to 3.0% above main valve setting).
- Refit the locking ferrules to main and pilot valve

Maintenance - general

For prolonged accurate and reliable operation, the valve should be stripped, cleaned and examined at yearly intervals and any worn or damaged parts replaced. Spare parts may be ordered individually or as spares packs. All sub-assemblies are designed for direct installation with no fitting required.

Maintenance - main valve

- Accurately measure and note the distance 'X' between the top of the adjusting screw (16) and the top face of the cover (4) as shown on the cross section drawing on page 12.
- Slacken off the main spring compression by unscrewing the adjusting screw (16)
- Remove the nuts holding the bonnet (3) (or pillar assembly) to the valve body (1), then remove spring (11) and bonnet (3)
- Grip the spindle (5) and firmly tap upwards against the underside of the cylinder (10)
- When the cylinder is free, lift off the complete assembly thus exposing the valve (7) and valve seat (6) to view.
- Carefully examine both valve and seat for damage i.e. pitting, wire-drawing etc. If damage is not severe, carefully grind the valve and valve seat using fine carborundum grinding paste
- On completion, clean off all traces of abrasive materials
- Should the valve (7) require to be replaced, remove the valve pin (8) and lap the new valve to the seat with fine carborundum paste, wiping off all traces when finished
- Inspect the piston (9) and the cylinder for scoring
- Should the valve seat require replacement, slacken off and remove the nuts securing the valve body (1) to the inlet piece (2) and lift off the valve chest. Using a suitable soft metal drift, tap out the valve seat (6) and replace.
- Re-assemble by reversing the above steps and observing maximum cleanliness of parts during these operations. Re-set the adjusting screw (16) to the measured setting 'X'.

Maintenance - pilot valve

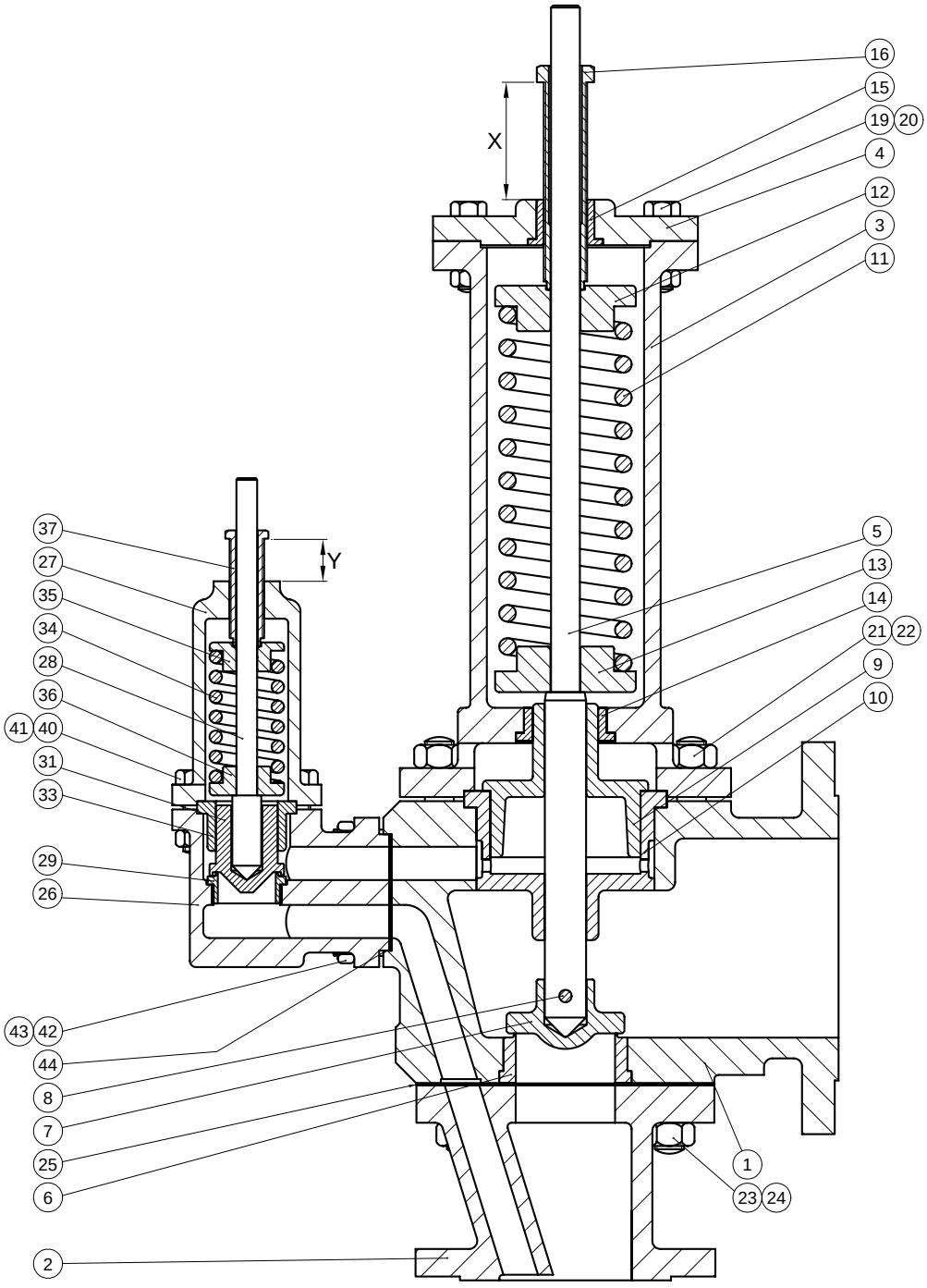
- Accurately measure the distance 'Y' between the top of the adjusting screw (37) and top of the face of the bonnet (27).
- Slacken off the pilot spring compression by unscrewing the adjusting screw (37).
- Remove the nuts holding the bonnet (3) to the valve body (1).
- Grasp the spindle and the bonnet (27), then firmly tap upwards to free the valve guide (33) seating in the valve body (26).
- Lift off the complete upper assembly thus exposing the valve (21) and the valve seat (29) to view.
- Examine the valve and seat for damage and repair or replace as described for the main valve.
- Re-assemble and reset the distance 'Y' on the pilot valve.

Operation check

Auld Valves recommend that the safety valve is floated to check the spring operating settings before the valve is returned to normal service. (see 'Setting the safety valve' on page 10).

DA column valve

Note the measured settings 'X' and 'Y' shown on the cross section before stripping valve.



Spares packs

Complete spares packs for the DA full lift safety valve are available to suit the valve size. Spares packs include the following items:

Main valve	Valve seat	Item No.6
	Internal valve lid	Item No.7
	Spring	Item No.11
	Spring cap (2)	Item No.12 & 13
Pilot valve	Valve seat	Item No.29
	Valve plug	Item No.31
	Spring	Item 34
	Spring cap (2)	Item 35 & 36

Useful conversions

Multiply	By	To obtain
mbar	0.001	bar
Pa (N/mm^2)	0.00001	bar
kgf/cm^2	0.9807	bar
lb/in^2	0.069	bar
atmosphere	1.013	bar
in H_20	0.0025	bar
ft H_20	0.03	bar
m H_20	0.098	bar
mm Hg	0.0013	bar
in Hg	0.0339	bar
lb/s	1633	kg/h
lb/min	27.216	kg/h
lb/h	0.4536	kg/h
UK ton/h	1016	kg/h
t/h	1000	kg/h
kg/s	3600	kg/h
L/s	3.6	m^3/h
L/m	0.06	m^3/h
L/h	0.001	m^3/h
UK gal/s	16.364	m^3/h
UK gal/min	0.2728	m^3/h
UK gal/h	0.004546	m^3/h
US gal/min	0.2272	m^3/h
ft^3/min	1.699	m^3/h
m^3/s	3600	m^3/h
m^3/min	60	m^3/h

Fault finding

The majority of problems associated with DA full lift safety valves are caused immediately following installation by pipe slag, foreign matter and pipe scale being allowed to enter the valve during installation. If the valve is found to be leaking past the seat, it will require to be stripped and examined for seat damage. (see 'Maintenance' on page 11).

In the unlikely event of the valve setting having altered during transit, it should be reset using the procedure described under 'Setting the safety valve' on page 10.