FINAL CONTROL ELEMENT

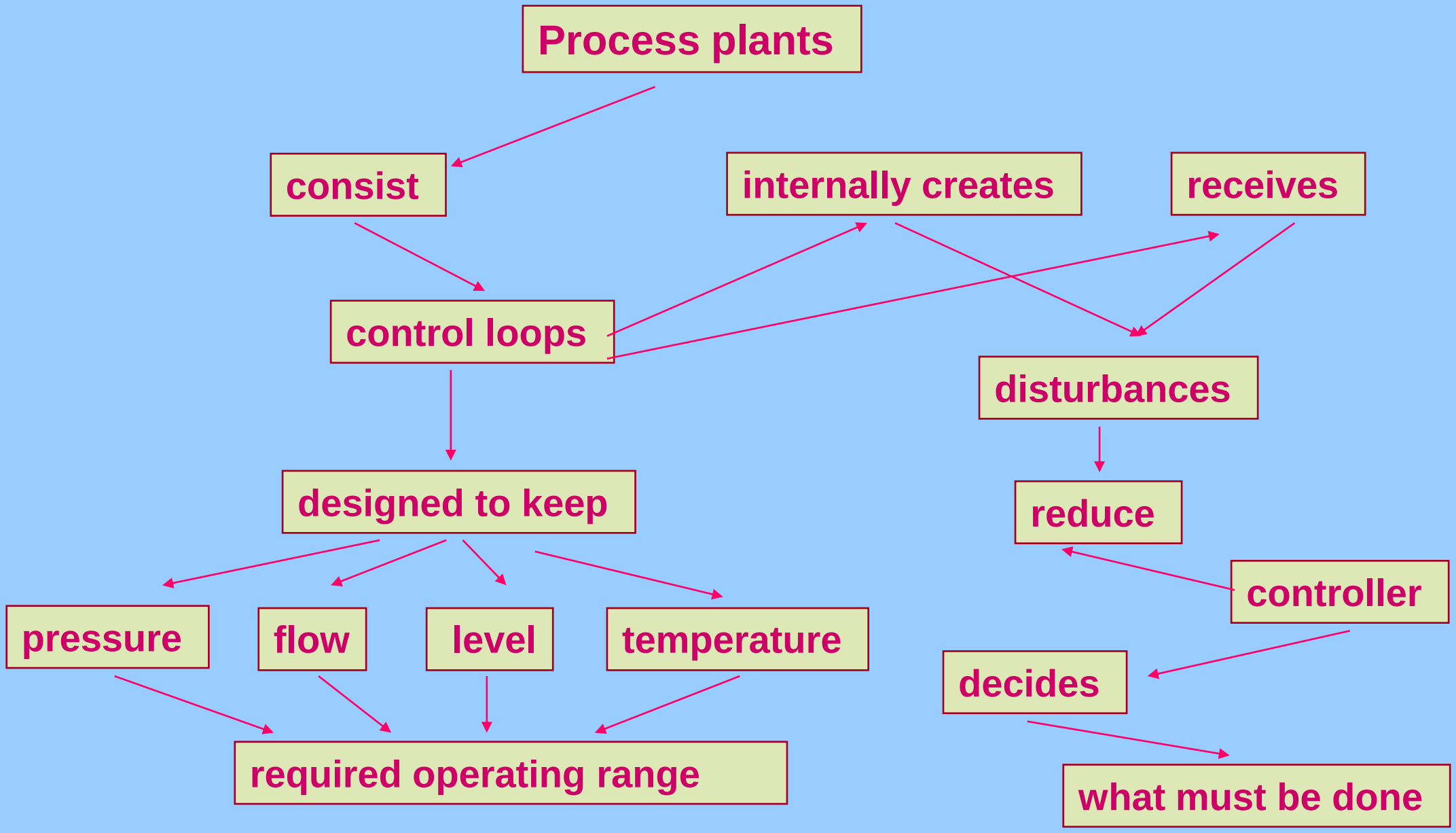
CONTROL SYSTEM MODULE 1

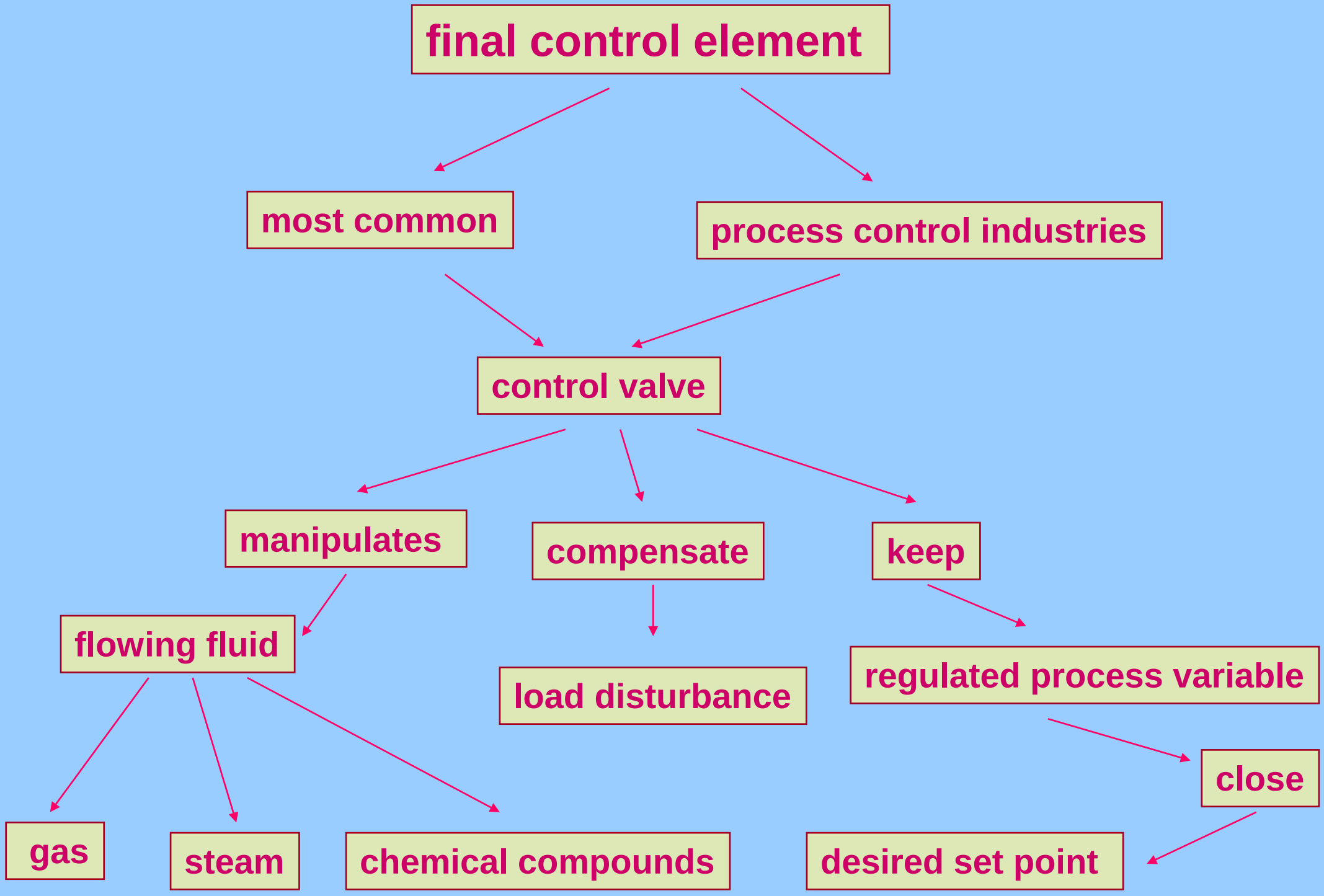
UNIT 4

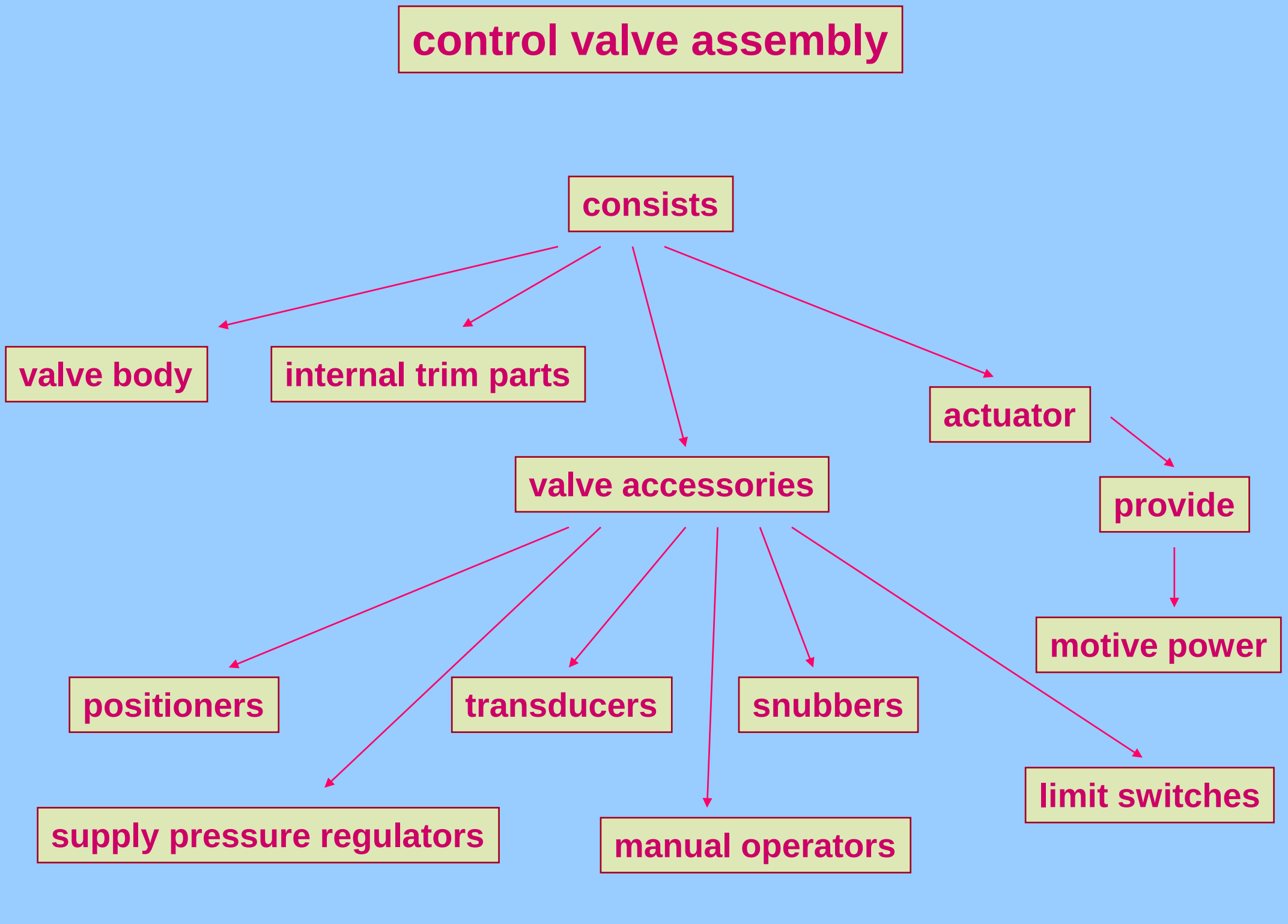
ZERY ENGINEERING INSTITUTE OF TECHNOLOGY

Table of Contents

Introduction to Control Valves

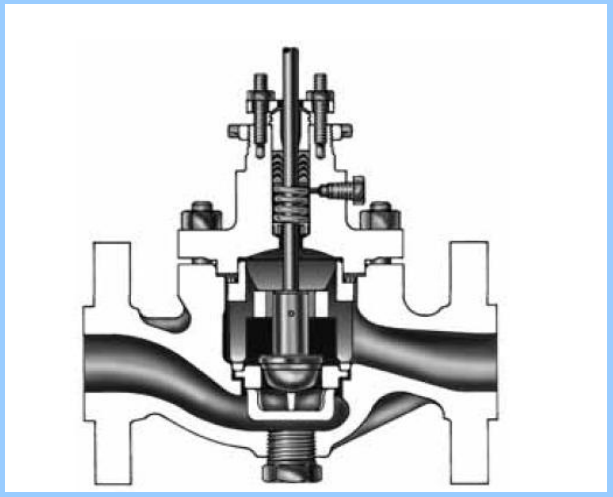


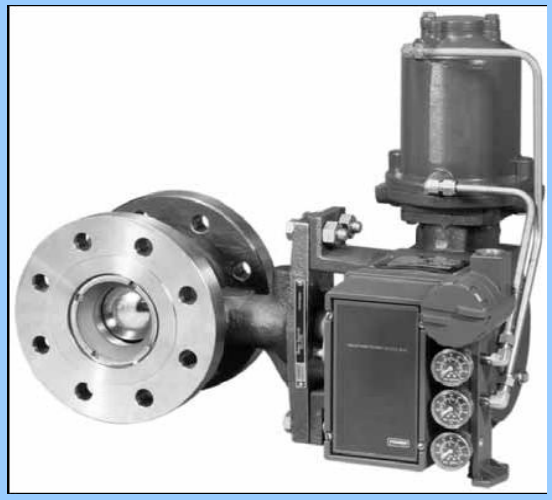

final control element
most common
process control industries
control valve
manipulates
compensate
keep
flowing fluid
load disturbance
regulated process variable
close
gas
steam
chemical compounds
desired set point


control valve assembly
consists
valve body
internal trim parts
actuator
valve accessories
provide
motive power
positioners
transducers
snubbers
limit switches
supply pressure regulators
manual operators

VALVE TYPES

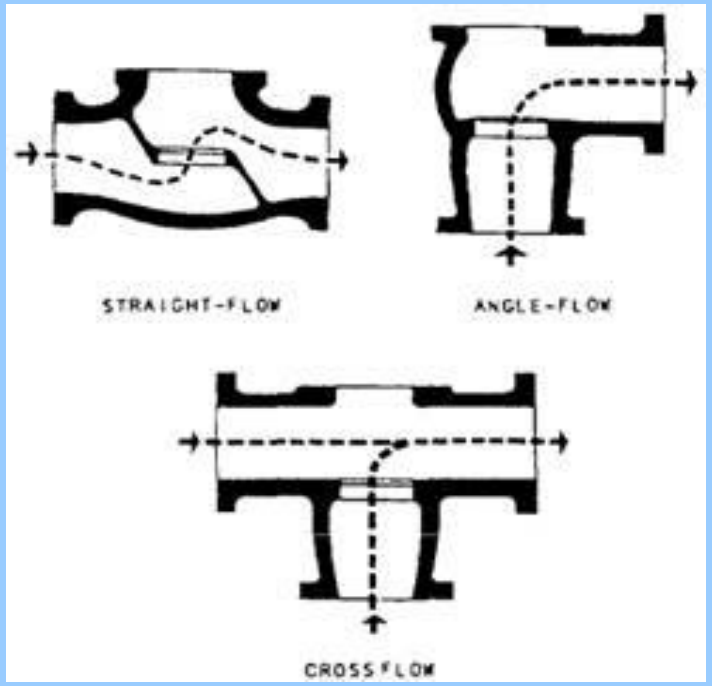
- check valves
- stop valves
  - GLOBE VALVES
  - GATE VALVES
  - BUTTERFLY VALVES
  - BALL VALVES





GLOBE VALVES

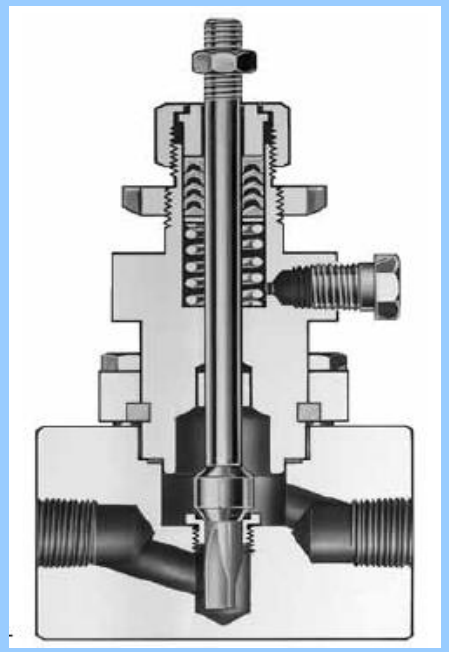
- most common
  - in existence
- common types
  - straight-flow
  - angle-flow
  - cross flow
- Double-Ported Valve Bodies
- Single-Port Valve Bodies

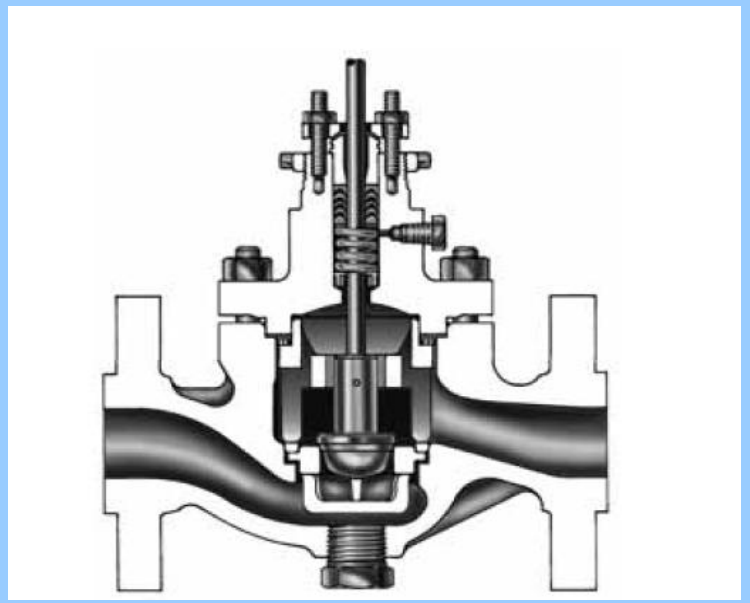


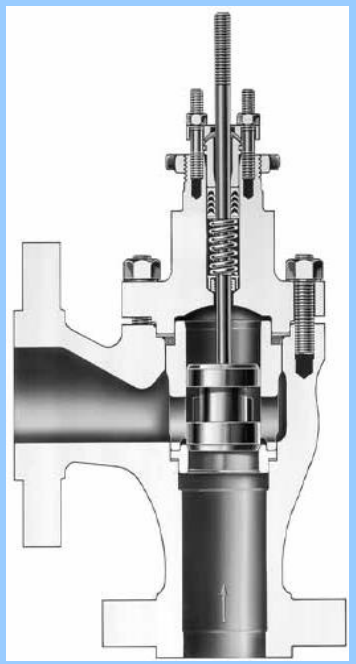
GLOBE VALVES

Single-Port Valve Bodies

- simple in construction
- most common
  - body style
- various forms
  - bar stock
  - globe
  - angle





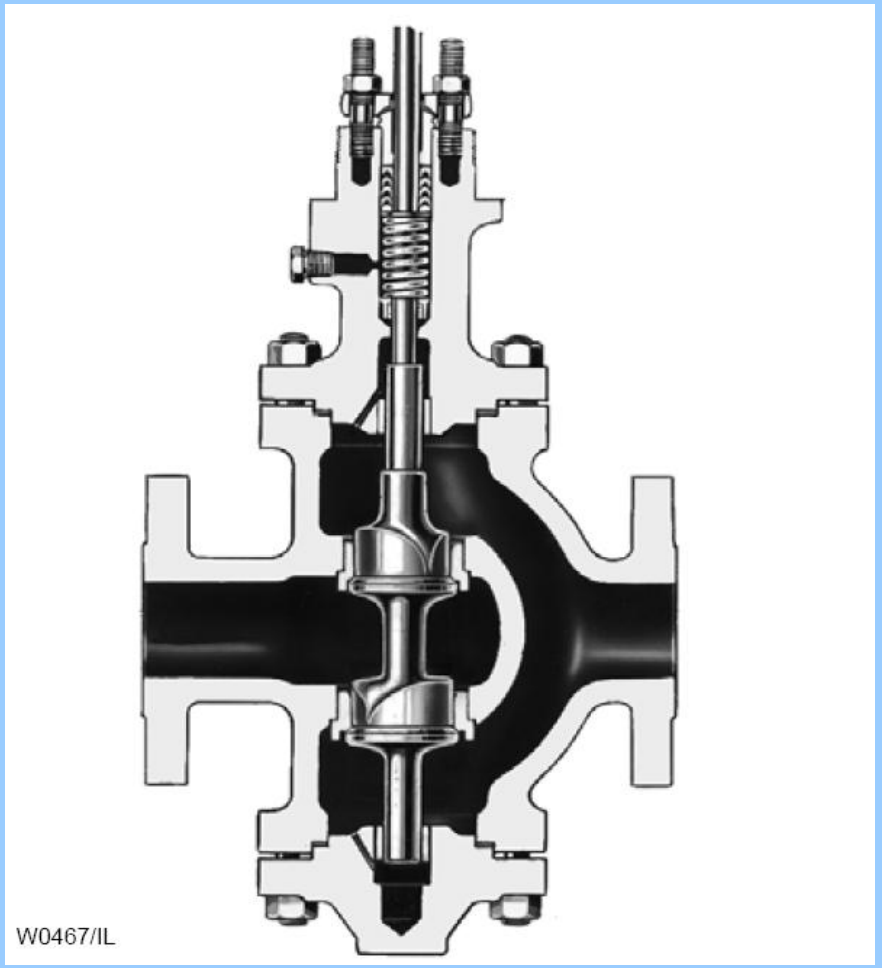


GLOBE VALVES

Double-Ported Valve Bodies

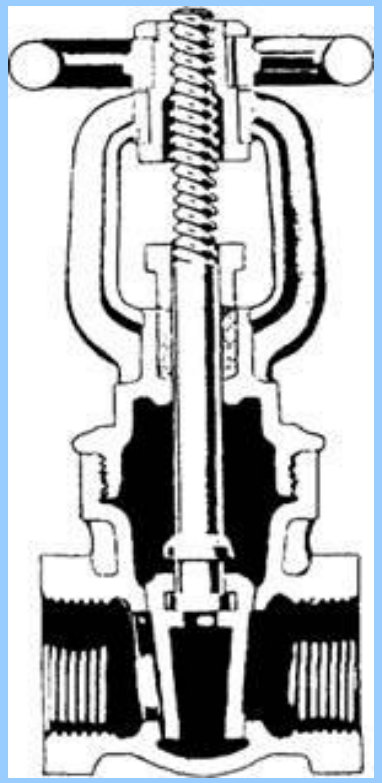
- higher capacity
- smaller actuator

than single-ported

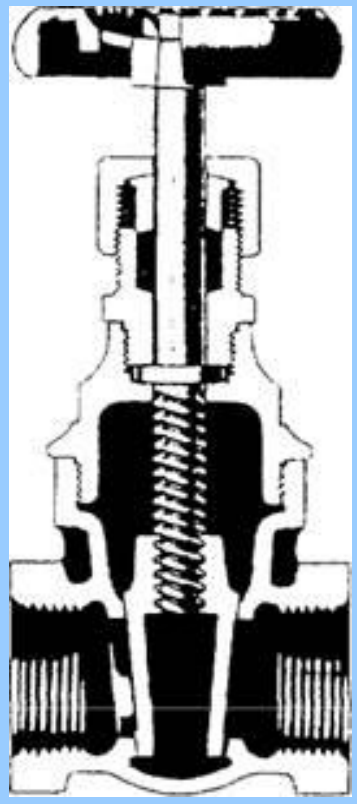


GATE VALVES

- are used
  - minimum restriction
    - is desired
- not suitable
  - for throttling
- classified as
  - RISING-STEM



  - NONRISING-STEM



BUTTERFLY VALVES

- light in weight
- relatively small
- relatively quick-acting
- can be used for throttling

- has
  - stem
  - packing
  - a handle
  - butterfly disk
  - resilient seat
  - notched positioning plate

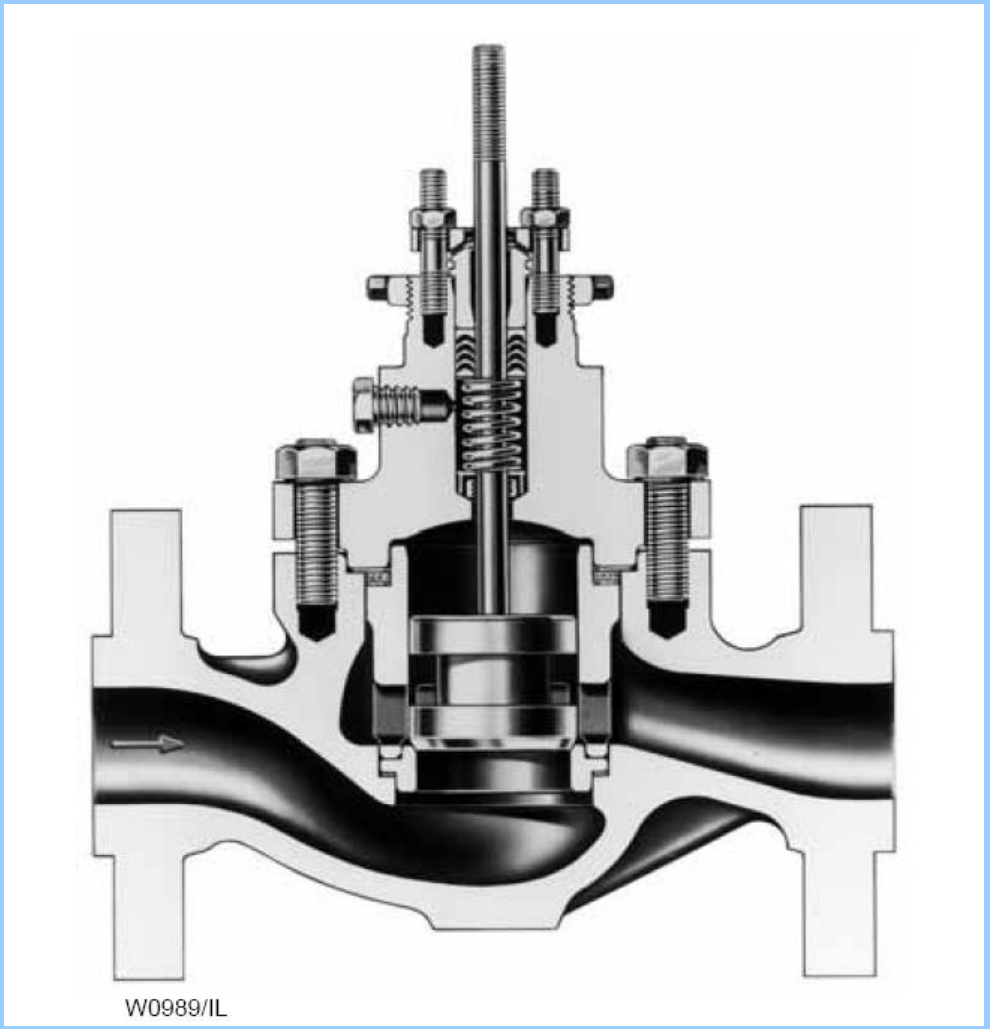
BALL VALVES

- quick-acting
- 90-degree turn to operate
- planetary gear operated
- found in the following systems
  - seawater
  - hydraulic
  - sanitary
  - air
  - trim and drain
  - oil transfer

Valve Body Bonnets

provides a means of

- mounting
  - actuator
    - to the body
- houses
  - packing box



Typical Bonnet, Flange, and Stud Bolts

Valve Body Bonnets

not have

made

the high pressure

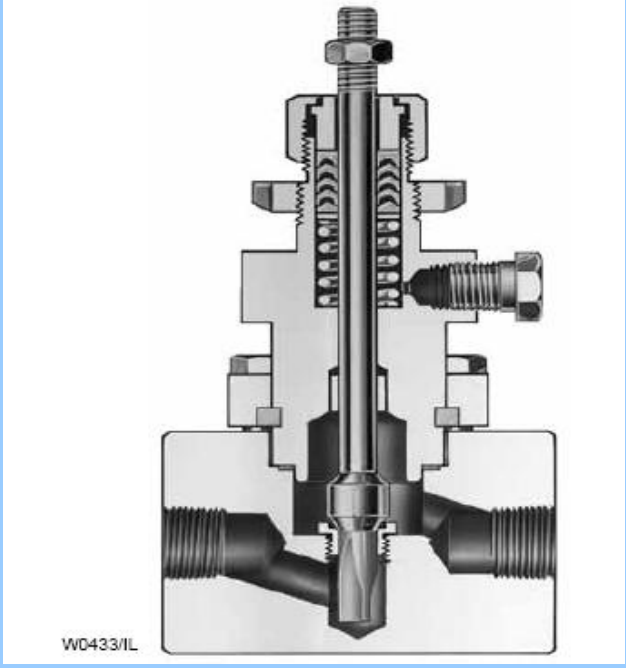
rotary valves

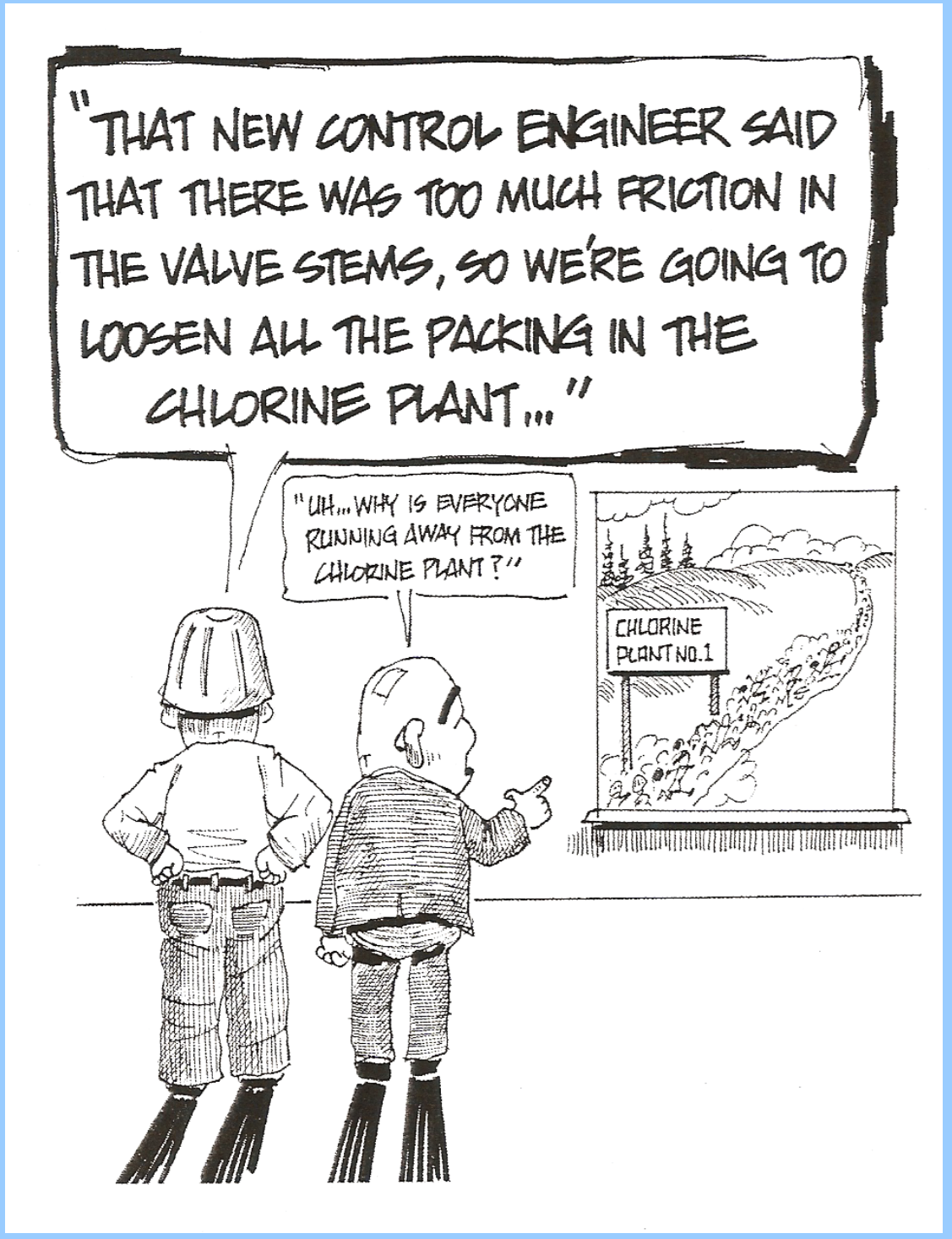
same material

screwed into

valve body

globe-style control valve

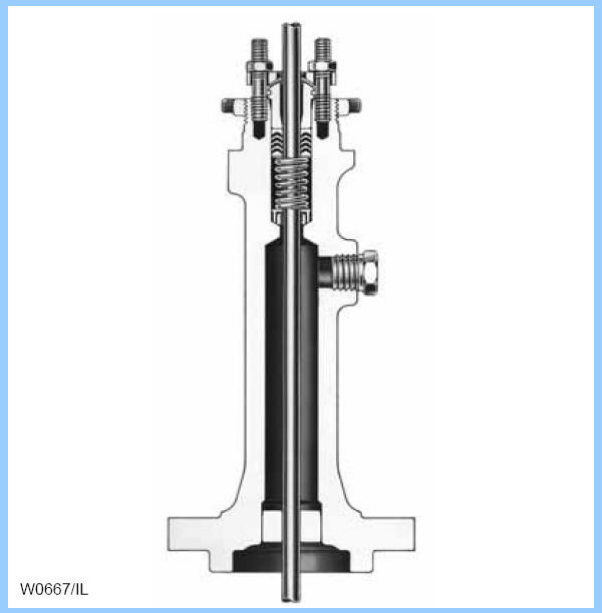



"THAT NEW CONTROL ENGINEER SAID THAT THERE WAS TOO MUCH FRICTION IN THE VALVE STEMS, SO WE'RE GOING TO LOOSEN ALL THE PACKING IN THE CHLORINE PLANT..."
"UH... WHY IS EVERYONE RUNNING AWAY FROM THE CHLORINE PLANT?"
CHLORINE PLANT NO.1

Valve Body Bonnets

Extension Bonnets

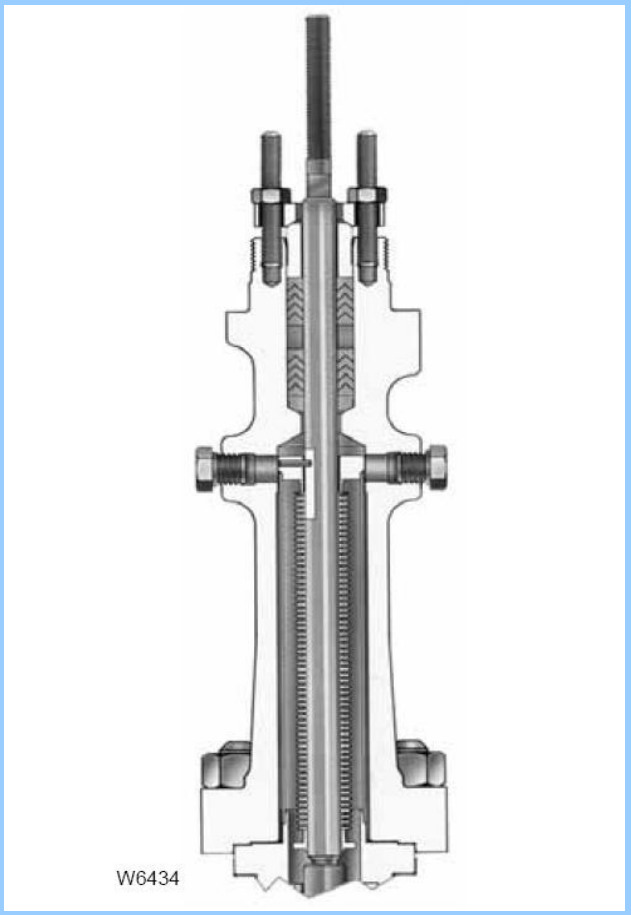
- **used**
  - **high**
  - **low**
  - → **temperature service**
    - → **protect**
      - → **valve stem packing**
- **cast**
  - → **better high-temperature service**
- **fabricated**
  - → **are preferred for cold service**



Valve Body Bonnets

Bellows Seal Bonnets

- used
  - no leakage
    - along the stem
      - can be tolerated
  - process fluid
    - toxic
    - radioactive
    - volatile
    - highly expensive



Control Valve Packing

most control valves

↓

use

↓

packing boxes

↓

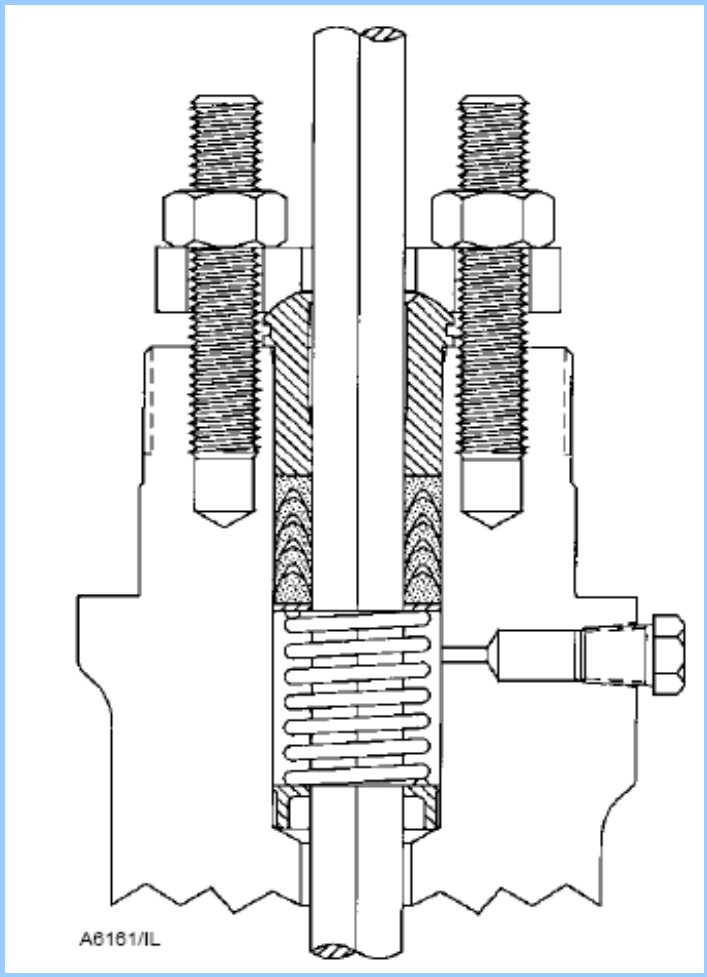
with the packing retained

↓

adjusted by

↙ ↘

flange stud bolts

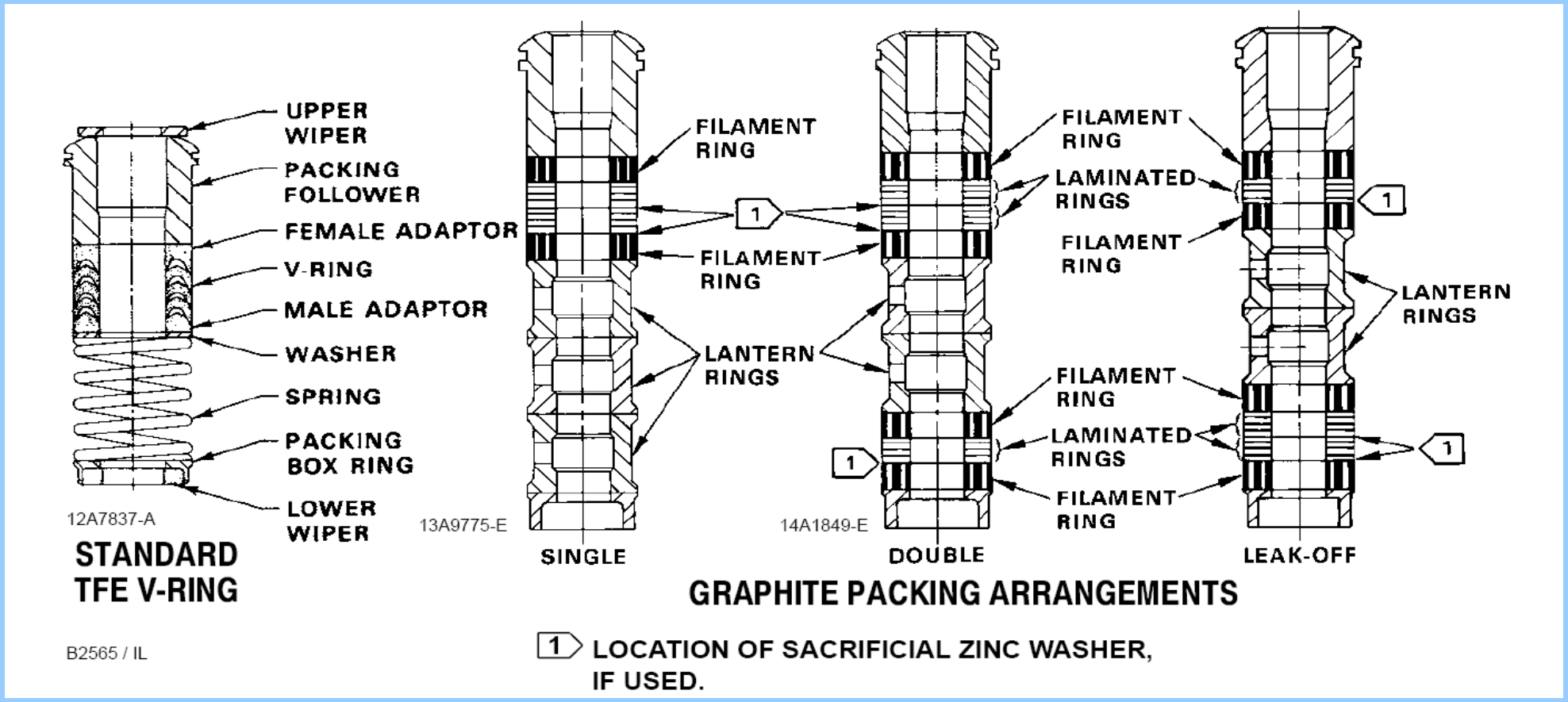


Single PTFE V-Ring Packing

Polytetrafluoroethylene (PTFE)

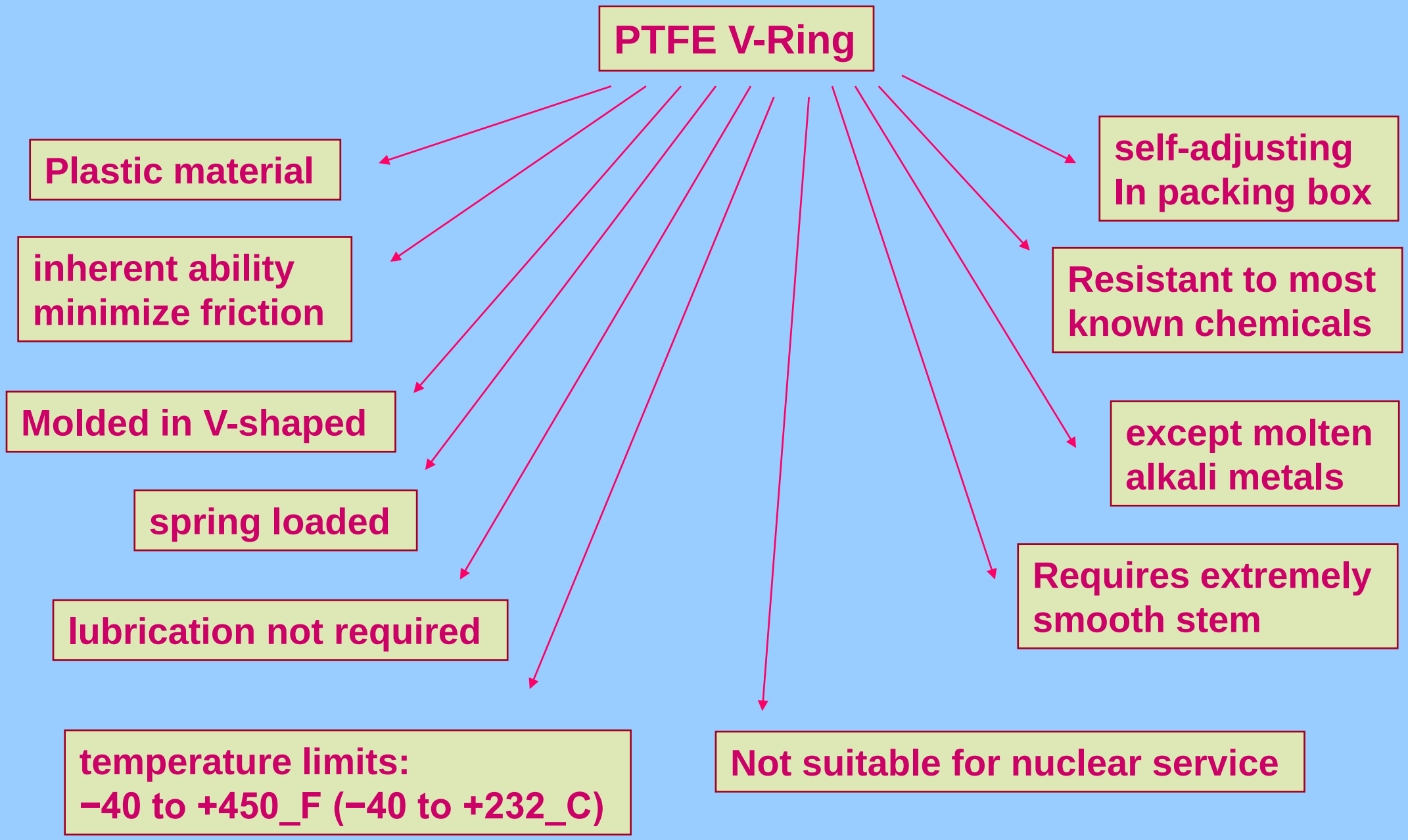
Control Valve Packing

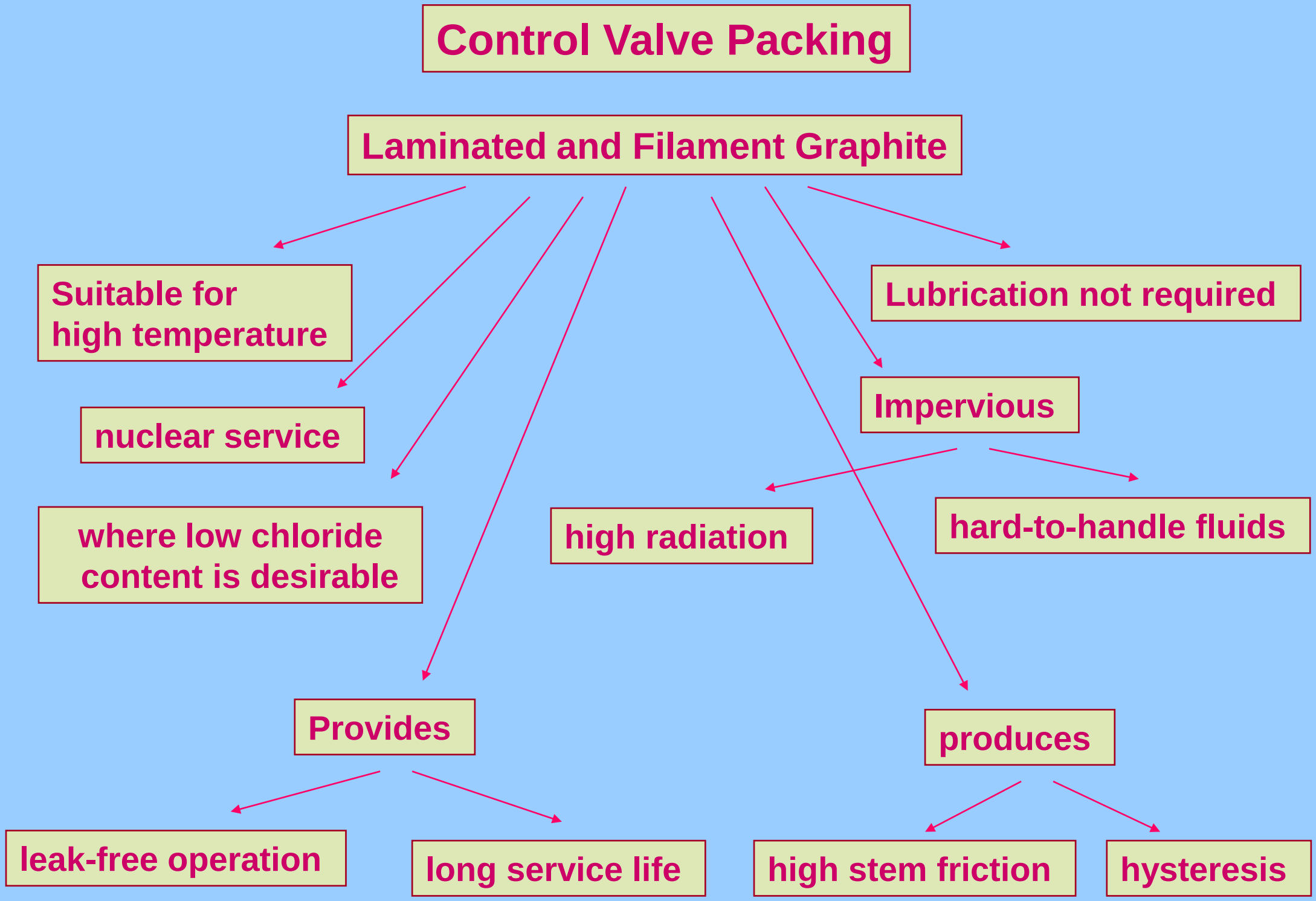
packing materials → can be used depending → on the service conditions



Comprehensive Packing Material Arrangements for Globe-Style Valve Bodies

Control Valve Packing




Control Valve Packing
Laminated and Filament Graphite
Suitable for high temperature
nuclear service
where low chloride content is desirable
Provides
leak-free operation
long service life
high radiation
Impervious
hard-to-handle fluids
Lubrication not required
produces
high stem friction
hysteresis

PTFE V-Ring

Single PTFE V-Ring Packing

uses

coil spring

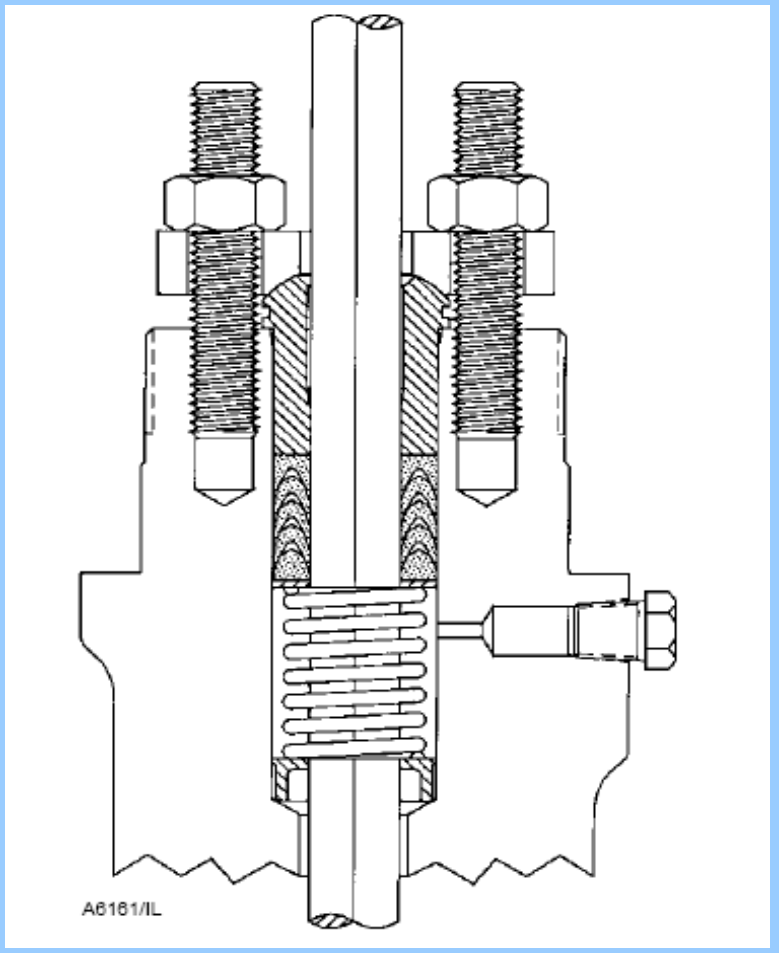
pressure

not exceed 20.7 bar (300 psi)

between

packing

packing follower



Single PTFE V-Ring Packing

PTFE V-Ring

ENVIRO-SEAL_ PTFE Packing

advanced packing method

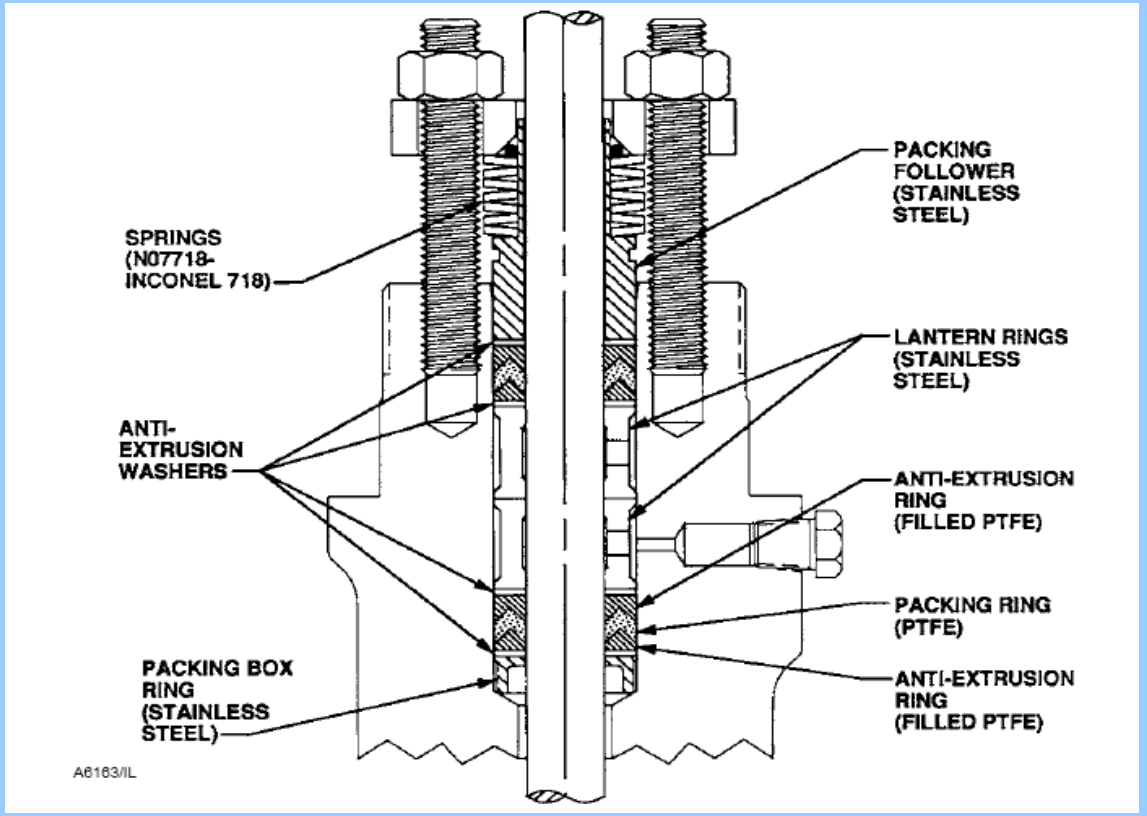
utilizes

suited to

compact, live-load spring

environmental applications

up to 51.7 bar and 232^{0}C (750 psi and 450^{0}F).



ENVIRO-SEAL Duplex Packing

Provides components

PTFE

graphite

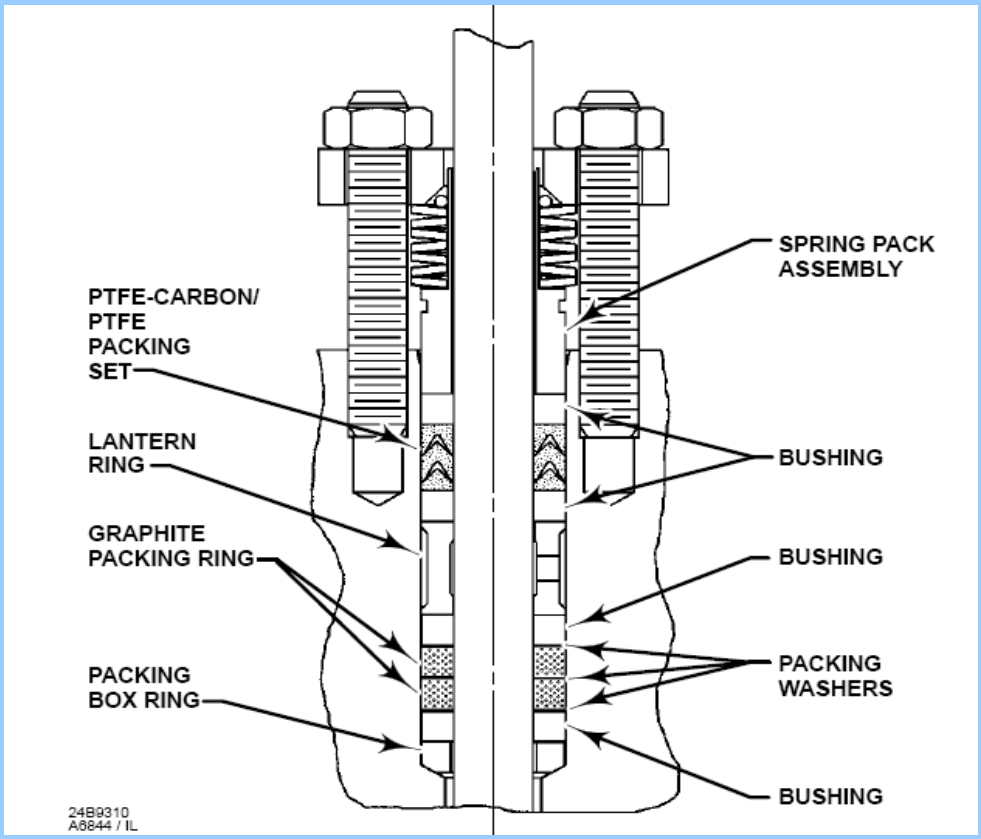
yield

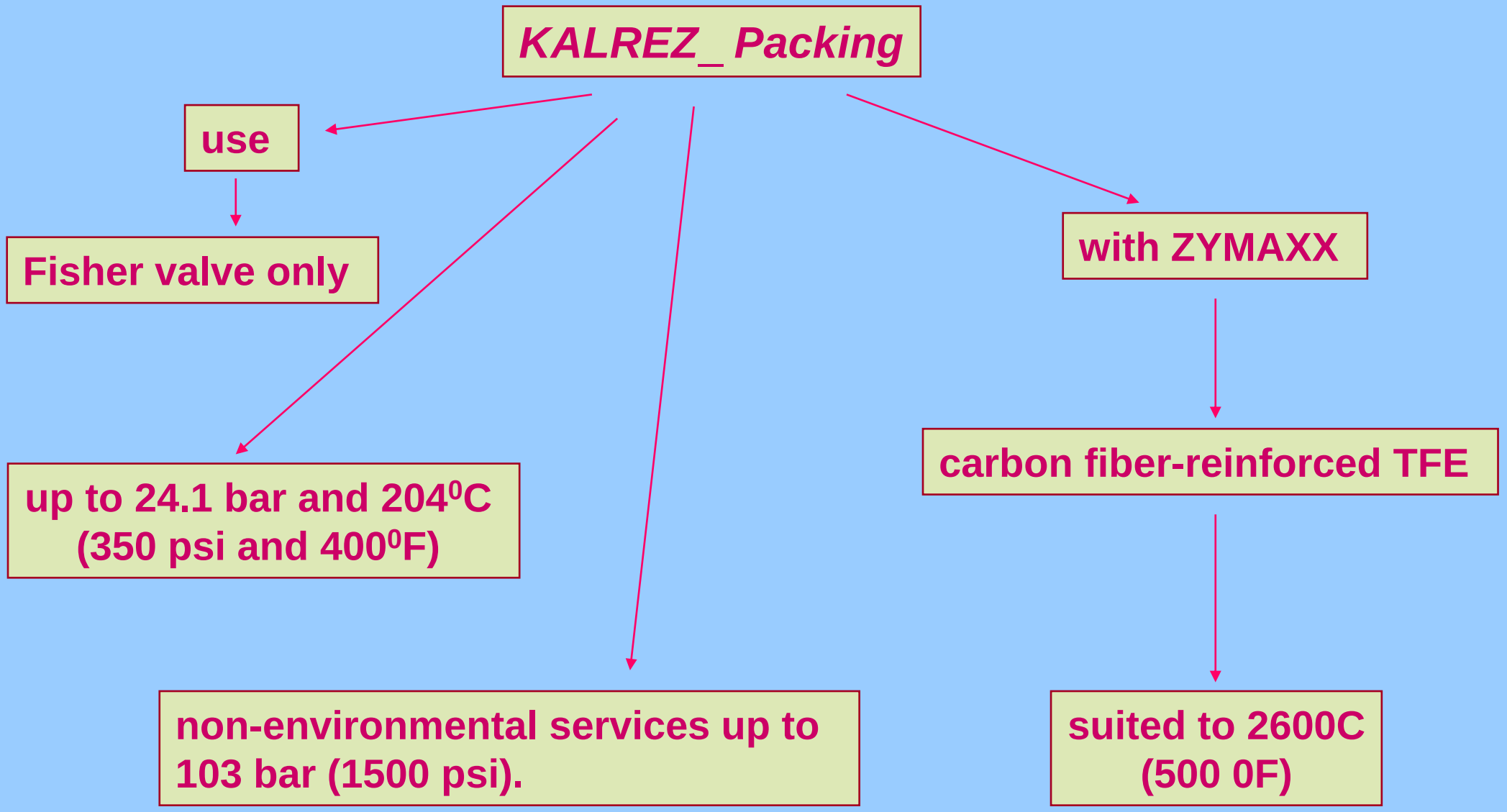
low friction

low emission

fire-tested solution

temperatures up to 232^{0}C (450^{0}F).




KALREZ_ Packing
use
Fisher valve only
up to 24.1 bar and 204⁰C
(350 psi and 400⁰F)
non-environmental services up to
103 bar (1500 psi).
with ZYMAXX
carbon fiber-reinforced TFE
suited to 2600C
(500 0F)

Laminated and Filament Graphite

ENVIRO-SEAL_ Graphite ULF

Designed for

applications at

excess of 232_C (450_F).

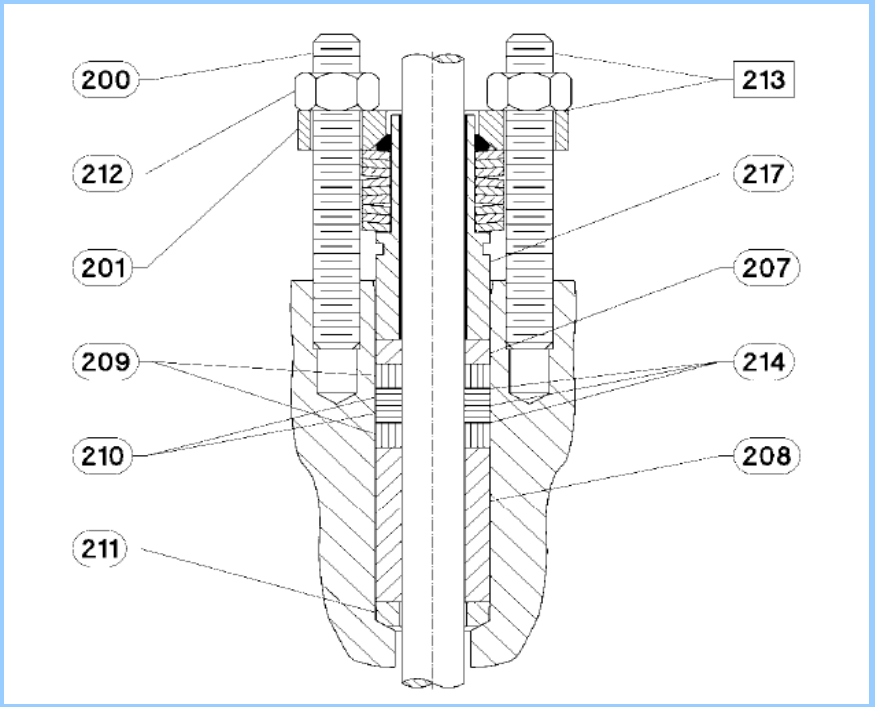
incorporates

very thin PTFE layers

inside the

each side

packing rings



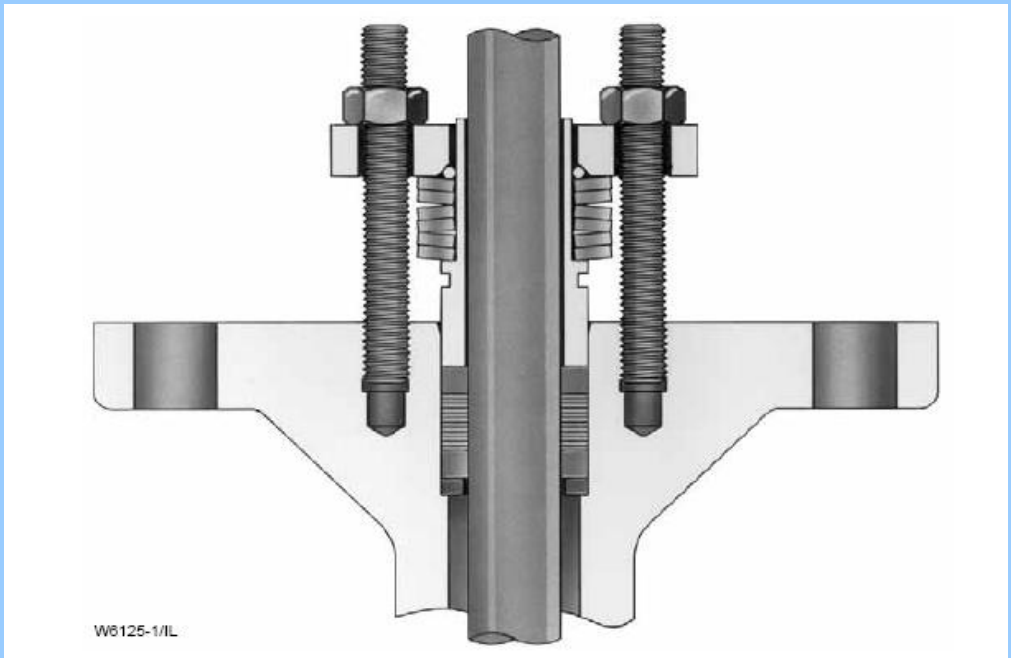
Laminated and Filament Graphite

ENVIRO-SEAL_ Graphite for Rotary Valves

from −6^{0}C to 316^{0}C (20^{0}F to 600^{0}F)

pressures to 103 bar (1500 psi)

500 ppmv EPA leakage criteria.



ENVIRONMENTAL PROTECTION AGENCY

Sliding-Stem Environmental Packing Selection

Packing System	Maximum Pressure & Temperature Limits for 500 PPM Service(1)		Seal Performance Index	Service Life Index	Packing Friction
	Customary US	Metric			
Single PTFE V-Ring	300 psi 0 to 200°F	20.7 bar -18 to 93°C	Better	Long	Very Low
ENVIRO-SEAL PTFE	See Fig. 3-25 -50 to 450°F	See Fig. 3-25 -46 to 232°C	Superior	Very Long	Low
ENVIRO-SEAL Duplex	750 psi -50 to 450°F	51.7 bar -46 to 232°C	Superior	Very Long	Low
ENVIRO-SEAL Graphite ULF	1500 psi 20 to 600°F	103 bar -7 to 315°C	Superior	Very Long	Moderate

(1) The values shown are only guidelines. These guidelines can be exceeded, but shortened packing life or increased leakage might result. The temperature ratings apply to the actual packing temperature, not to the process temperature.

Rotary Environmental Packing Selection

Packing System	Maximum Pressure & Temperature Limits for 500 PPM Service(1)		Seal Performance Index	Service Life Index	Packing Friction
	Customary US	Metric			
ENVIRO-SEAL PTFE	1500 psig -50 to 450°F	103 bar -46 to 232°C	Superior	Very Long	Low
ENVIRO-SEAL Graphite	1500 psig 20 to 600°F	103 bar -18 to 315°C	Superior	Very Long	Moderate

(1) The values shown are only guidelines. These guidelines can be exceeded, but shortened packing life or increased leakage might result. The temperature ratings apply to the actual packing temperature, not to the process temperature.

Control Valve Performance

Process Variability

non-uniformity

in the raw materials

processes

causes

variation

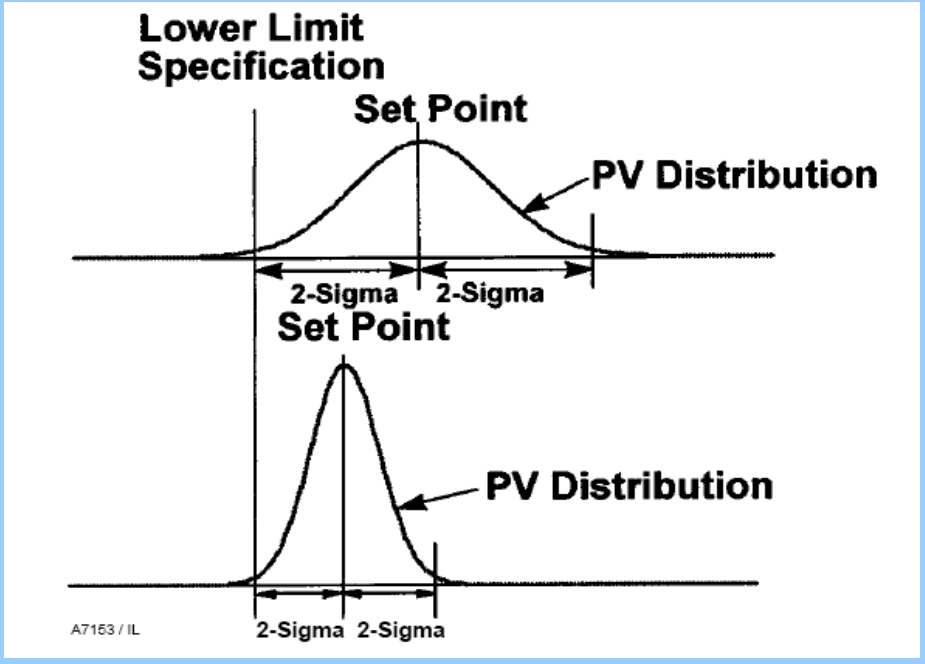
above

below

set point

typically follows

bell-shaped normal distribution.



Process Variability cont.

measure

tightness of control

Reducing

is a key

achieving

business goals

expressed

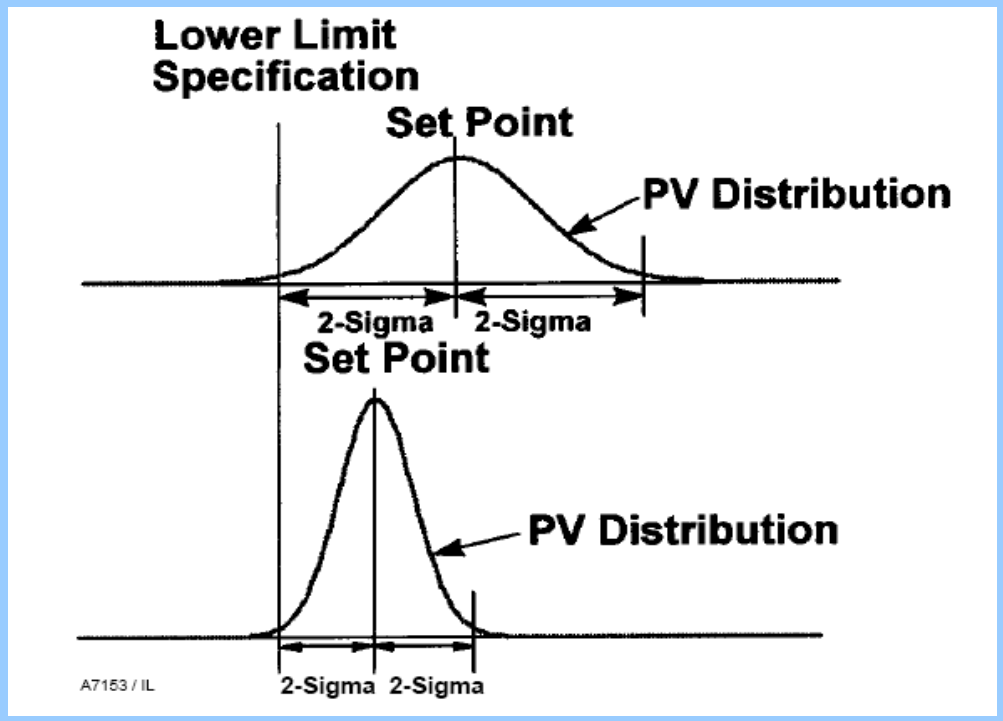
percentage

of the set point

+/-2 sigma band

statistically derived

values on this distribution



Process Variability cont.

reducing

studies

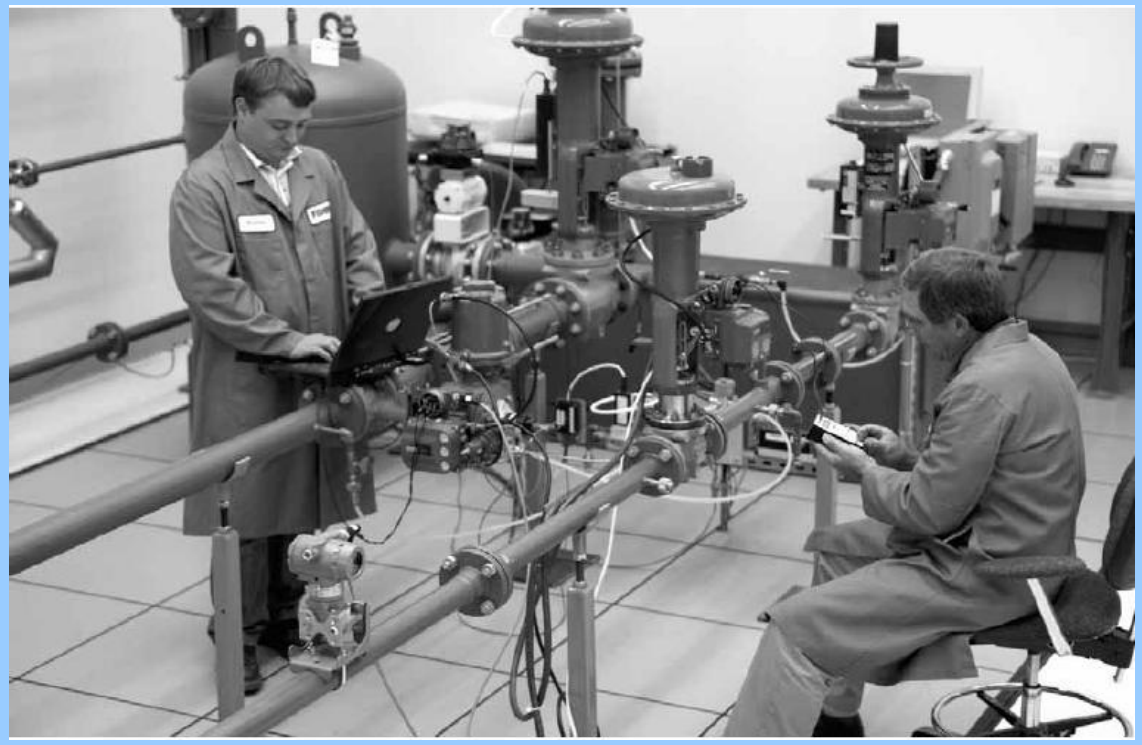
test products

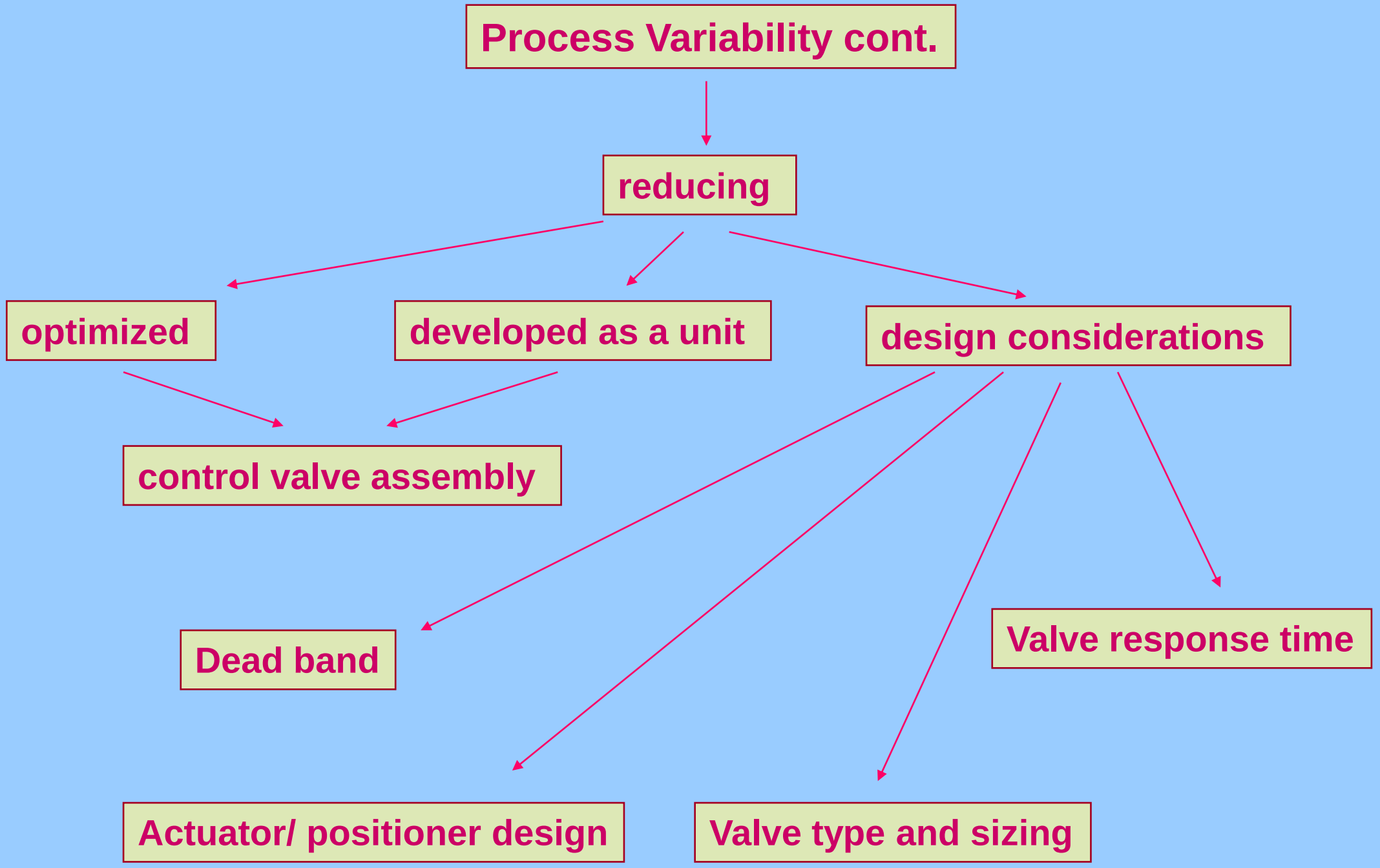
control loops

under dynamic process conditions

performed

flow lab




Process Variability cont.
reducing
optimized
developed as a unit
design considerations
control valve assembly
Dead band
Valve response time
Actuator/ positioner design
Valve type and sizing

Dead Band

range through which

input signal can be varied,

withoutchange in the output signal.

controller output (CO)

process variable (PV)

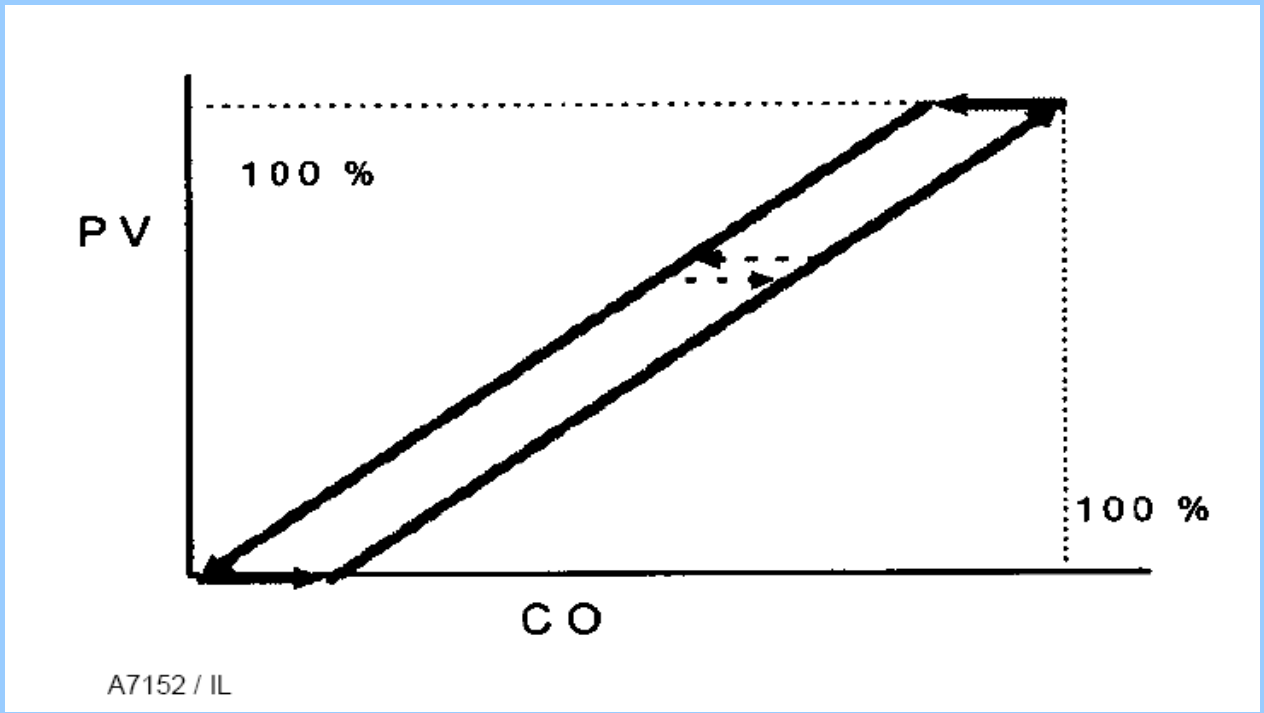
causes

friction

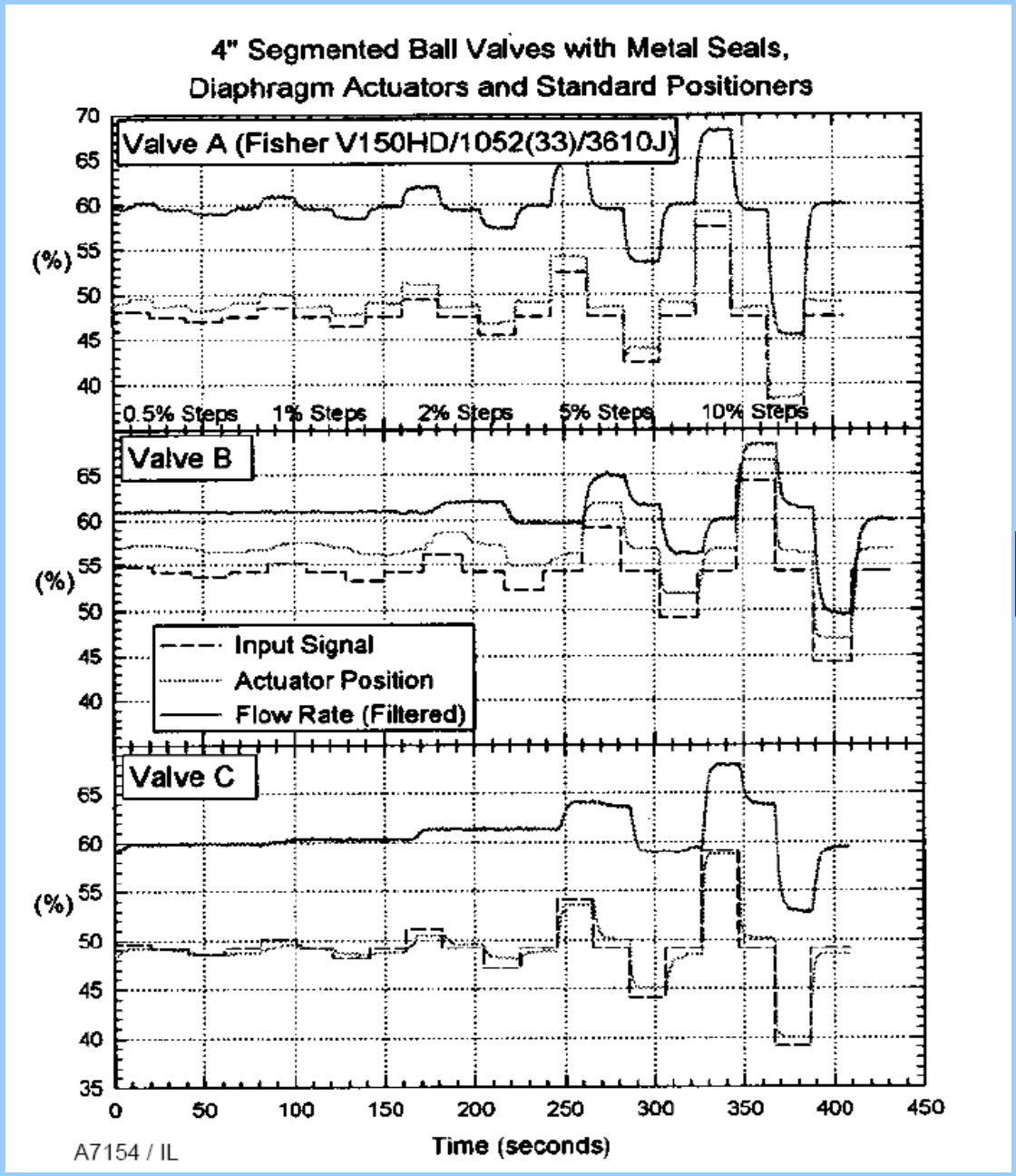
backlash

slack

looseness



Dead Band cont.



Valve A

Valve B

Valve C

process variable

responds well

considerably worse

input signal

low as 0.5 %

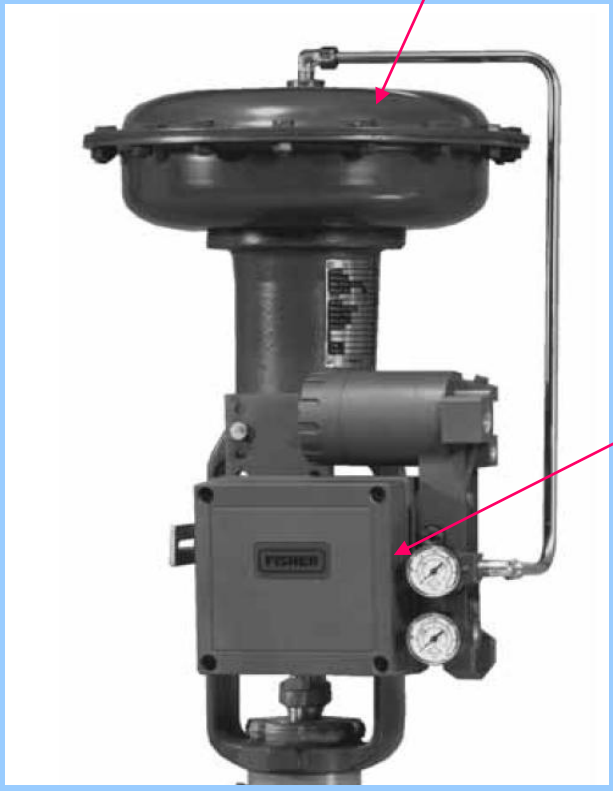
great as 10%

great as 5%

Actuator-Positioner Design

Actuator

Positioner



must be considered together

greatly affects

static performance (dead band)

the dynamic response

Positioner

allow for

most important characteristic

precise positioning accuracy

faster response

high gain

to process upsets

static

dynamic

Sensitivity of the device

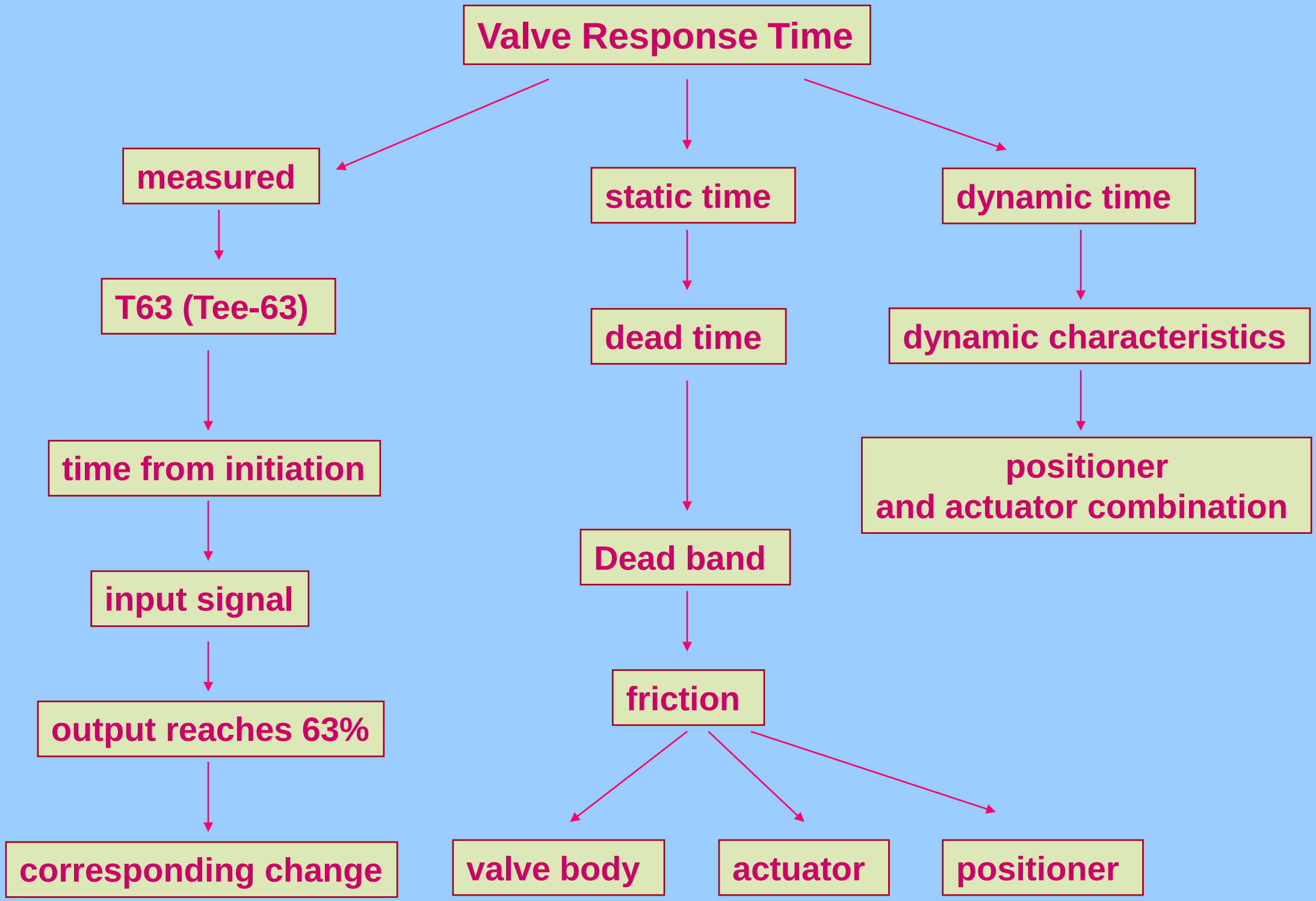
power amplifier function

(0.125% or less)

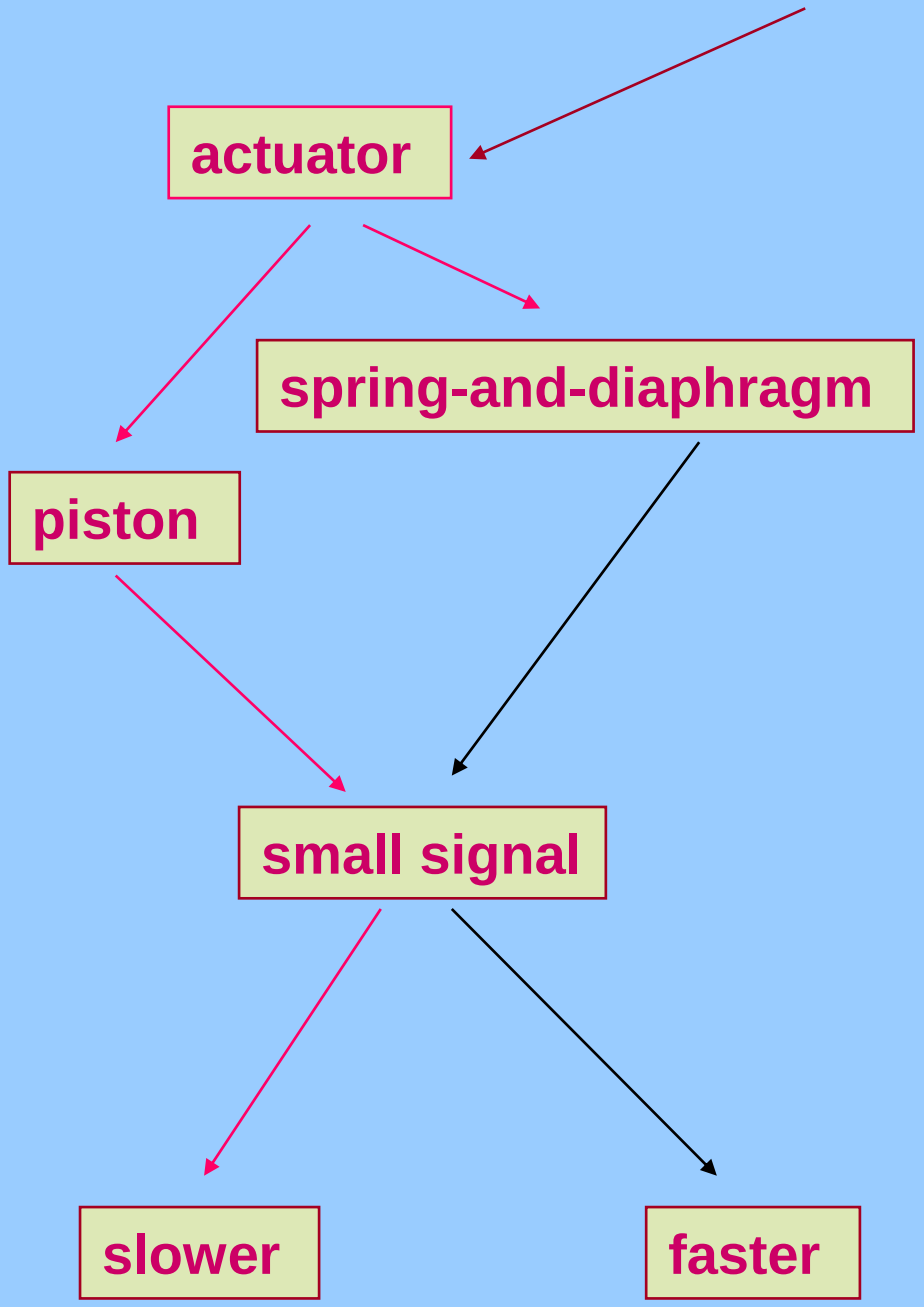
relay

spool

preamplifier


Valve Response Time
measured
static time
dynamic time
T63 (Tee-63)
dead time
dynamic characteristics
time from initiation
positioner
and actuator combination
input signal
Dead band
output reaches 63%
friction
corresponding change
valve body
actuator
positioner

Valve Response Time



VALVE RESPONSE TIME			
	STEP SIZE	T(d) SEC.	T63 SEC.
ENTECH SPEC. 4" VALVE SIZE	%	≤ 0.2	≤ 0.6
Valve A (Fisher V150HD/1052(33)/3610J)			
VALVE ACTION / OPENING	2	0.25	0.34
VALVE ACTION / CLOSING	−2	0.50	0.74
VALVE ACTION / OPENING	5	0.16	0.26
VALVE ACTION / CLOSING	−5	0.22	0.42
VALVE ACTION / OPENING	10	0.19	0.33
VALVE ACTION / CLOSING	−10	0.23	0.46
Valve B			
VALVE ACTION / OPENING	2	5.61	7.74
VALVE ACTION / CLOSING	−2	0.46	1.67
VALVE ACTION / OPENING	5	1.14	2.31
VALVE ACTION / CLOSING	−5	1.04	2
VALVE ACTION / OPENING	10	0.42	1.14
VALVE ACTION / CLOSING	−10	0.41	1.14
Valve C			
VALVE ACTION / OPENING	2	4.4	5.49
VALVE ACTION / CLOSING	−2	NR	NR
VALVE ACTION / OPENING	5	5.58	7.06
VALVE ACTION / CLOSING	−5	2.16	3.9
VALVE ACTION / OPENING	10	0.69	1.63
VALVE ACTION / CLOSING	−10	0.53	1.25
NR = No Response			

Valve Response Time Summary

Valve Type And Characterization

inherent characteristic

relationship between

flow capacity (flow or Cv).

valve travel

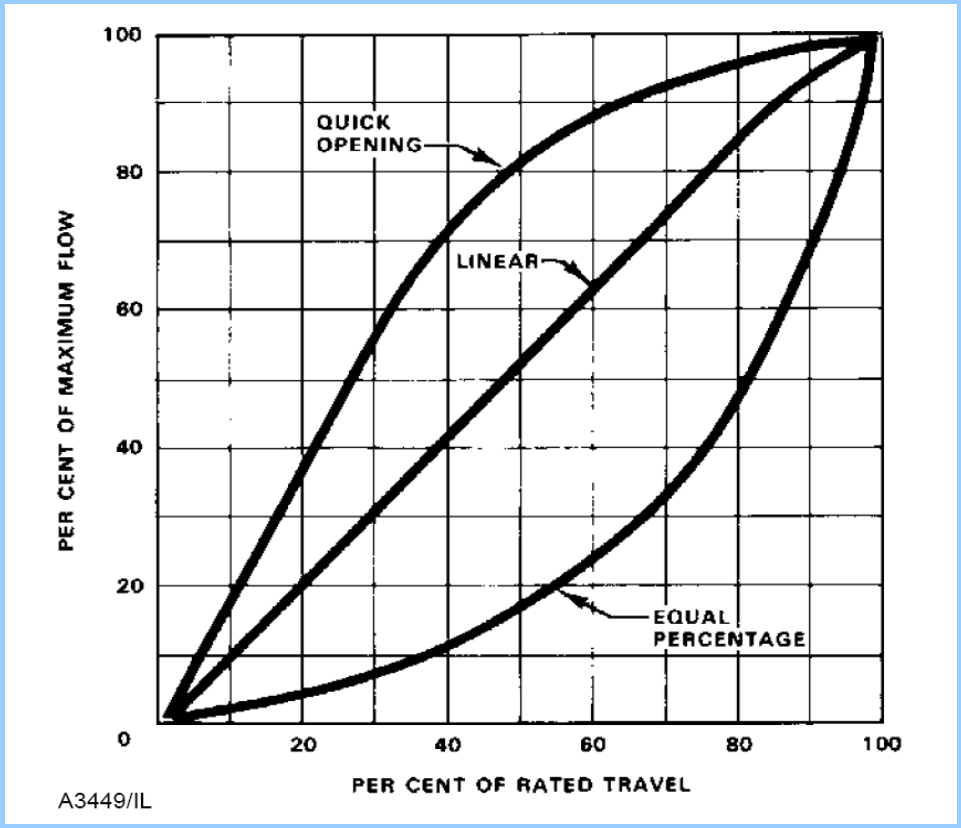
differential pressure drop

constant

valve

sufficient size

pass the required flow



Inherent Valve Characteristics

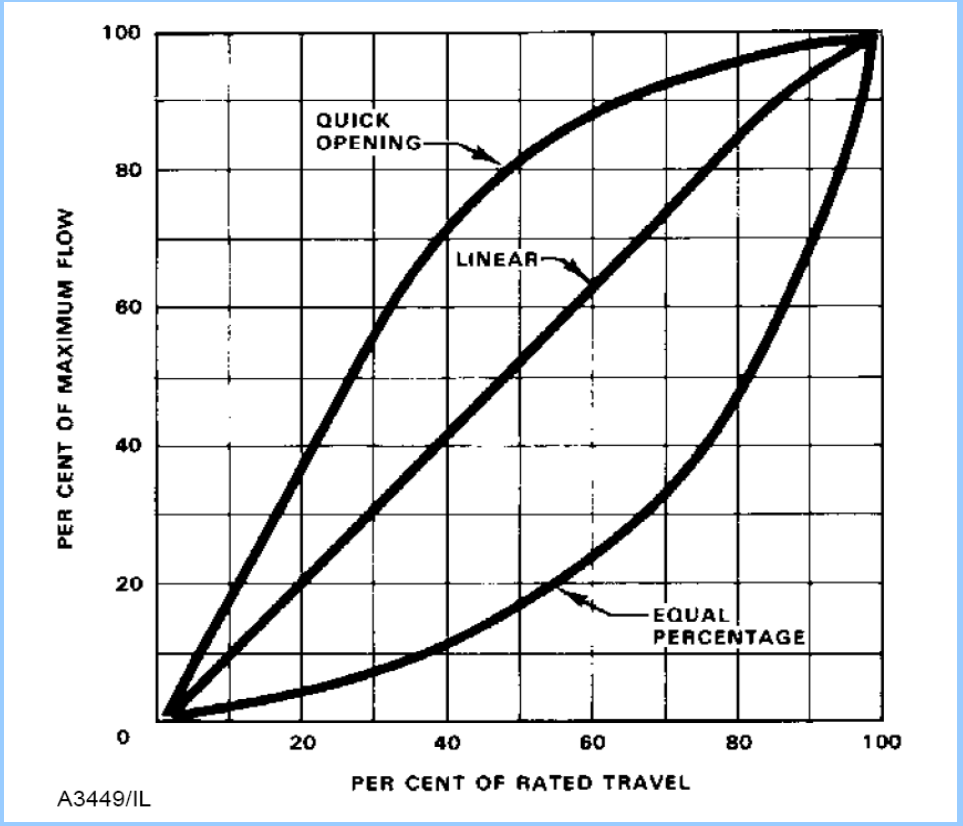
Inherent Valve Characteristics

- linear
- quick-opening
- equal percentage

→ valve gain

- constant inherent
  - full
- greatest
  - lower end
  - largest

→ range



Inherent Valve Characteristics

Installed flow characteristic

useful

pressure drop

more important

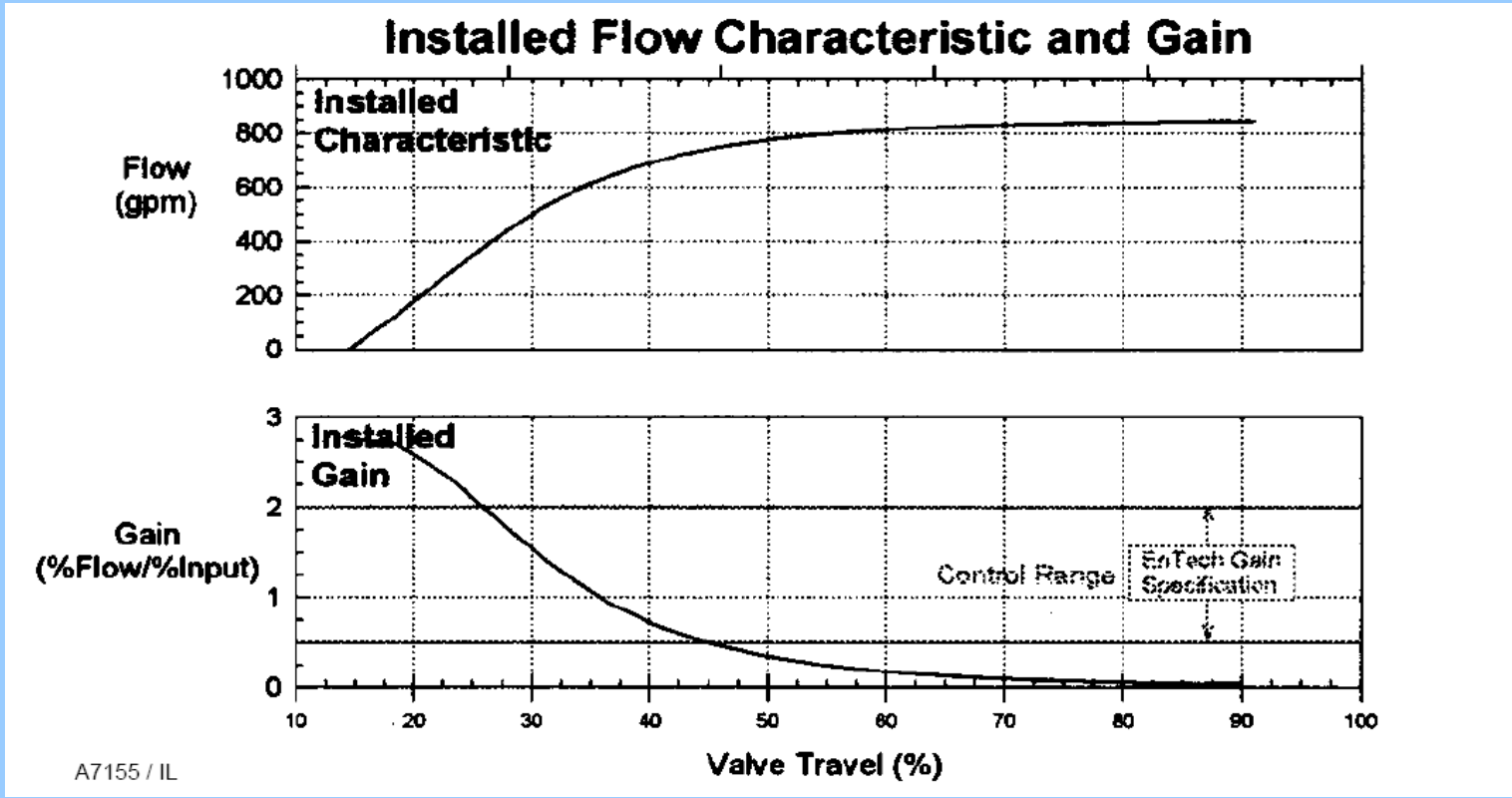
across the valve

flow characteristic

constant

change naturally

entire process



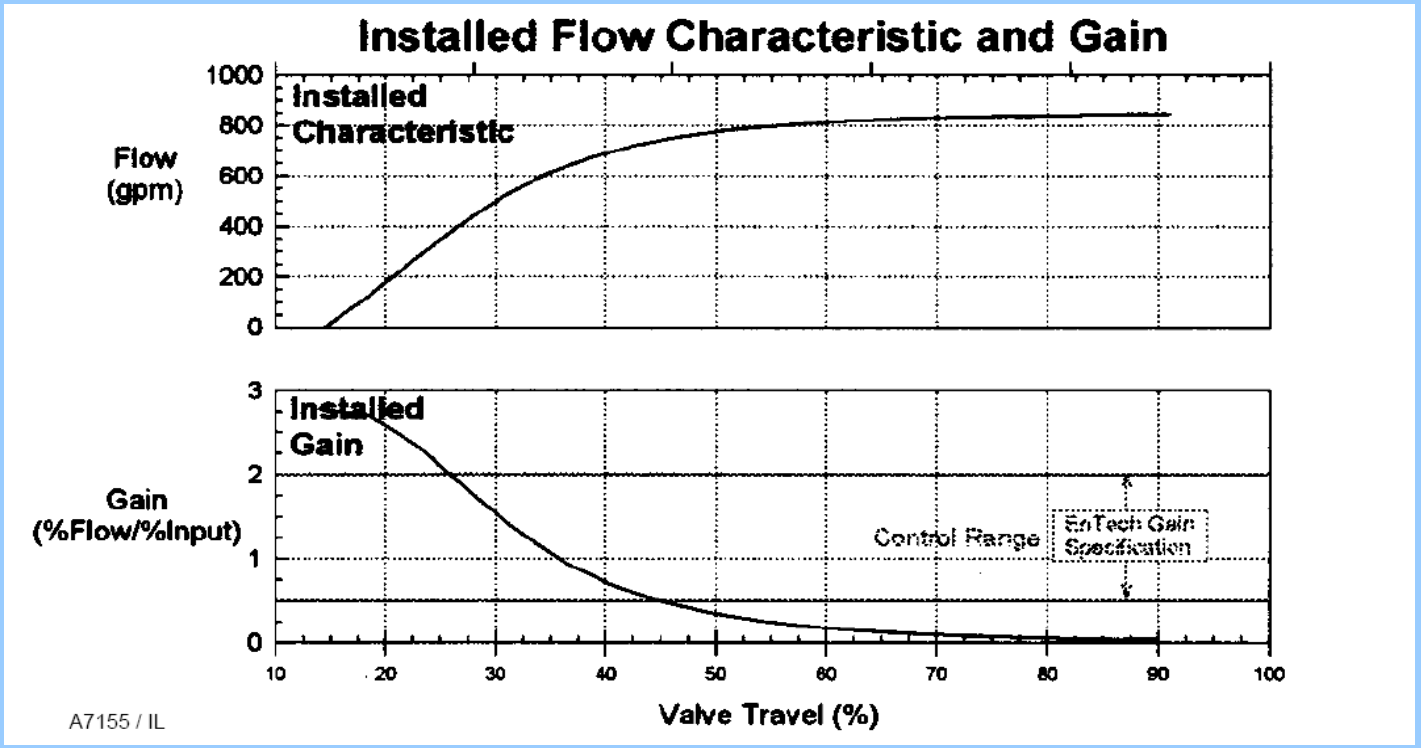
Installed flow characteristic

obtained under

laboratory conditions

by placing

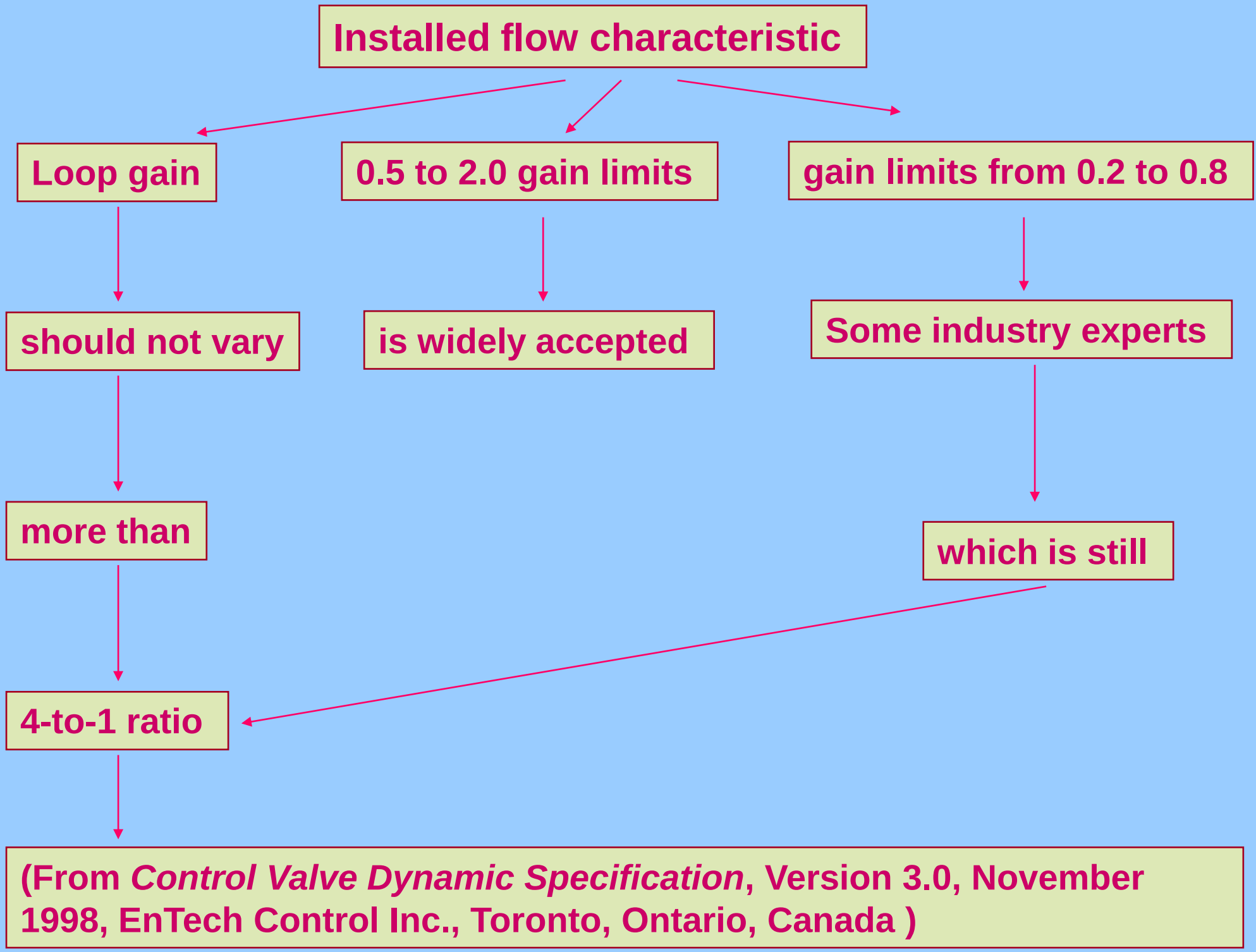
entire loop



in operation

some nominal set point

no load disturbances.


Installed flow characteristic
Loop gain
0.5 to 2.0 gain limits
gain limits from 0.2 to 0.8
should not vary
is widely accepted
Some industry experts
more than
which is still
4-to-1 ratio
(From *Control Valve Dynamic Specification*, Version 3.0, November 1998, EnTech Control Inc., Toronto, Ontario, Canada)

Installed flow characteristic

globe valve

butterfly valve

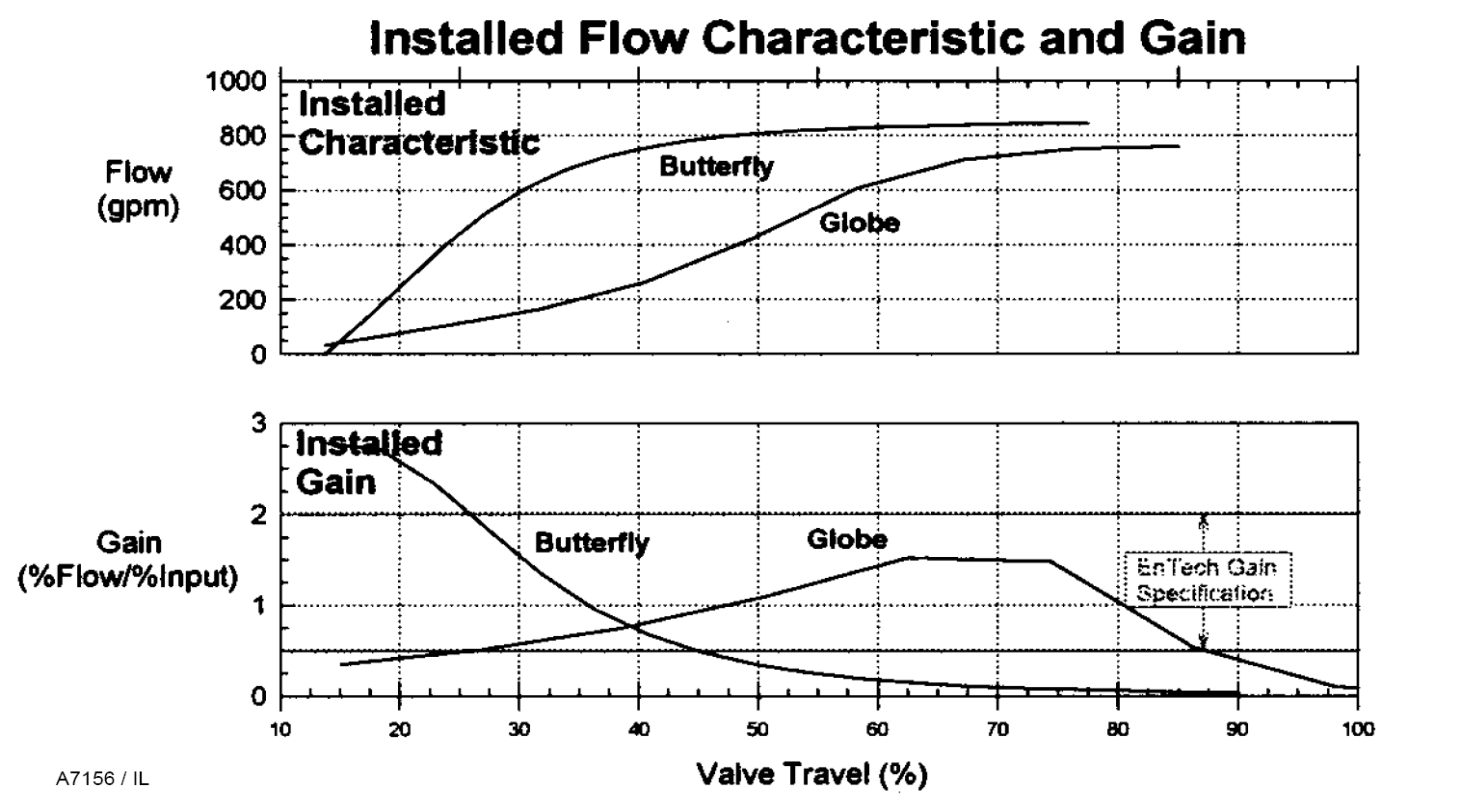
wider

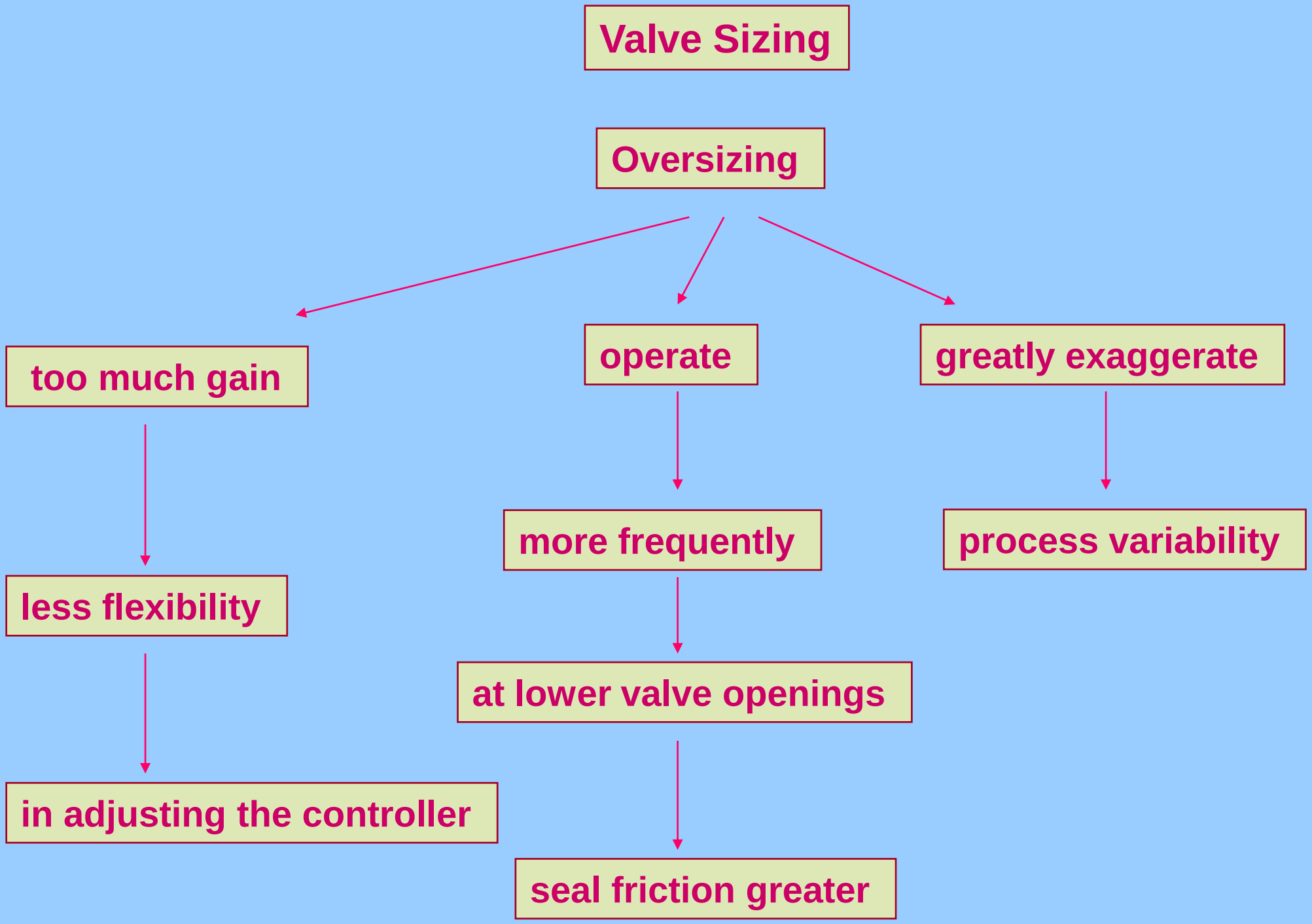
narrowest

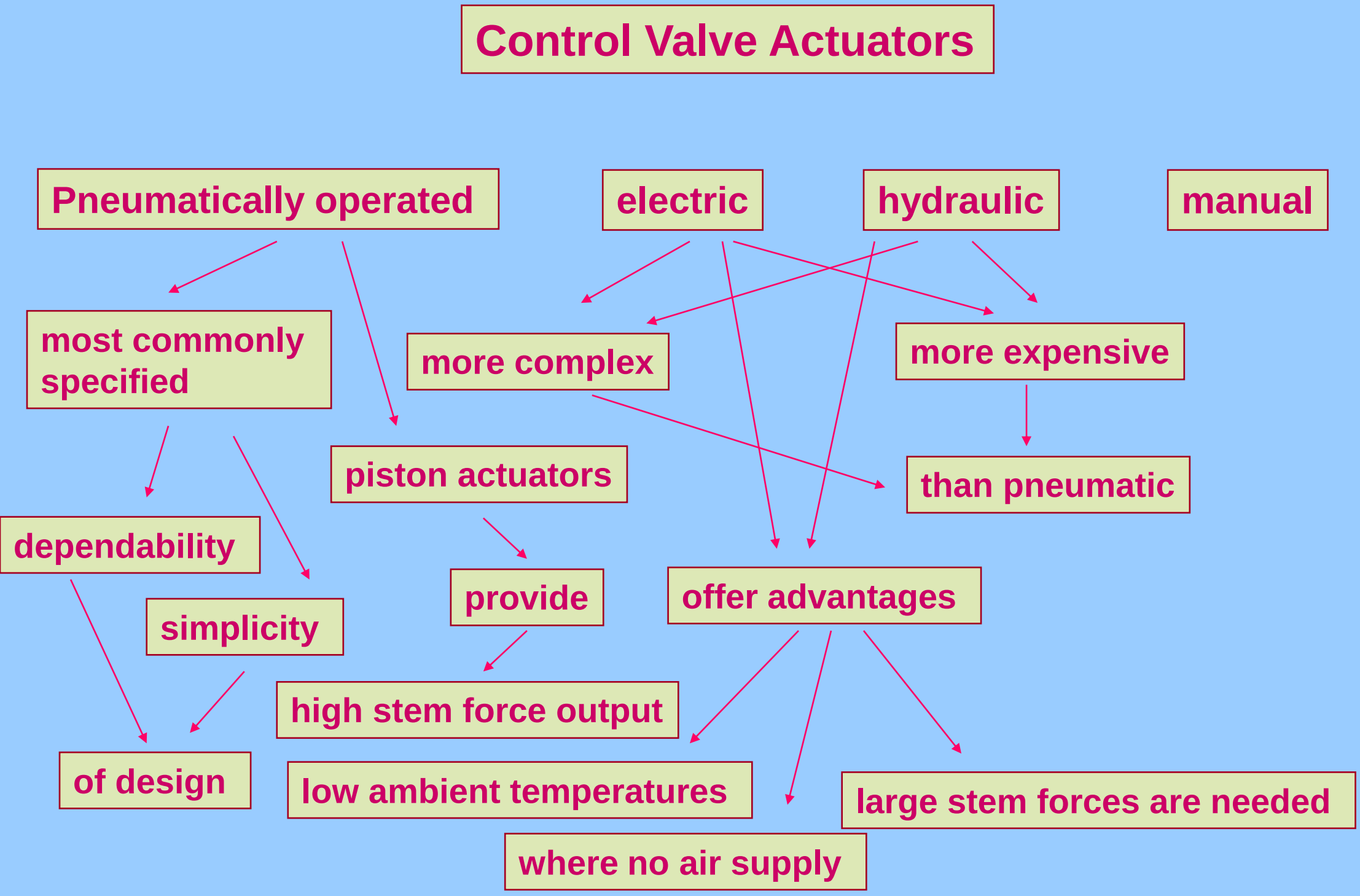
control range

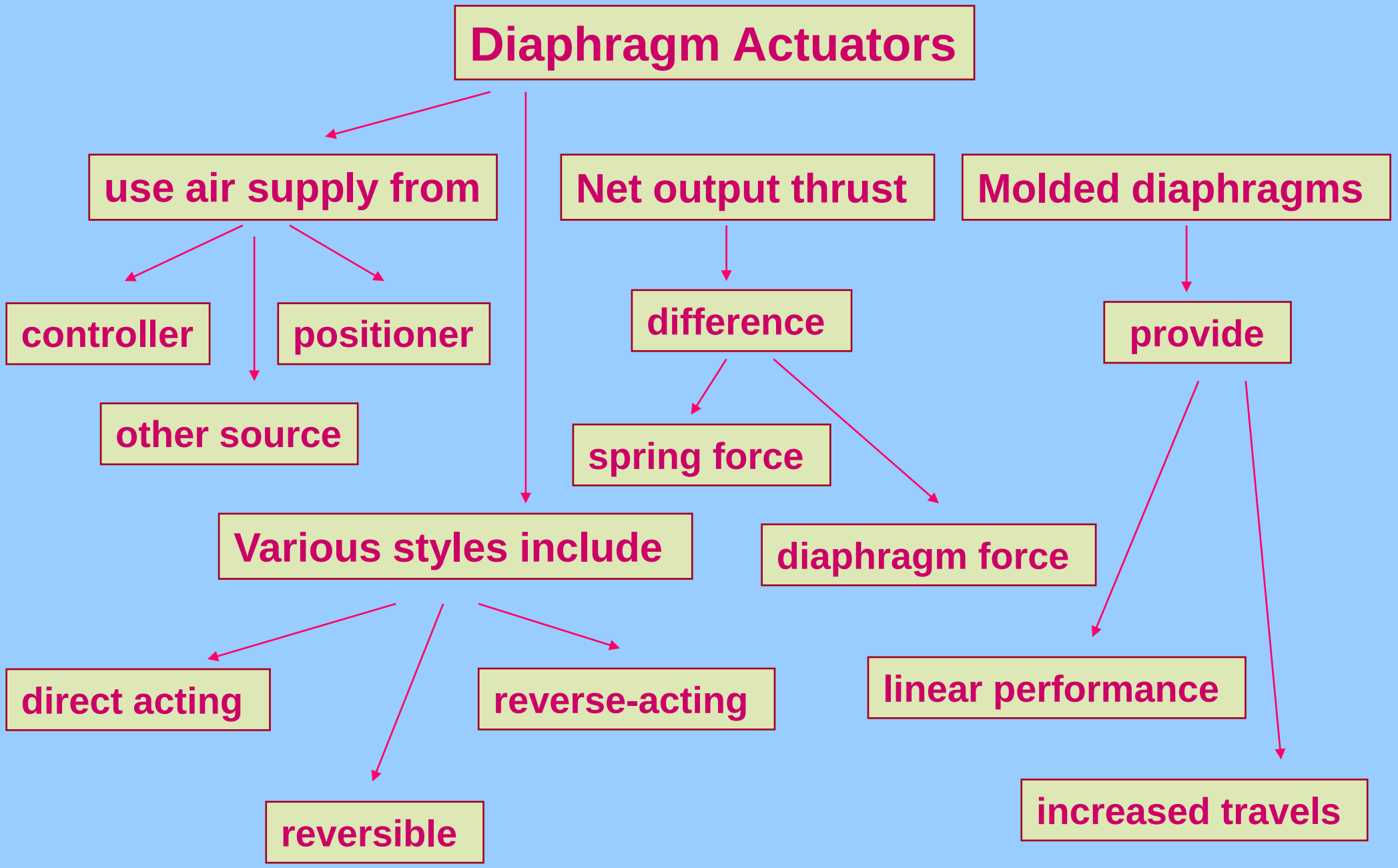
valve style

varies dramatically




Valve Sizing
Oversizing
too much gain
operate
greatly exaggerate
less flexibility
more frequently
process variability
at lower valve openings
in adjusting the controller
seal friction greater


Control Valve Actuators
Pneumatically operated
electric
hydraulic
manual
most commonly specified
more complex
more expensive
piston actuators
than pneumatic
dependability
provide
offer advantages
simplicity
high stem force output
of design
low ambient temperatures
large stem forces are needed
where no air supply


Diaphragm Actuators
use air supply from
Net output thrust
Molded diaphragms
controller
positioner
other source
difference
provide
spring force
diaphragm force
Various styles include
direct acting
reverse-acting
reversible
linear performance
increased travels

direct acting

increasing air pressure

pushes down diaphragm

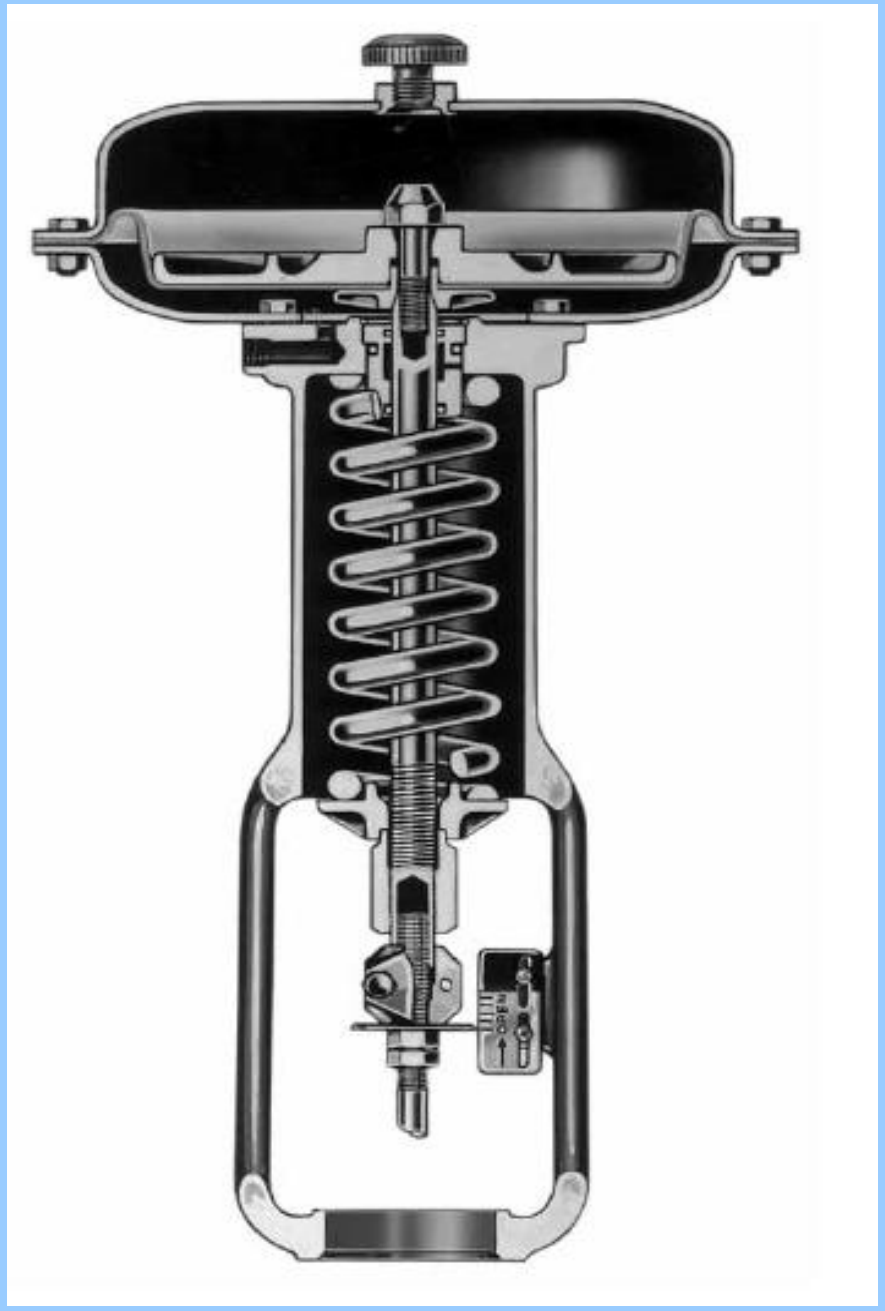
extends actuator stem

reverse-acting

increasing air pressure

pushes up diaphragm

retracts actuator stem,



reversible

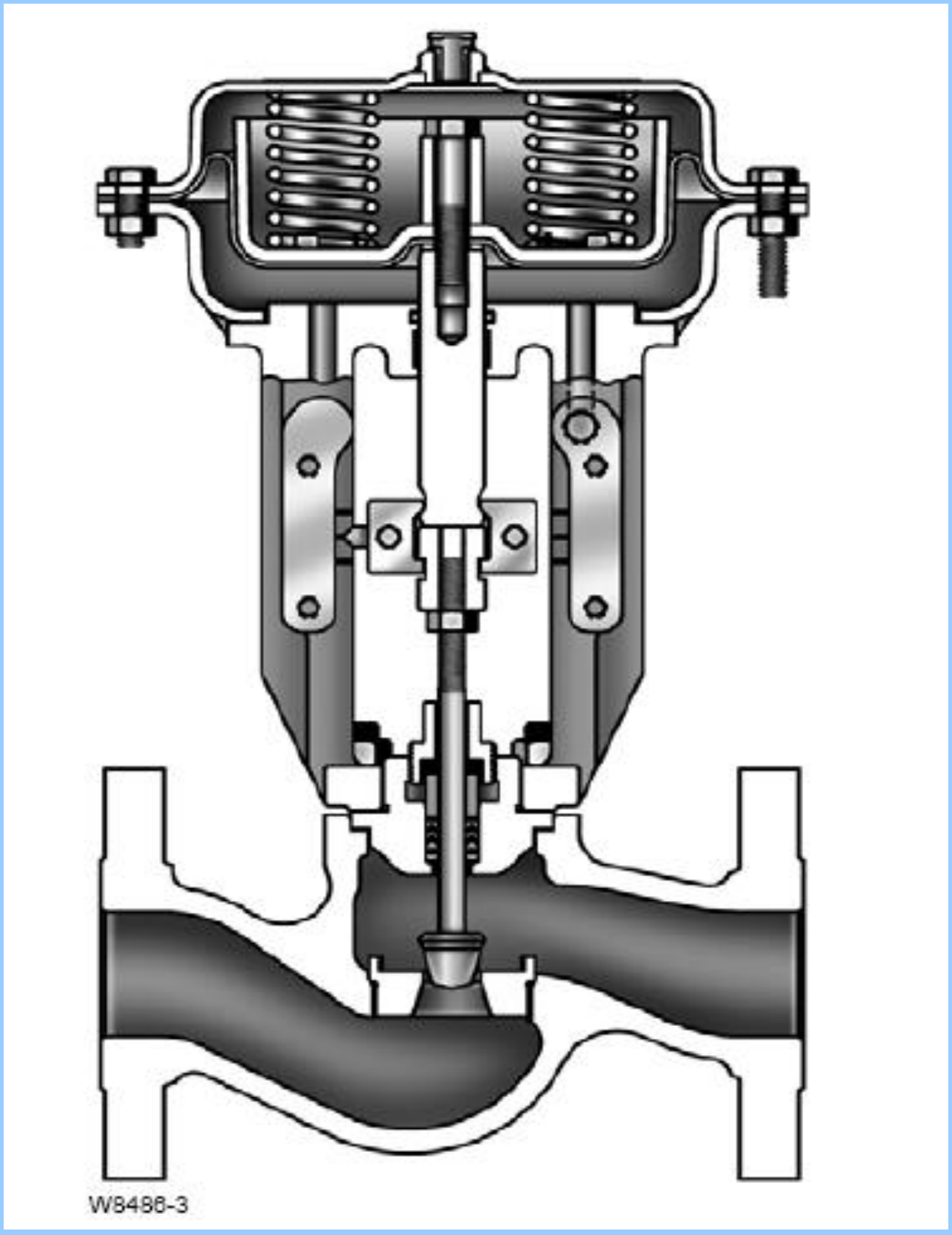
air pressure pushes

down on diaphragm

open or close

depending on orientation

lever on the valve shaf



Piston Actuators

- pneumatically operated
  - high-pressure plant air to 150 psig
- furnish
  - fast stroking speeds
  - maximum thrust output
- double acting
  - maximum force in both directions
- spring return
  - provide
    - fail-open
    - fail-closed
    - operation

Electrohydraulic Actuators

require only

electrical power

electrical input signal

ideal for

isolated locations

precise control

valve plug position needed

pneumatic supply not available

Control Valve with Double-Acting Electrohydraulic Actuator and Handwheel

Manual Actuators

Useful where

automatic

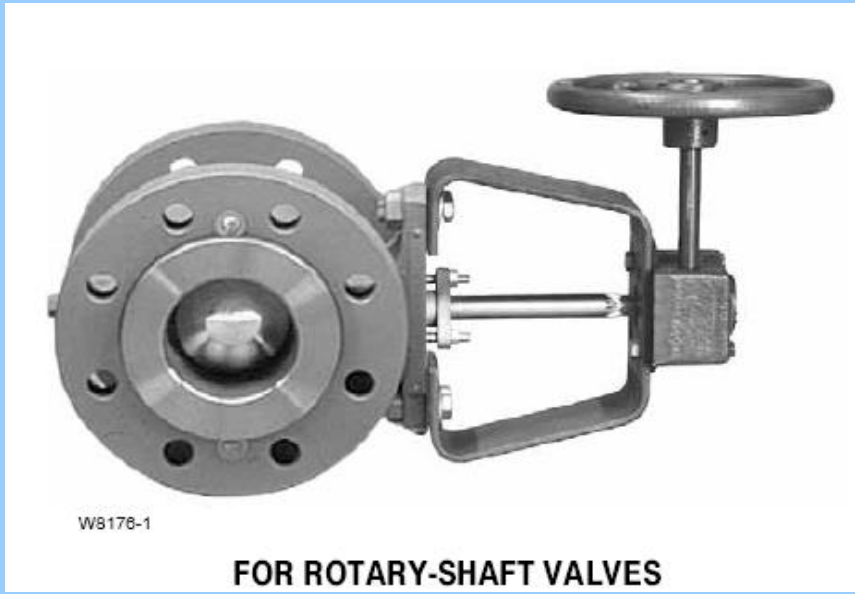
good manual

ease operation

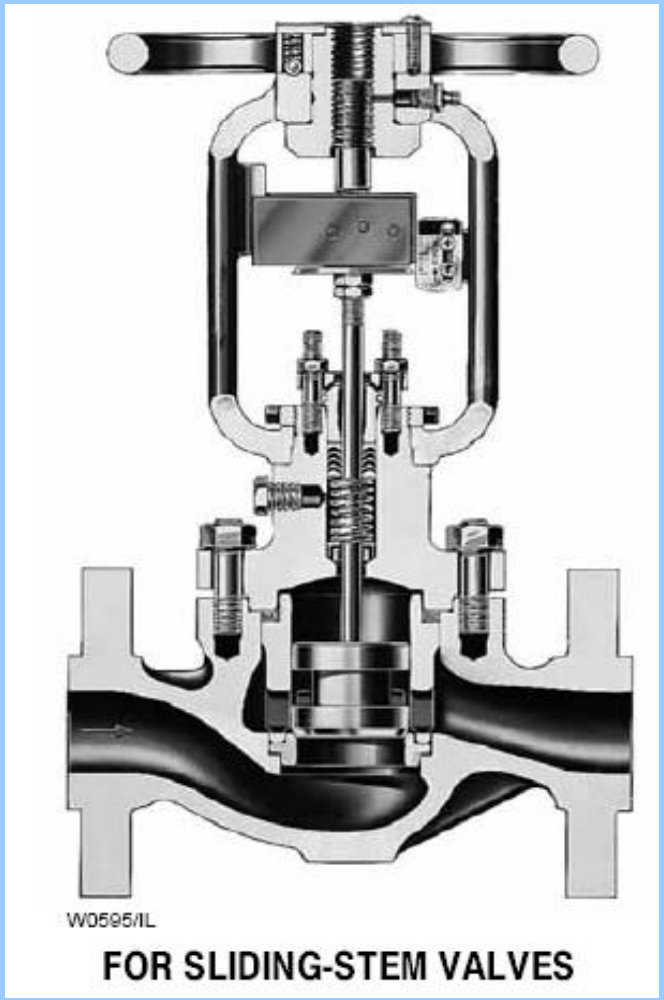
control

still necessary

not required



FOR ROTARY-SHAFT VALVES



FOR SLIDING-STEM VALVES

Rack and Pinion Actuators

provide

compact

economical

solution

for rotary shaft valves

typically used

on-off applications

process variability

not a concern

Typical Rack and Pinion Actuator

Electric Actuators

designs use

more expensive than pneumatic

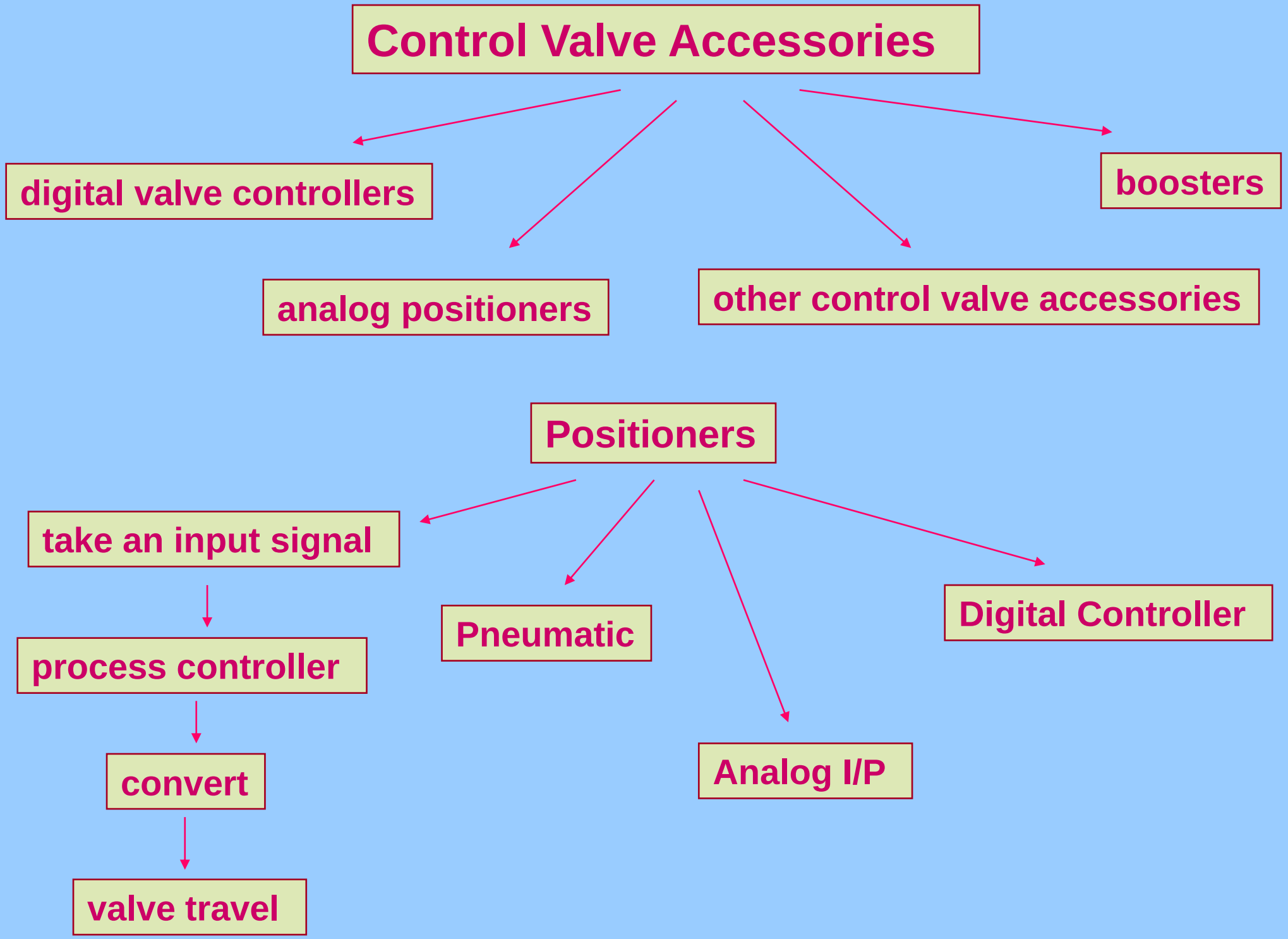
electric motor

gear reduction

move the valve

same

performance levels


Control Valve Accessories
digital valve controllers
analog positioners
other control valve accessories
boosters
Positioners
take an input signal
process controller
convert
valve travel
Pneumatic
Analog I/P
Digital Controller

Positioners

Pneumatic

pneumatic signal

↓

supplied

↓

(usually 3-15 psig)

↓

translates

↓

required valve position

Positioners

Analog I/P

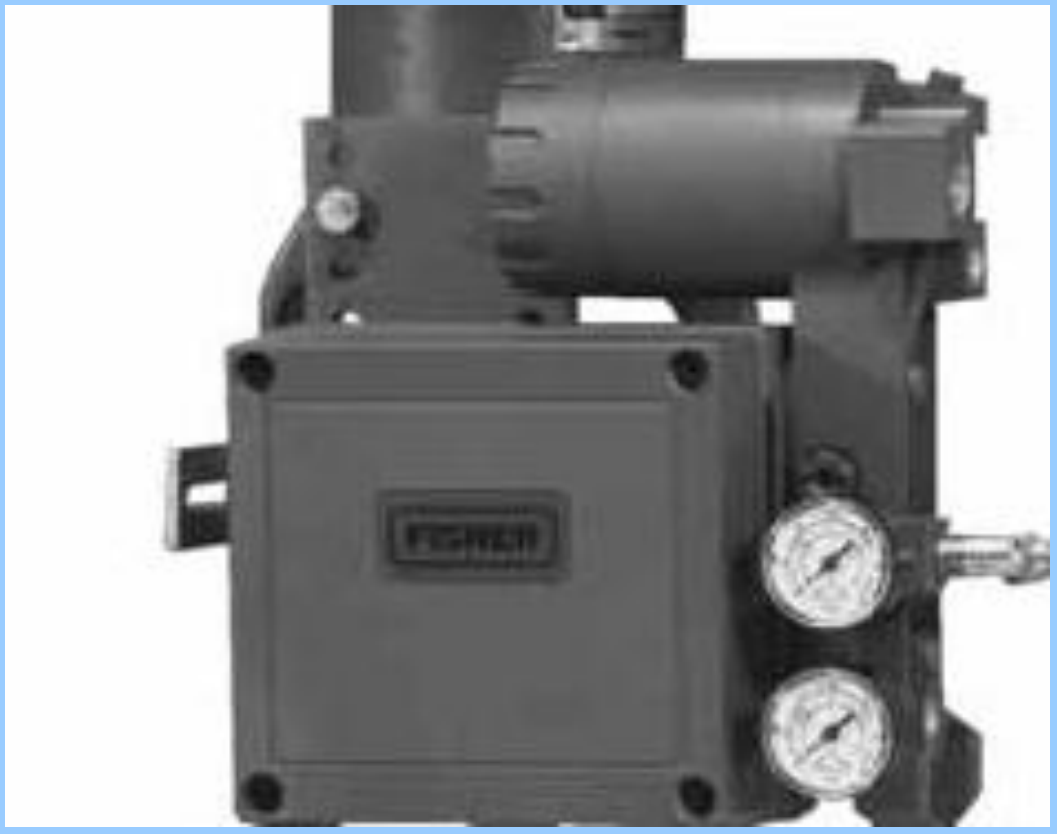
uses

electrical current

usually 4-20 mA

translates

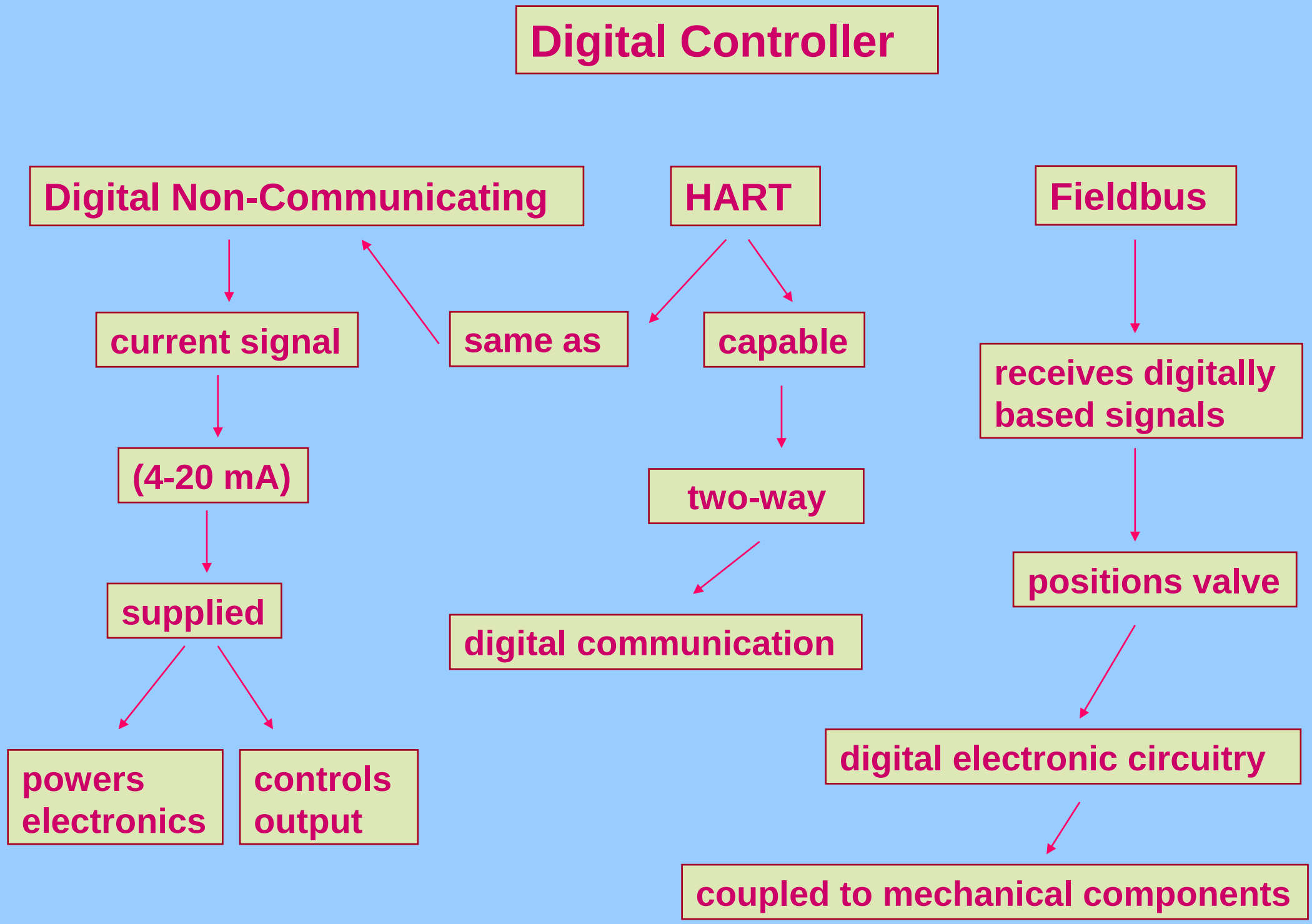
required valve position



Positioners

- Digital Controller
  - functions
    - same as
      - Analog I/P
    - differs in
      - electronic signal conversion
        - digital
  - HART
  - Fieldbus
  - Digital Non-Communicating

Modern Control Valves Utilizing Digital Valve Controllers


Digital Controller
Digital Non-Communicating
HART
Fieldbus
current signal
same as
capable
receives digitally based signals
(4-20 mA)
two-way
supplied
digital communication
positions valve
powers electronics
controls output
digital electronic circuitry
coupled to mechanical components

Other Control Valve Accessories

top-mounted handwheel

direct-acting

reverse-acting

Diaphragm actuator

used as

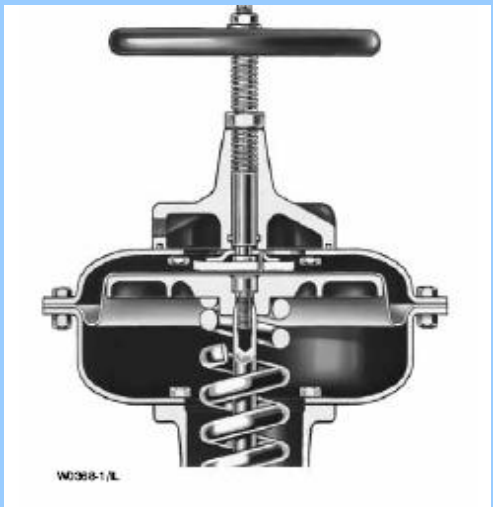
used as

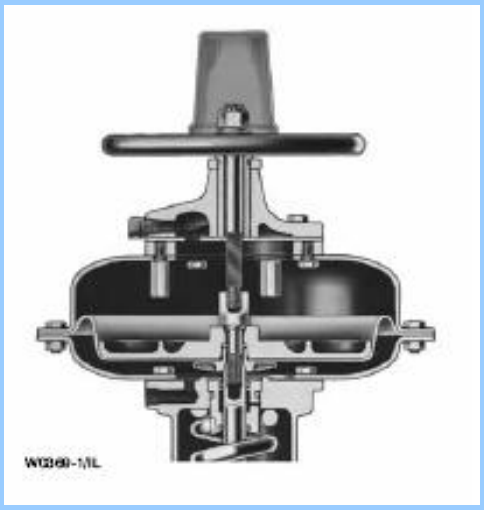
adjustable travel stop

manually close push-down-to-close

adjustable travel stop

manually close push-down-to-open





Limit Switches

operate discrete inputs

distributed control system

signal lights

alarms

solenoid valves

electric relays

cam-operated

two

four

individual switches

operated

by movement of

valve stem

Solenoid Valve Manifold

can be used

double-acting pistons

single-acting diaphragm

actuators

Supply Pressure Regulator

commonly called airsets

reduce plant air supply

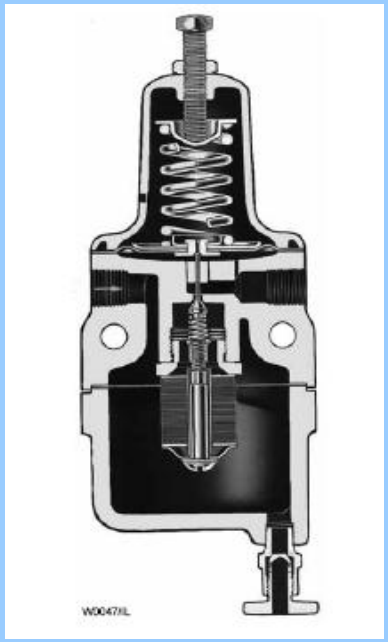
valve positioners

other control equipment

mounts

integrally to the positional

to the actuator



Fail-Safe Systems for Piston Actuators

actuator piston

The volume tank

moves

top

bottom

cylinder

pressure falls

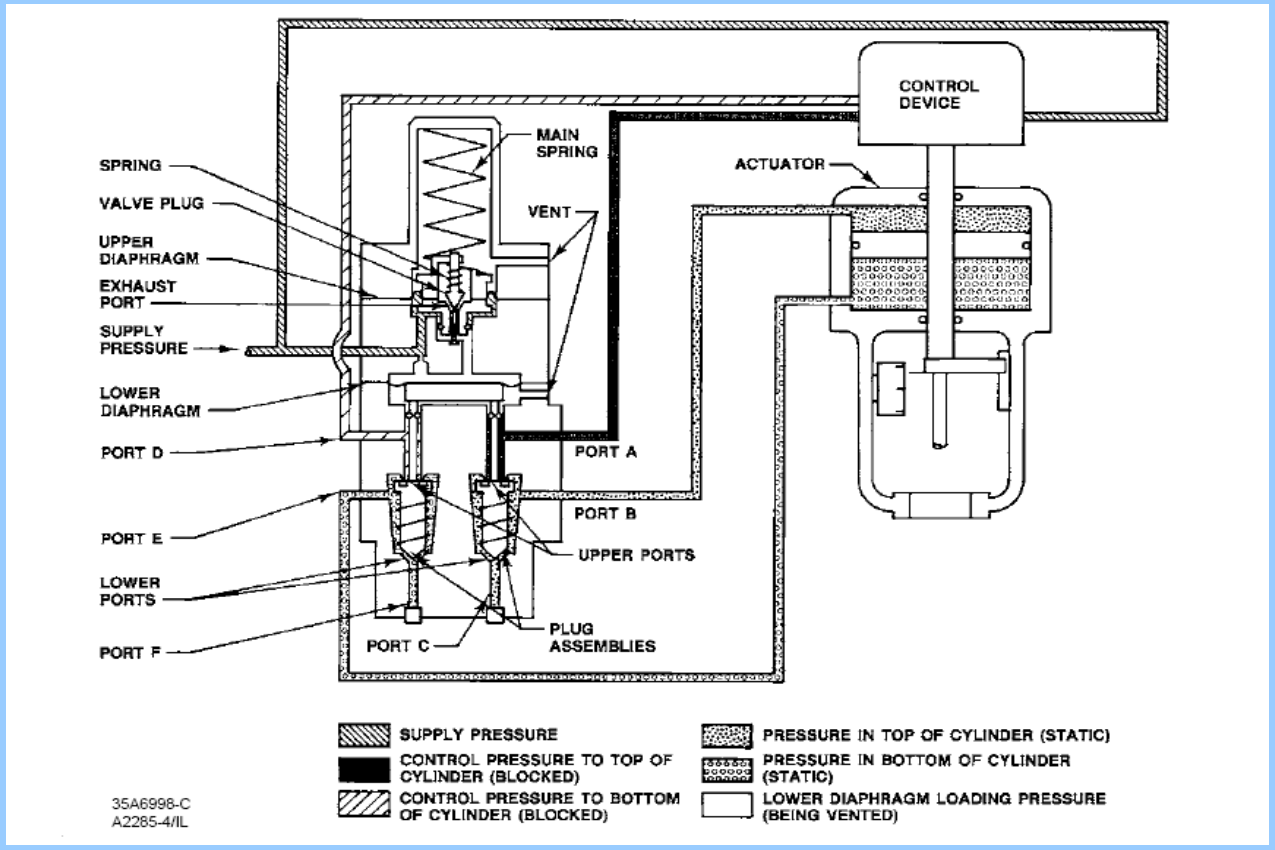
provides loading pressure

below a pre-determined value

pressure fails

moving the piston

desired position



Electro-Pneumatic Transducers

receives

direct current input signal

uses

torque motor

pneumatic relay

nozzle-flapper

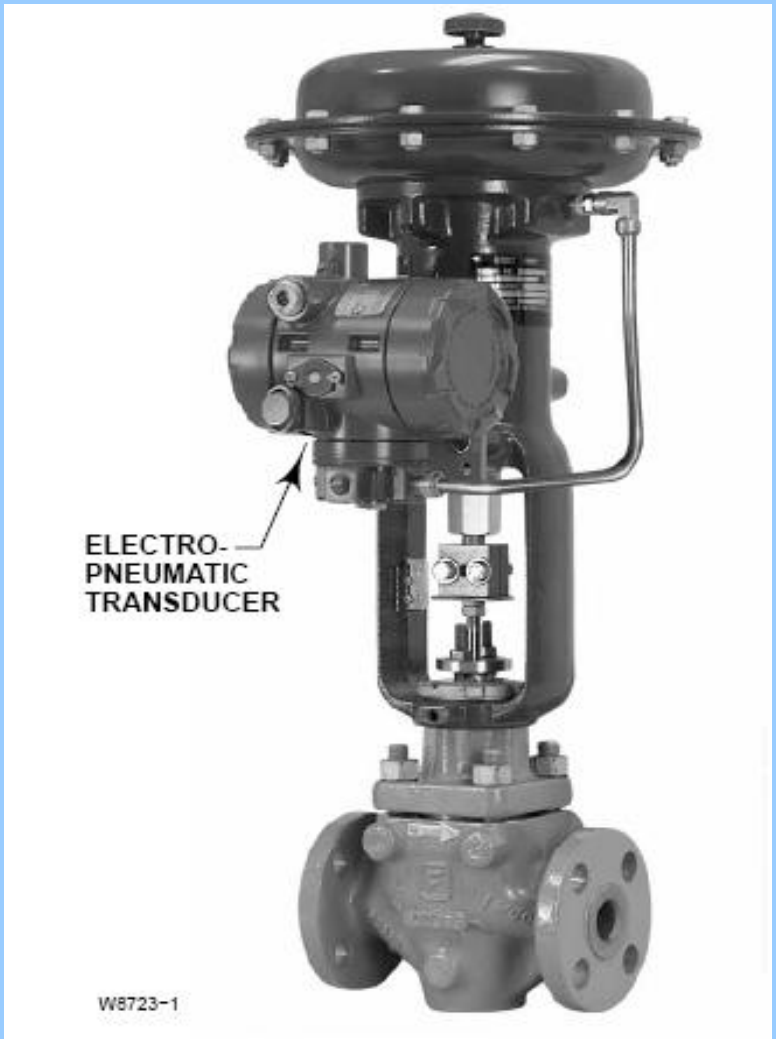
convert

proportional pneumatic output signal

operate

without

additional boosters or positioners



Electro-Pneumatic Transducer Mounted on a Diaphragm-Actuated Control Valve

Electro-Pneumatic Valve Positioners

used

receives

Split-range operation

electronic control loops

can provide

operate

4 to 20 mA DC input

diaphragm control valve actuators

full travel of the actuator

portion of the input signal

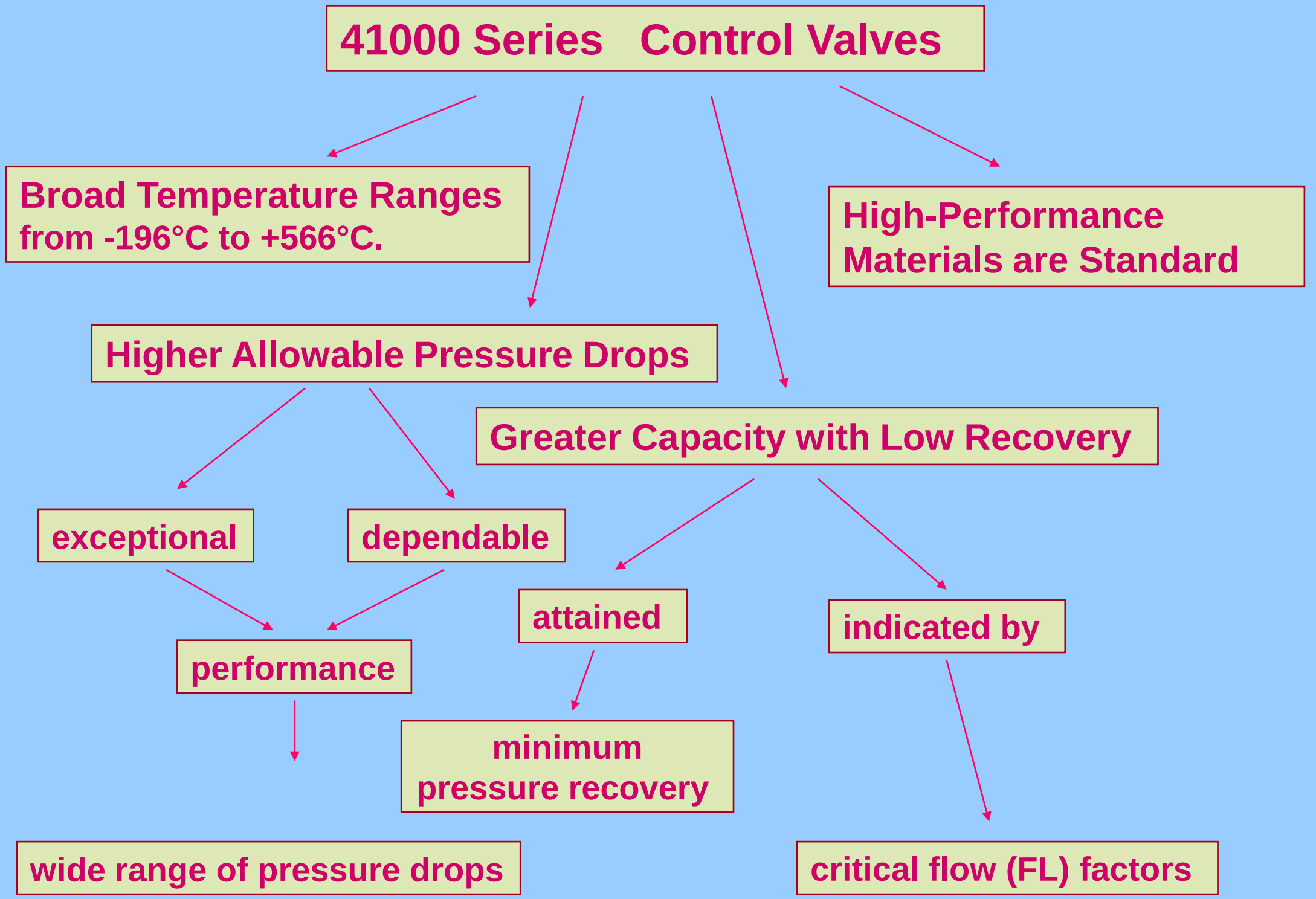
convert to a pneumatic output signal

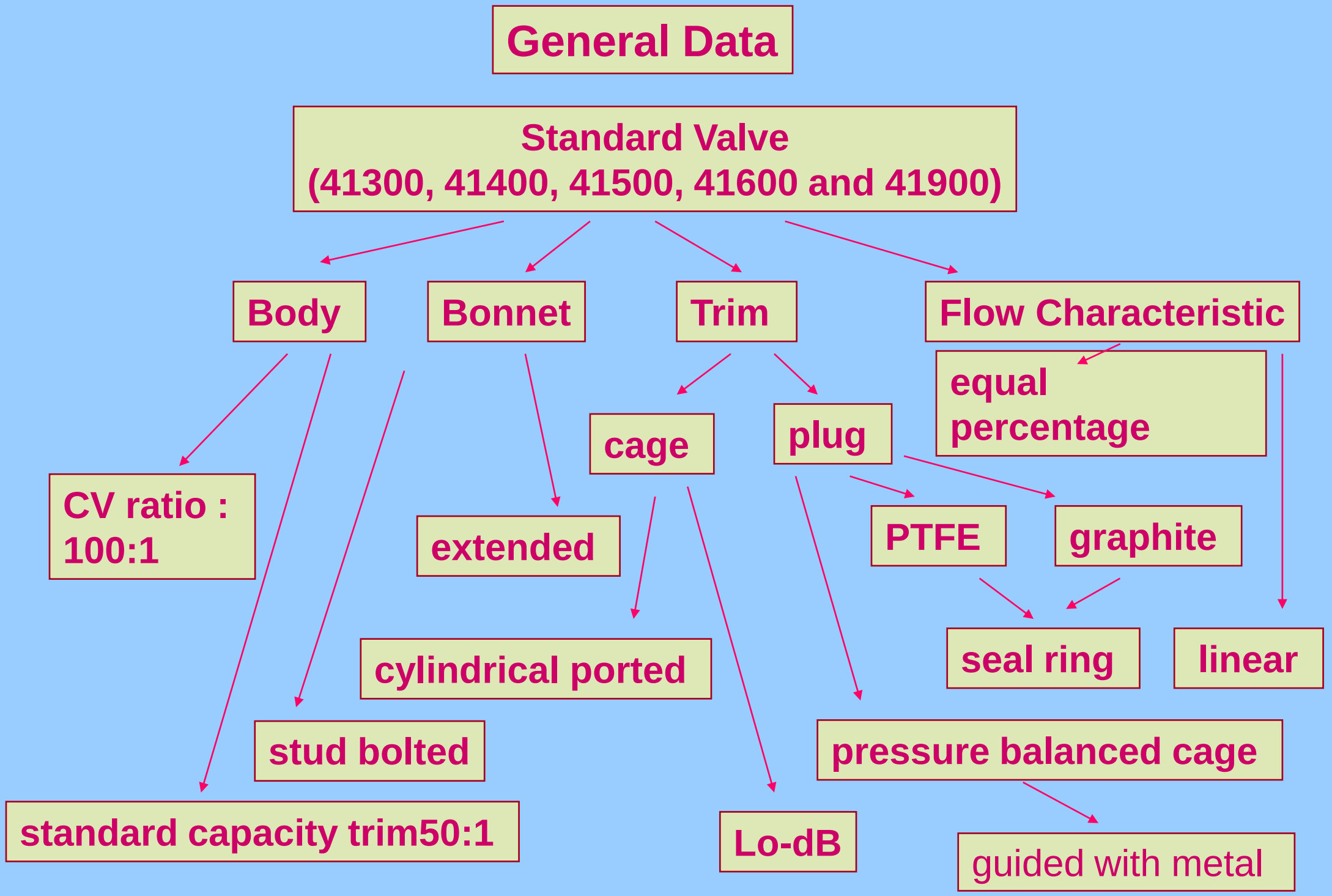
Electro-Pneumatic Positioner on Diaphragm Actuator

Masoneilan
Valve & Controls DRESSER

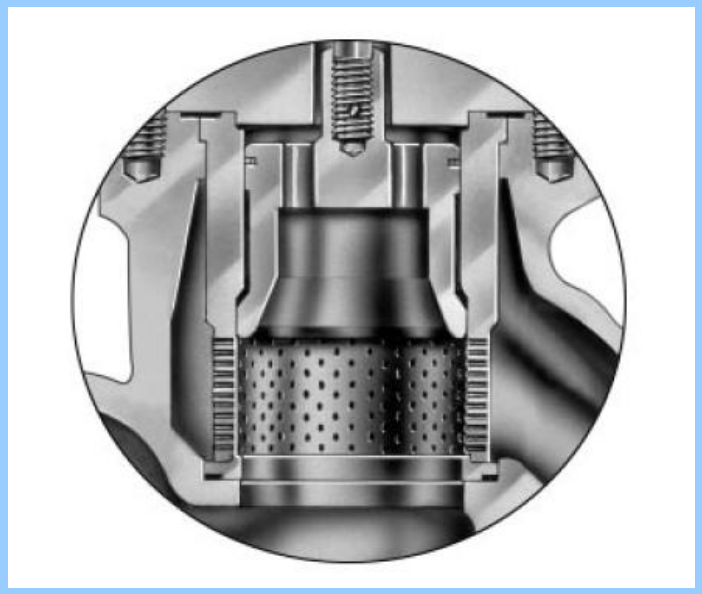
41000 Series Control Valves

A Complete Line of Heavy Duty, Balanced, Cage Guided, Globe Valves with Noise Control Lo-dB® Trim

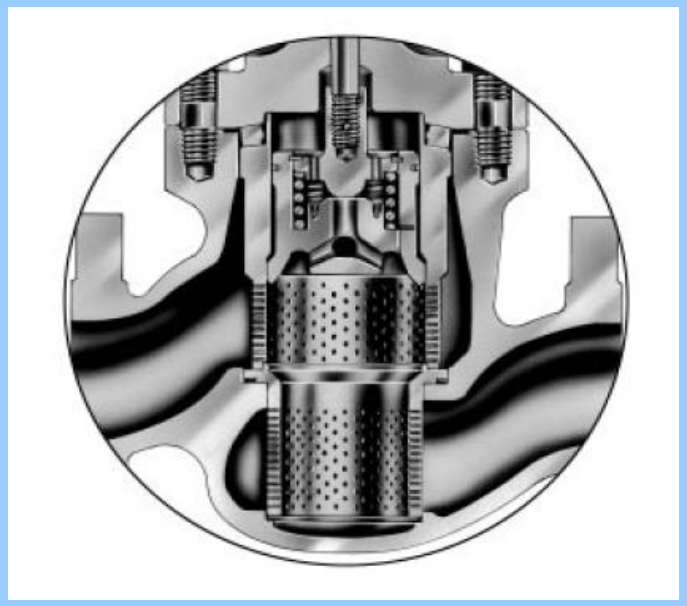

41000 Series Control Valves
Broad Temperature Ranges
from -196°C to +566°C.
High-Performance
Materials are Standard
Higher Allowable Pressure Drops
Greater Capacity with Low Recovery
exceptional
dependable
attained
indicated by
performance
minimum
pressure recovery
wide range of pressure drops
critical flow (FL) factors


General Data
Standard Valve
(41300, 41400, 41500, 41600 and 41900)
Body
Bonnet
Trim
Flow Characteristic
equal
percentage
CV ratio :
100:1
extended
cage
plug
PTFE
graphite
seal ring
linear
cylindrical ported
stud bolted
pressure balanced cage
standard capacity trim50:1
Lo-dB
guided with metal

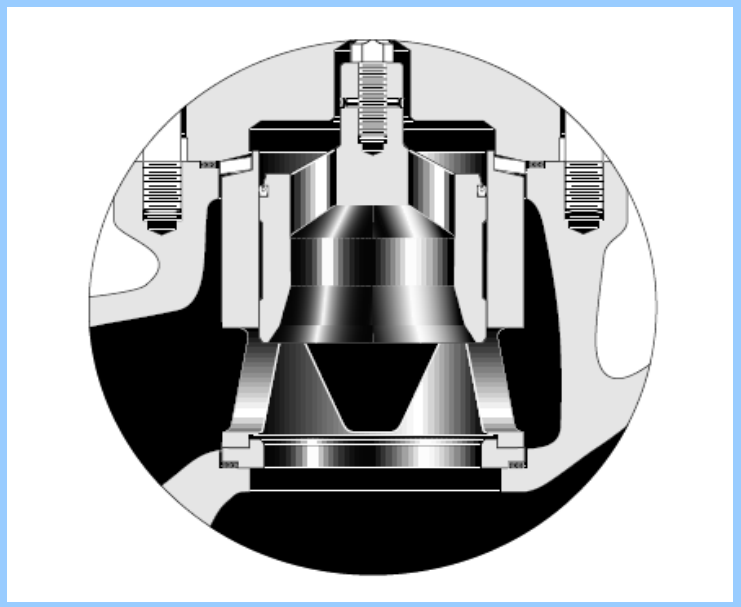
Optional Trim Types



Single Stage Multi-hole Low Noise and Cavitation Protection
DN 50 - DN 100 Shown
(2" - 4")



Multi-hole, Low Noise and Cavitation Protection
Trim with Internal Diffuser
DN 150 - DN 400



Pressure Energized Seal
DN 150 - DN 400 Shown
(6" - 16")

Body Construction

1 Valve plug stem
2 Packing flange stud
3 Packing flange nut
4 Packing flange
5 Packing spacer
6 Packing
7 Bonnet
8 Valve body nut
9 Plug pin
10 Valve body gasket
11 Seal ring type
12 Plug spring (41400 only)
13 Seat ring
14 Seat ring gasket
15 Valve plug
16 Cage
17 Flat spring (6" to 16")
18 Body
19 Retaining ring (41400 only)
20 Auxiliary plug (41400 only)
21 Valve body stud
22 Guide bushing
23 Packing follower

Temperature Range/Seat Leakage

Cv and FL versus Travel

Standard Trim (Single Stage) Models 41411, 41511, 41611 and 41911

Flow Characteristic : **LINEAR**

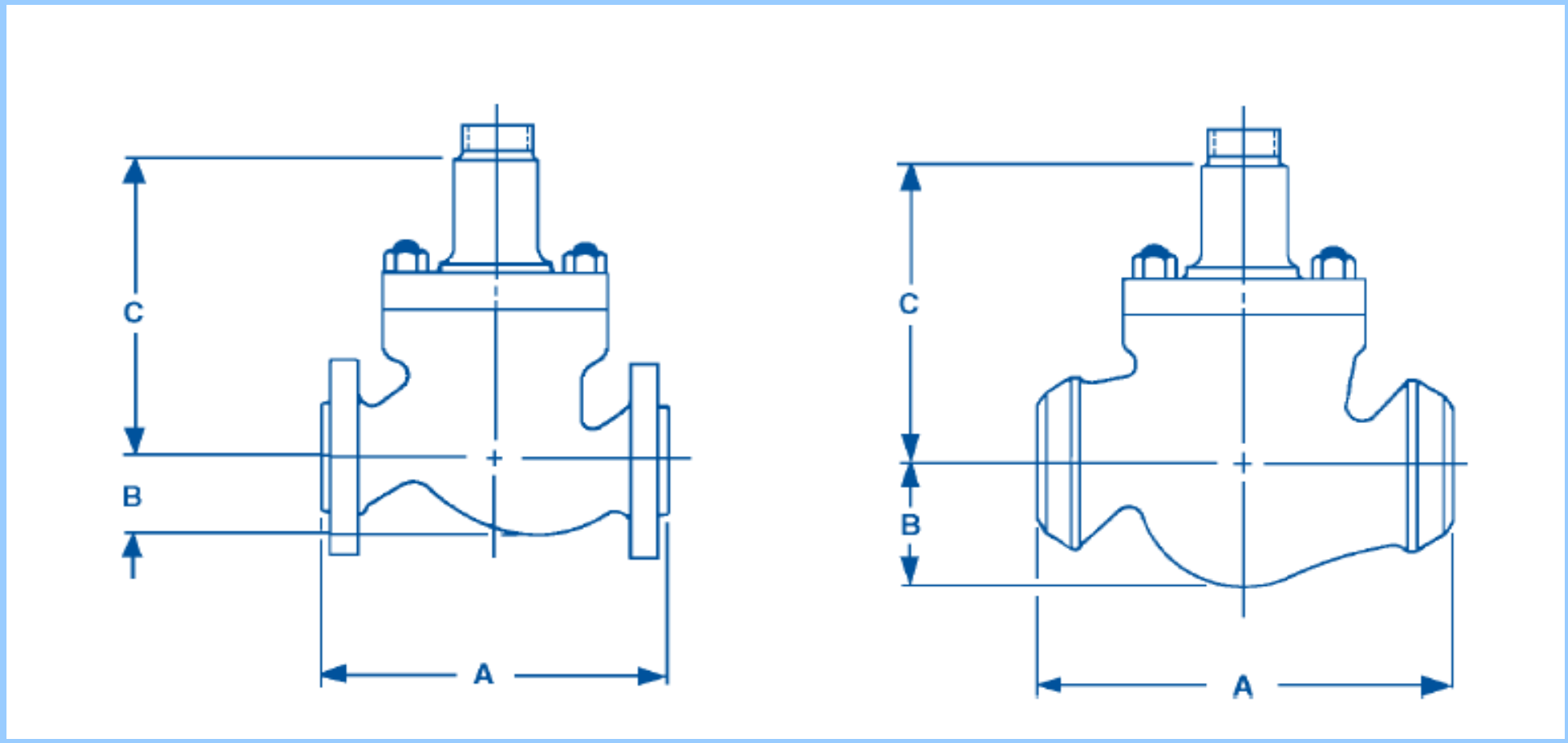
Percent of Travel					10	20	30	40	50	60	70	80	90	100
F_L					0.94	0.94	0.93	0.93	0.92	0.92	0.91	0.91	0.90	0.90
Valve Size		ANSI Class and equivalent PN	Orifice Diameter (mm)	Travel (mm)	Rated C_v									
mm	inch													
50	**2**	900-2500	46.7	20.3	1.4	2.7	4.2	6	8	10	12.5	14	15.5	16
					2	4.9	8.3	13	19	25	30	35	38	**40**
50	**2**	300,600	63.5	38.1	2.7	5.1	7.9	11	15	19	23	26	29	30
80	**3**	2500			4	8	14	22	34	46	56	65	72	**75**
80	**3**	300-1500	88.9	50.8	5.4	10	16	23	30	38	45	51	59	60
100	**4**	2500			8	17	28	46	70	95	115	134	148	**155**
100	**4**	300-1500	111.3	50.8	9	16	25	36	47	60	71	81	93	95
150	**6**	2500			12	32	55	86	122	156	184	208	226	**240**
150	**6**	150-1500	130.0	20.3	6	16	26	42	58	74	93	119	142	165
200	**8**	2500		50.8	20	54	90	145	205	260	305	345	375	**400**
200	**8**	150-1500	165.1	38.1	15	40	75	110	145	190	250	310	365	415
				63.5	30	85	145	235	330	415	495	550	600	**640**
250	**10**	150-1500	203.2	38.1	20	50	80	130	180	230	290	370	440	510
				76.2	50	130	230	370	510	650	770	860	940	**1000**
300	**12**	150-1500	247.7	50.8	30	70	140	200	270	350	450	570	680	770
				95.25	70	180	320	520	710	910	1080	1200	1320	**1400**
400	**16**	150-1500	330.2	63.5	30	130	230	298	410	548	730	900	1050	**1280**
				101.6	100	260	460	740	1020	1300	1540	1720	1880	**2000**

Allowable Pressure Drops for 41300 Series (bar)
Flow To Open

Model 41312 — **Model 37/38 Actuator**

Valve Size		ANSI Class and equivalent PN	Travel (mm)	Rated C_v	Actu-ator Size	AIR TO OPEN			AIR TO CLOSE		
mm	inch					Bench range	Supply (bar)	ΔP (bar)	Bench range	Supply (bar)	ΔP (bar)
200	**8**	600 900 1500	76.2	315	18	15-50 20-50	3.8 3.8	111 175	3-13 6-27 6-27 6-27	2.4 3.1 3.5 3.8	*89.5* 21 143 175
250	**10**	600 900 1500	88.9	500	18	-	-	-	3-15 3-15	2.8 3.1	*77.5* *90.5*
					24	19-46	3.5	138	6-30 6-30	3.1 3.5	8.5 138
300	**12**	600 900	101.6	725	18	-	-	-	3-15 3-15	3.1 3.5	38 *75*
					24	18-50	3.8	95	3-15	2.8	95
400	**16**	600	101.6	1200	24	18-50	3.8	52	3-15	3.1	*76*

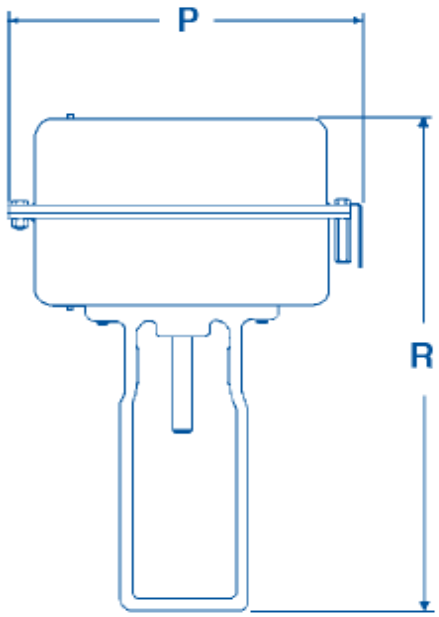
Dimensions (mm)

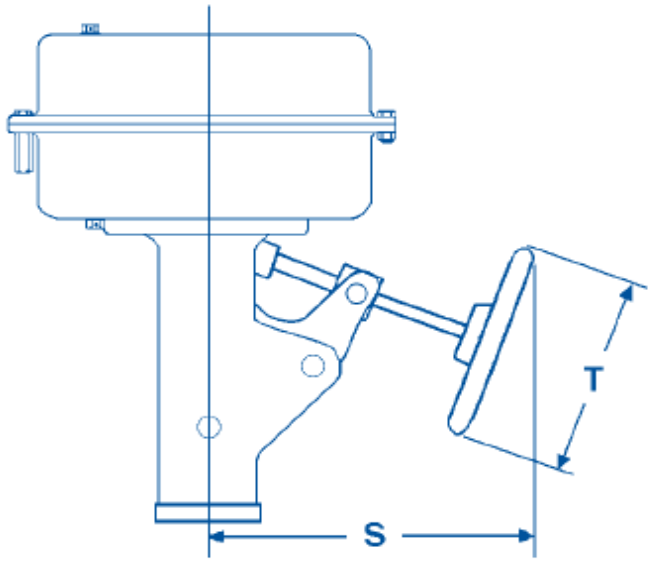


Dimensions (mm) cont.

Pressure Class		A											
		ANSI Class 150 and equivalent PN		ANSI Class 300 and equivalent PN			ANSI Class 600 and equivalent PN			ANSI Class 900 and equivalent PN		
Valve Size		RF	RTJ	BW & SW	RF	RTJ	BW & SW	RF	RTJ	BW & SW	RF	RTJ
mm	inch											
50	2	-	-	390	267	283	390	286	289	398	375	378
80	3	-	-	434	318	334	434	337	340	434	441	445
80x50x80	3x2x3			"	"	"	"	"	"	(a)	(a)	(a)
100	4	-	-	492	369	384	492	394	397	492	511	514
100x50x100	4x2x4			"	"	"	"	"	"	(a)	(a)	(a)
100x80x100	4x3x4			"	"	"	"	"	"	492	511	514
150	6	451	464	560	473	489	560	508	511	680	714	717
150x80x150	6x3x6			"	"	"	"	"	"	"	"	"
150x100x150	6x4x6			"	"	"	"	"	"	"	"	"
200	8	543	556	656	569	584	656	610	613	854	915	918
200x100x200	8x4x8			"	"	"	"	"	"	"	"	"
200x150x200	8x6x8			"	"	"	"	"	"	"	"	"
250	10	673	686	802	708	724	802	752	755	892	1092	1095
250x150x250	10x6x10			"	"	"	"	"	"			
300	12	737	750	822	775	791	822	819	822	1034	1130	1133
300x200x300	12x8x12			"	"	"	"	"	"	"	"	"
400	16	1016	1029	1002	1057	1072	(a)	1108	1111	1600	1375	1384
400x300x400	16x12x16			"	"	"	(a)	"	"	(a)	(a)	(a)

Dimensions (mm) cont.



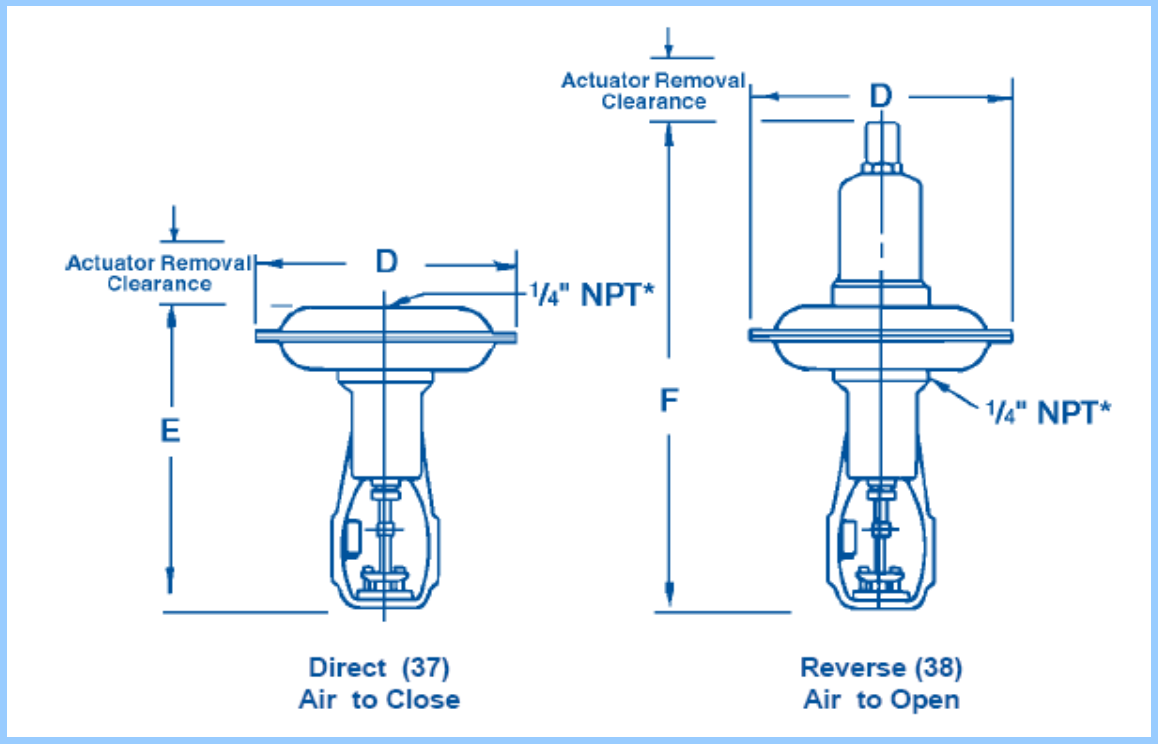


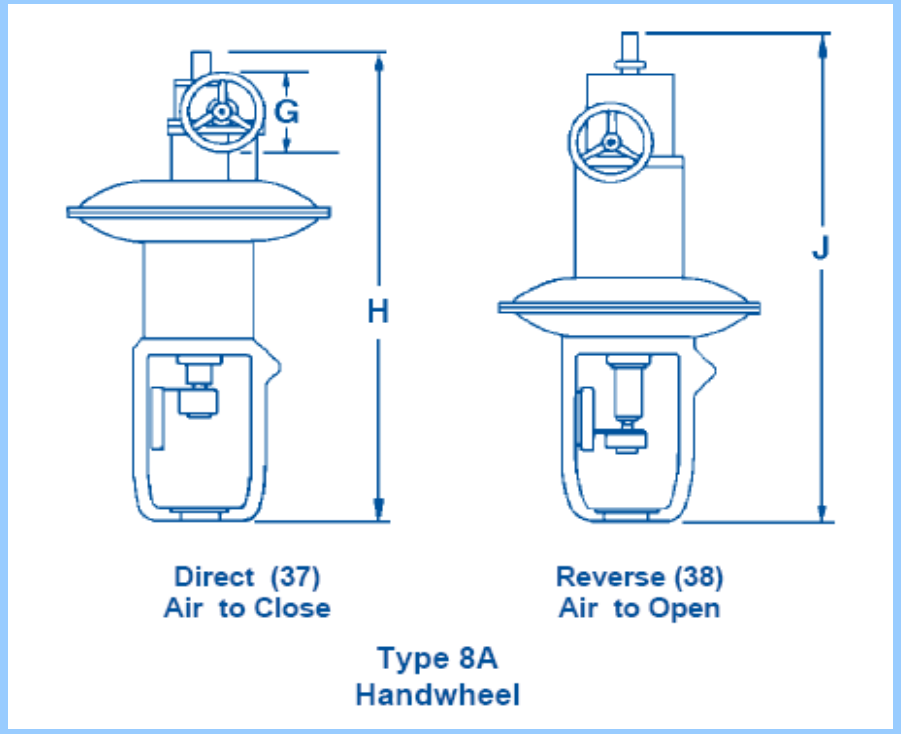
Shown with optional handwheel

Model 87/88 Spring Diaphragm Actuator

Actuator Size	P	R	S	T
6	292	394	254	228
10	368	497	277	305
16	476	717	330	457
23	549	780	381	457

Dimensions (mm) cont.





Model 37/38 Spring Diaphragm Actuator

Actuator					Top-Mounted Handwheel			
Size	Actuator Removal Clearance	D	E Dir.	F Rev.	Type	G	H Dir.	J Rev.
18 with 16" Spring	142	527	843	1069	8A	203	1346	1346
18 with 20" Spring	142	527	-	1321	8A	203	-	1346
24	127	699	881	1156	8A	305	1346	1473

MASONEILAN SVI®
SMART VALVE INTERFACE

digital valve positioner

process controller

configured

operated

single-loop PID controller

locally

remotely

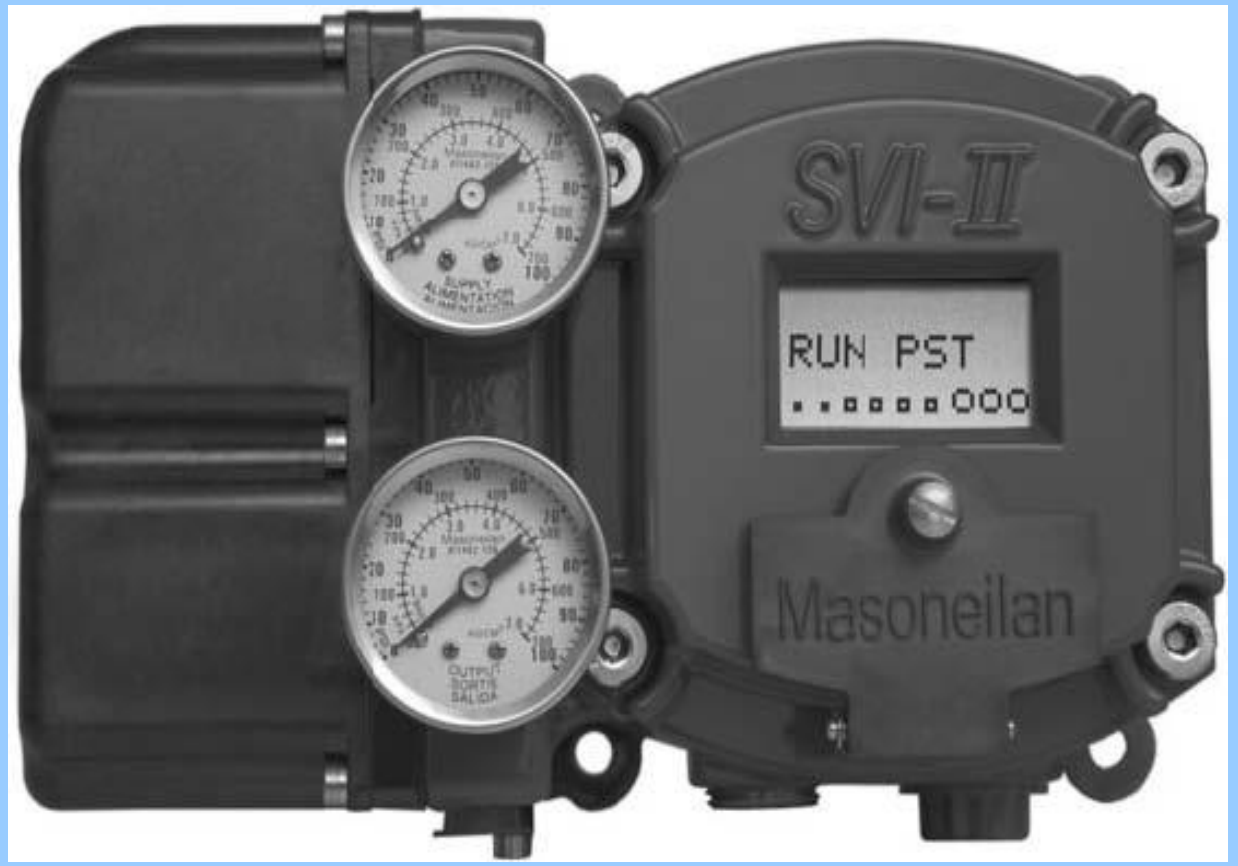
HART

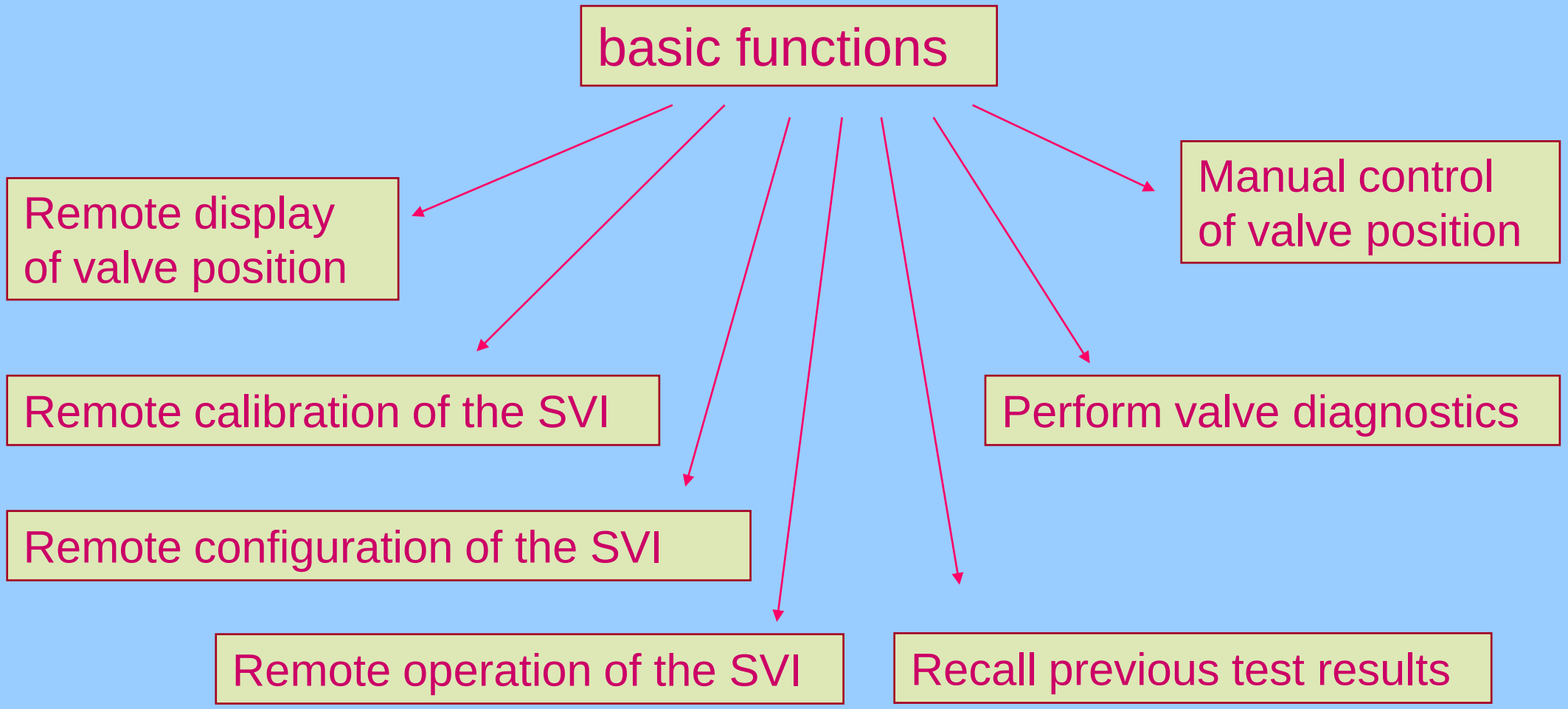
digital display

ValVue product

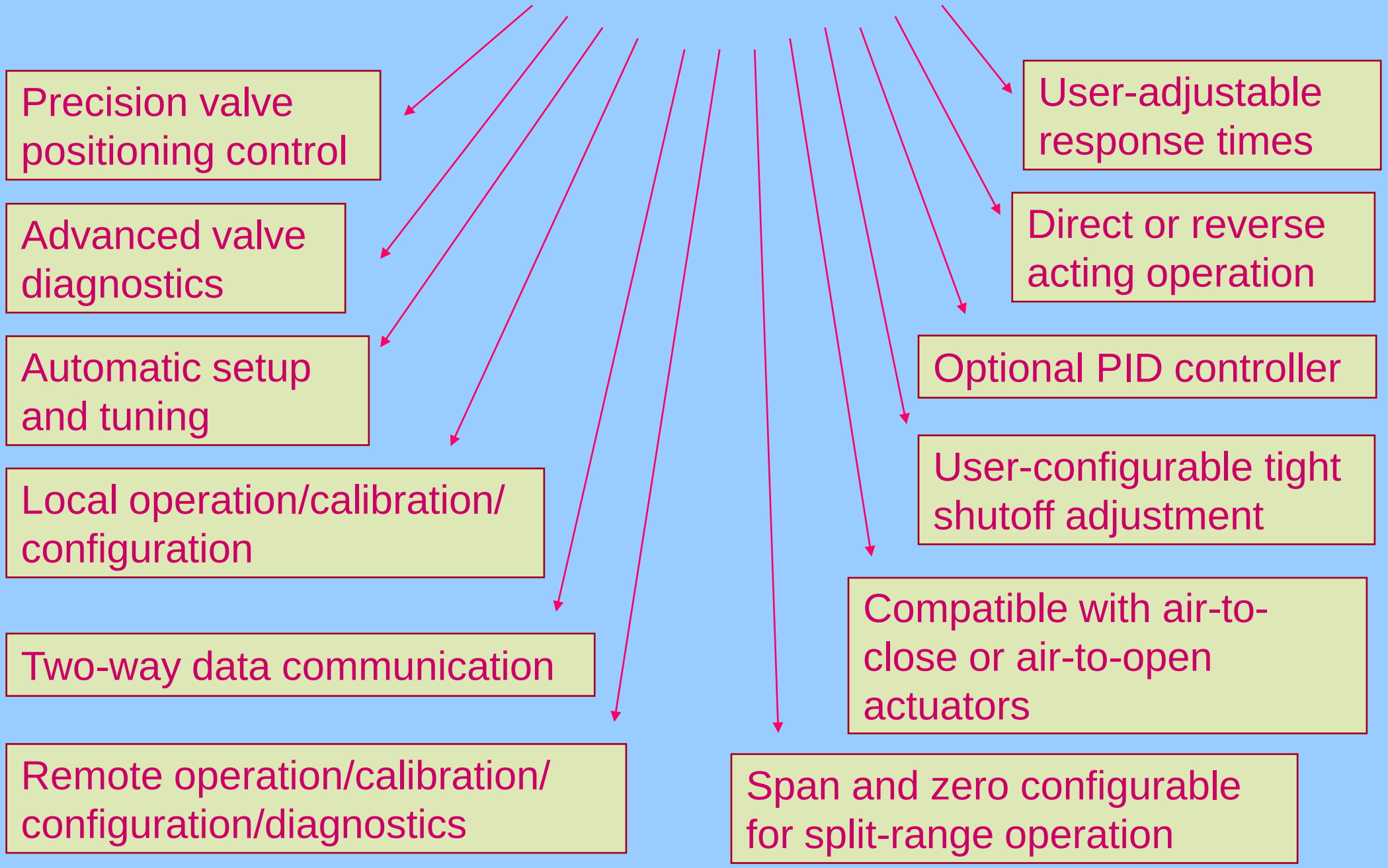
of local pushbuttons

MASONEILAN SVII®
SMART VALVE INTERFACE




basic functions
Remote display of valve position
Manual control of valve position
Remote calibration of the SVI
Perform valve diagnostics
Remote configuration of the SVI
Remote operation of the SVI
Recall previous test results

SVI Features and Functions



Performance Specifications

Performance Specifications (Positioner Mode Only)

Item	Specification
Positioner Inputs	4-20 mA signal input with HART protocol.
Split Range Capabilities	Programmable zero and span adjustments, 5 mA minimum span.
Minimum Current for Operation	3.6 mA operating minimum.
Compliance Voltage	12 volts maximum loop voltage drop in mA mode (typical 10.5 volts).
Digital Communication	HART ® Communication protocol signal from ValVue® software on personal computer or from HART Hand-held Communicator. HART slave and burst modes multidrop, up to 5 loops with 20 volts minimum at SVI. 4 mA load at 20 volts.
Controller (Process Variable) Input	Nominally 1-5 volts or 4-20 mA with a 250 Ohm resistor.
Local Display - Liquid Crystal (optional)	One seven character line of 14 segment alpha numeric. One six character line of 7 segment numeric. 22 segment bar graph.
Push Button	Three (3) explosionproof / flameproof push buttons.
Limit Switch Input	Two SPST with common. Cold contacts. Non isolated.
Remote Position Sensing	10 K Ohms potentiometer.
Accuracy	Total accuracy 0.5% of span (typical 0.25%).
Linearity (conformity)	< 0.2% (typical 0.1%).
Hysteresis Plus Deadband	< 0.2% of span (typical 0.1%).
Actuator Pressure Measurement Accuracy	< 0.3% of full scale.
Start-Up Drift	Less than 0.02% during first hour.
Long Term Drift	Less than 0.003% per month
Supply Pressure	20-100 psi (1.4 - 7 bar)
Air Delivery at 60 PSI	25 cubic meters / hour (15 SCFM)
Air Consumption	0.4 cubic meters / hour (7SLPM)

Performance Specifications (cont.)

Item	Specification
Operating Temperature Limits	- 40° C to 80° C
Storage Temperature Limits	- 45° C to + 93° C
Temperature Effect	< 0.01% / degree C typical.
Supply Pressure Effect	0.05% psi
Relative Humidity	0 to 100%
Humidity Effect	Less than 0.2% after 2 days at 40° C, 95% RH.
Insulation Resistance	Greater than 10 G Ohms at 50% RH.
MTBF	50 years based on MIL handbook calculation for electronic parts and field data on mechanical parts.
Electromagnetic Compatibility	Electrostatic discharge -- No effect with contact discharge level of 4KV and air discharge level of 8 KV (IEC 1000-4-2). Radio frequency interference -- Less than 0.2% at 10 volts per meter (EN 50140).
Fast Transient Burst	No effect at 2 KV (Coupling clamp IEC 1000-4-4).
Magnetic Field	Negligible at 30 A/m (EN61000-4-8). EC MARK certified to EN50081-2 and EN50082-2.
Connections: Pneumatic - Electrical -	1/4 inch NPT Two (2) 1/2 inch NPT or M20
Enclosure Rating	IP 65, NEMA 4X. Suitable for coastal environment, atmosphere with acids, atmosphere with dust (fly ash).
Position Travel Limits	Rotary: 18 to 100 degrees (short travel version 9 - 50 degrees). Reciprocating: 12 to 64 mm, 0.5 to 4.5 inches. Short travel version 6 to 32 mm, 0.25 to 1.25 inches. Above 64 mm consult factory for mounting.
Flow Characterization	Linear Equal percentage (50:1 or 30:1) Quick opening (inverse of 50:1 equal percentage) User configurable for 10 segments Tight Shut-off (0 - 20% of input)

Electrical Safety Specifications

Electrical Safety Design Specifications

Agency	Service	Applicable Class
Factory Mutual Approvals	Explosionproof	Class I, Division 1, Groups B, C, and D
	Dust-ignitionproof	Class II, III, Division 1, Groups E, F, and G
	Intrinsically Safe	Class I, II, III, Division 1, Groups A, B, C, D, E, F, and G
	Non-incendive	Class I, Division 2, Groups A, B, C, and D
	Suitable for	Class II, III, Division 2, Groups F and G
	Enclosure Rating	NEMA 4X
CSA Approvals	Explosionproof	Class I, Division 1, Groups B, C, and D
	Dust-ignitionproof	Class II, III, Division 1, Groups E, F, and G
	Intrinsically Safe	Class I, II, III, Division 1, Groups A, B, C, D, E, F, and G
	Non-incendive	Class I, Division 2, Groups A, B, C, and D
	Suitable for	Class II, III, Division 2, Groups F and G
	Enclosure Rating	Type 4X
CENELEC Approvals	Flameproof	EEx d IIB + H2 T5 (ambient temp. not to exceed 80°C) per EN 50014 and EN 50018
	Intrinsic Safety	EEx ia IIC T4 (ambient temperature not to exceed 80°C) per EN 50014 and EN 50020
	Enclosure Rating	IP 65 per EN 60529
CE Conformity		Yes

Principle of Operation

electropneumatic valve positioner

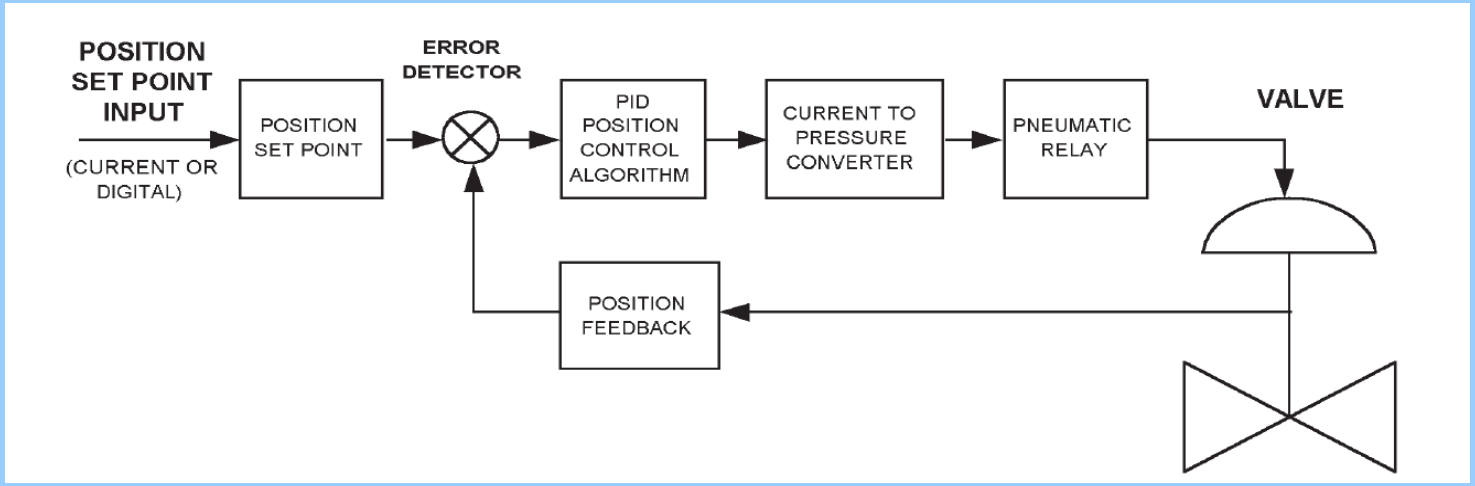
SVI accepts a 4-20 mA

compares

to the valve position

Difference conditioned

control algorithm → converted → pneumatic signal



SVI Controller

accepts

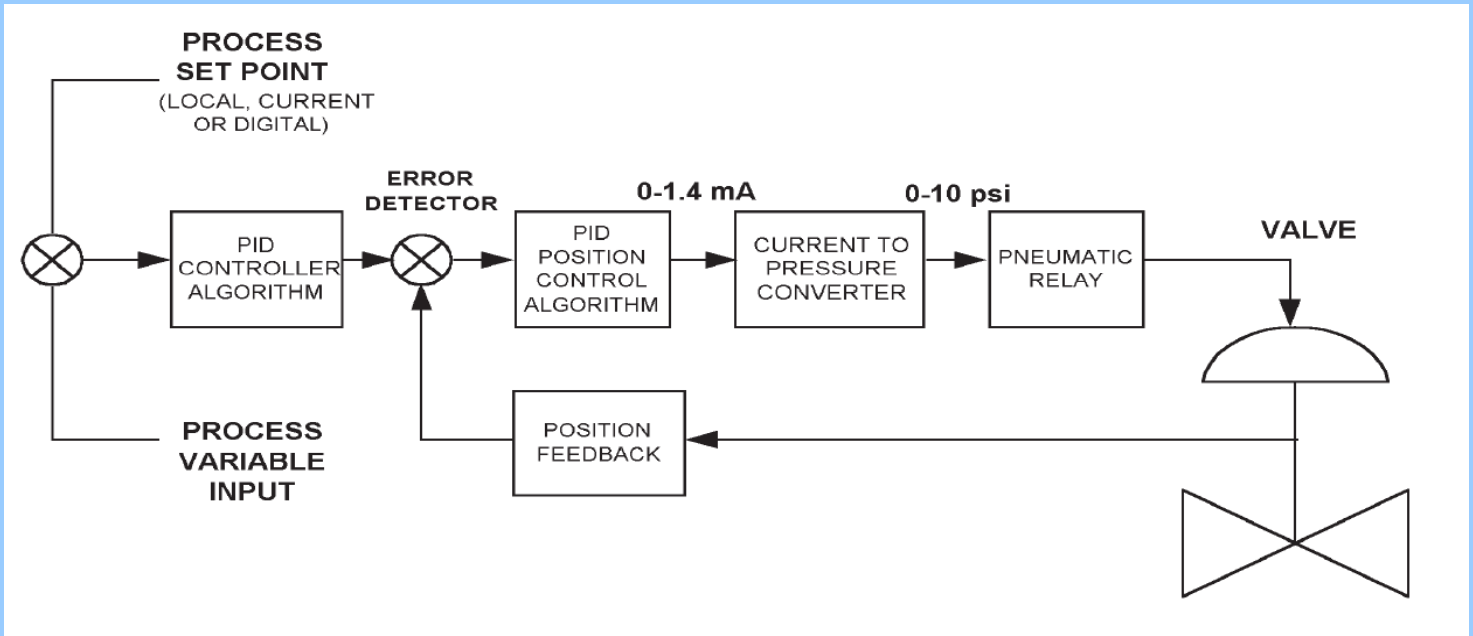
local control setting

4-20 mA signal

primary process measurement

is fed

voltage signal of 1 to 5 V dc



difference → conditioned

PID controller

position control

algorithm → converted

pneumatic signal

boosted → pneumatic relay → drives actuator

High-Capacity Rotary Valves

suitable

used

provides

for throttling

on-off service

full 0 to 90 degree ball rotation

high-capacity control of

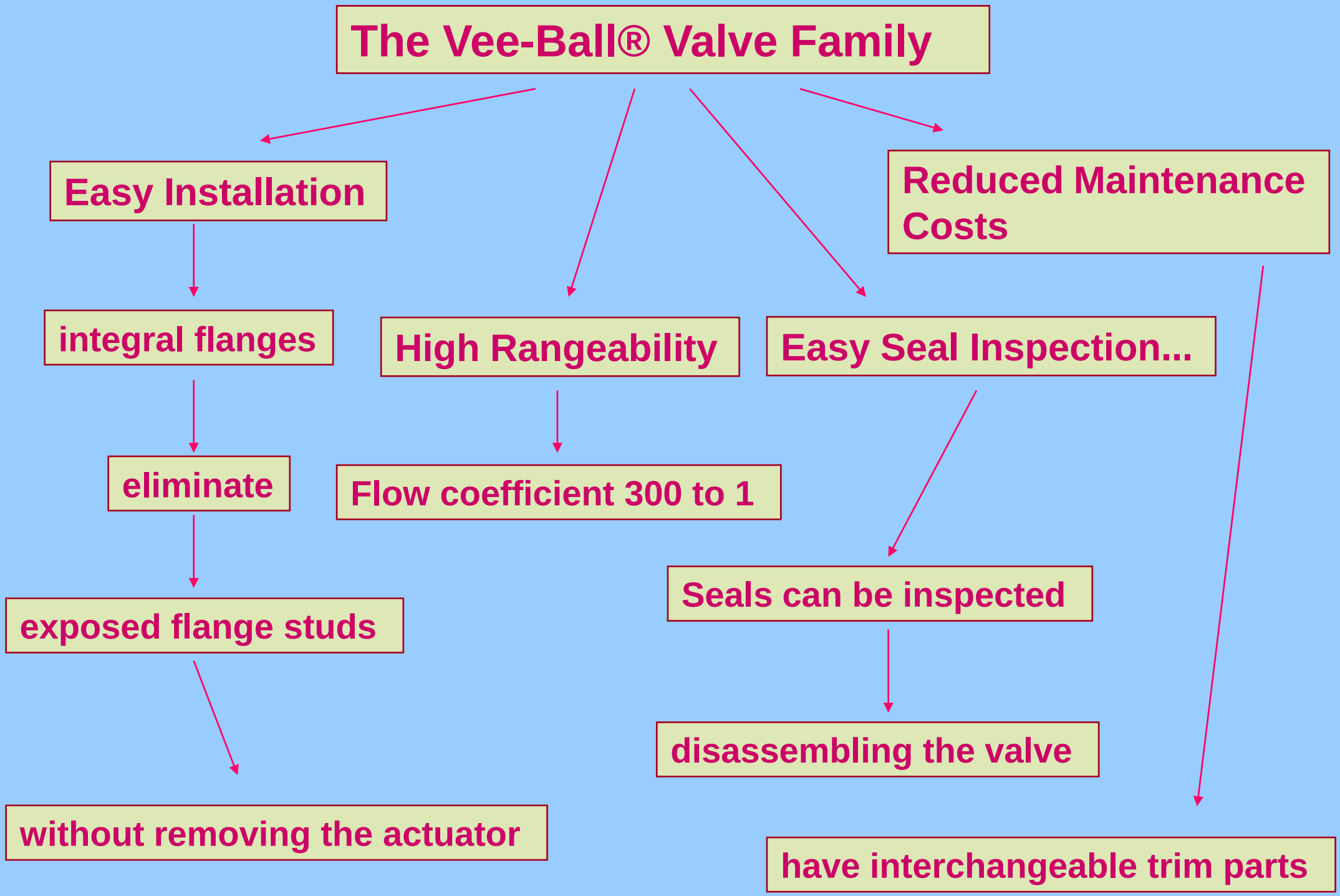
liquid

steam

gas

fibrous slurries

V150 Series B Valve


The Vee-Ball® Valve Family
Easy Installation
integral flanges
eliminate
exposed flange studs
without removing the actuator
High Rangeability
Flow coefficient 300 to 1
Easy Seal Inspection...
Seals can be inspected
disassembling the valve
Reduced Maintenance Costs
have interchangeable trim parts

Body Materials, End Connections, and Ratings

Design V150

Valve Body Materials	Sizes	Ratings and Raised-Face Flanges	Notes
DIN 1.0619,or DIN 1.4408	DN 25, 40, 50, 80, 100, 150, 200, 250	PN10/16	DIN materials available in DIN sizes and ratings
	DN 300	PN16	
CF3M, WCC, CG8M, or CW2M	1, 1-1/2, 2, 3, 4, 6, 8, 10, 12	Class 150	CG8M available in inch sizes and ANSI ratings only. Refer to page 14 for CW2M ratings
WCC, CG8M, or CW2M	14, 16, 20		

Maximum Inlet Pressure for CW2M (Hastelloy C) Valve Bodies

TEMPERATURE, °C	MAXIMUM INLET PRESSURE, BAR			NOTE
	150	300	600	
–46 to 38	20.0	51.7	103	CW2M is not listed in ASME B16.34. The designations 150, 300, and 600 indicate relative pressure-retaining capabilities and are not ANSI pressure-temperature rating classes.
93	17.9	51.7	103	
149	15.9	50.3	100	
204	13.8	48.6	97.2	
232	12.8	47.2	94.5	

Flow Coefficients

Design V150, V200, and V300 (Forward Flow)

VALVE SIZE		VALVE ROTATION, DEGREES (LINE SIZE EQUALS VALVE SIZE)															
		10	30	60	90	10	30	60	90	10	30	60	90	10	30	60	90
		C_v				K_v				F_L				X_T			
Composition Seals, Flat Metal Seals (DN 50 - DN 300 & 3 - 12 inches only), and Flow Ring Construction																	
DN 25[1]	1[1]	.0098	2.53	12.4	34.6	.0085	2.19	10.7	29.9	.93	.90	.84	.69	.392	.571	.507	.275
DN 40[1]	1-1/2[1]	.014	6.15	27.8	76.0	.012	5.32	24.0	65.7	.87	.86	.82	.73	.492	.548	.516	.328
DN 50[1]	2[1]	.028	9.60	46.1	123	.024	8.30	39.9	106	.94	.90	.83	.75	.386	.585	.559	.366
DN 80	3	.746	27.7	120	321	.645	24.0	104	278	.91	.88	.80	.74	.664	.628	.501	.302
DN 100	4	3.56	47.2	195	596	3.08	40.8	169	516	.88	.90	.80	.62	.697	.792	.518	.221
DN 150	6	5.34	82.1	340	1100	4.62	71.0	294	952	.93	.91	.80	.58	.574	.770	.518	.200
DN 200	8	6.99	122	518	1820	6.05	106	448	1570	.89	.90	.82	.54	.526	.735	.537	.176
DN 250	10	43.5	252	1000	3000	37.6	218	865	2600	.85	.88	.80	.56	.219	.735	.473	.189
DN 300	12	44.2	390	1530	3980	38.2	337	1320	3440	.81	.83	.78	.63	.366	.632	.490	.245
- - -	14	60.0	541	1670	5610	51.9	468	1450	4850	.89	.79	.80	.37	.999	.605	.593	.198
- - -	16	70.0	692	2380	8270	60.6	599	2060	7150	.89	.79	.80	.37	.273	.566	.452	.133
- - -	20	110	993	3070	10,300	95.2	859	2660	8910	.89	.79	.80	.73	.999	.605	.593	.198
HD (Heavy-Duty) Metal Seats																	
		C_v								F_L				X_T			
DN 25	1[1]	.0503	2.53	11.3	33.1	.0435	2.19	9.77	28.6	.95	.94	.88	.68	.829	.687	.553	.243
DN 40	1-1/2[1]	.0180	4.20	23.2	70.8	.0156	3.63	20.1	61.2	.91	.94	.87	.70	.591	.683	.561	.265
DN 50	2[1]	.020	6.75	40.4	122	.017	5.84	34.9	106	.89	.91	.87	.72	.749	.589	.558	.314
DN 80	3	.169	24.1	112	338	.146	20.8	96.9	292	.96	.91	.82	.73	.710	.597	.563	.278
DN 100	4	.108	34.2	158	539	.093	29.6	137	466	.89	.94	.82	.64	.941	.718	.605	.233
DN 150	6	.996	56.9	290	1070	.862	49.2	251	925	.94	.95	.84	.58	.578	.788	.544	.185
DN 200	8	1.41	94.7	481	1750	1.22	81.9	416	1510	.96	.89	.80	.51	.348	.693	.508	.158
DN 250	10	7.28	199	897	2950	6.30	172	776	2550	.97	.90	.79	.54	.107	.664	.494	.174
DN 300	12	7.48	291	1300	4010	6.47	252	1120	3470	.97	.92	.82	.60	.800	.710	.508	.228
- - -	14	56.0	502	1550	5200	48.4	434	1340	4500	.89	.79	.80	.37	.999	.605	.593	.198
- - -	16	30.0	600	2040	7840	26.0	519	1770	6780	.89	.79	.80	.37	.965	.593	.533	.135
- - -	20	105	942	2910	9770	90.8	815	2520	8450	.89	.79	.80	.37	999	.605	.593	1.98
Micro-Notch V-Notch Ball (Metal Ball with Composition or HD (Heavy-Duty) Metal Seal																	
		C_v								F_L				X_T			
DN 25	1	.0143	.360	1.43	5.23	.0124	.311	1.24	4.52	.95	.93	.90	.88	.551	.660	.620	.578
Micro-Notch V-Notch Ball (Ceramic Ball with HD (Heavy-Duty) Metal Seal																	
		C_v								F_L				X_T			
DN 25	1	.0180	.415	1.78	3.64	.0156	.389	1.54	3.15	.90	.94	.90	.92	.581	.693	.612	6.12

1. The coefficient listed for 10 degrees was measured at 12 degrees rotation.

FIELDVUE digital Valve controllers

provide

highly accurate positioning

as well as

high-speed

stable valve response

output capacity

simplified schematics

eliminate

boosters

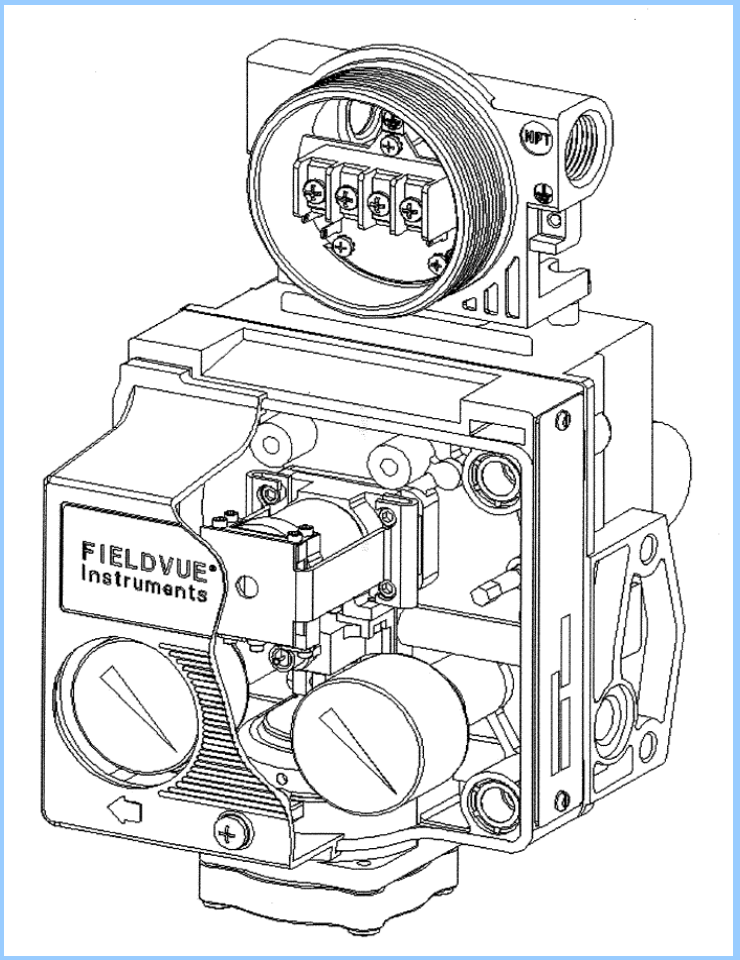
quick releases

Fisher® FIELDVUE® DVC5010f Series digital valve controller

Instrument Description

DVC5000f Series digital valve controllers

- interoperable
- communicating
- process controlling
- microprocessor-based
- digital-to-pneumatic



Cutaway View of FIELDVUE® Type DVC5010f Digital Valve Controller

DVC5000f Series digital valve controller

primary function

converting

digital input signal

pneumatic output

using

FOUNDATION fieldbus

access to information

health of

instrument

actuator

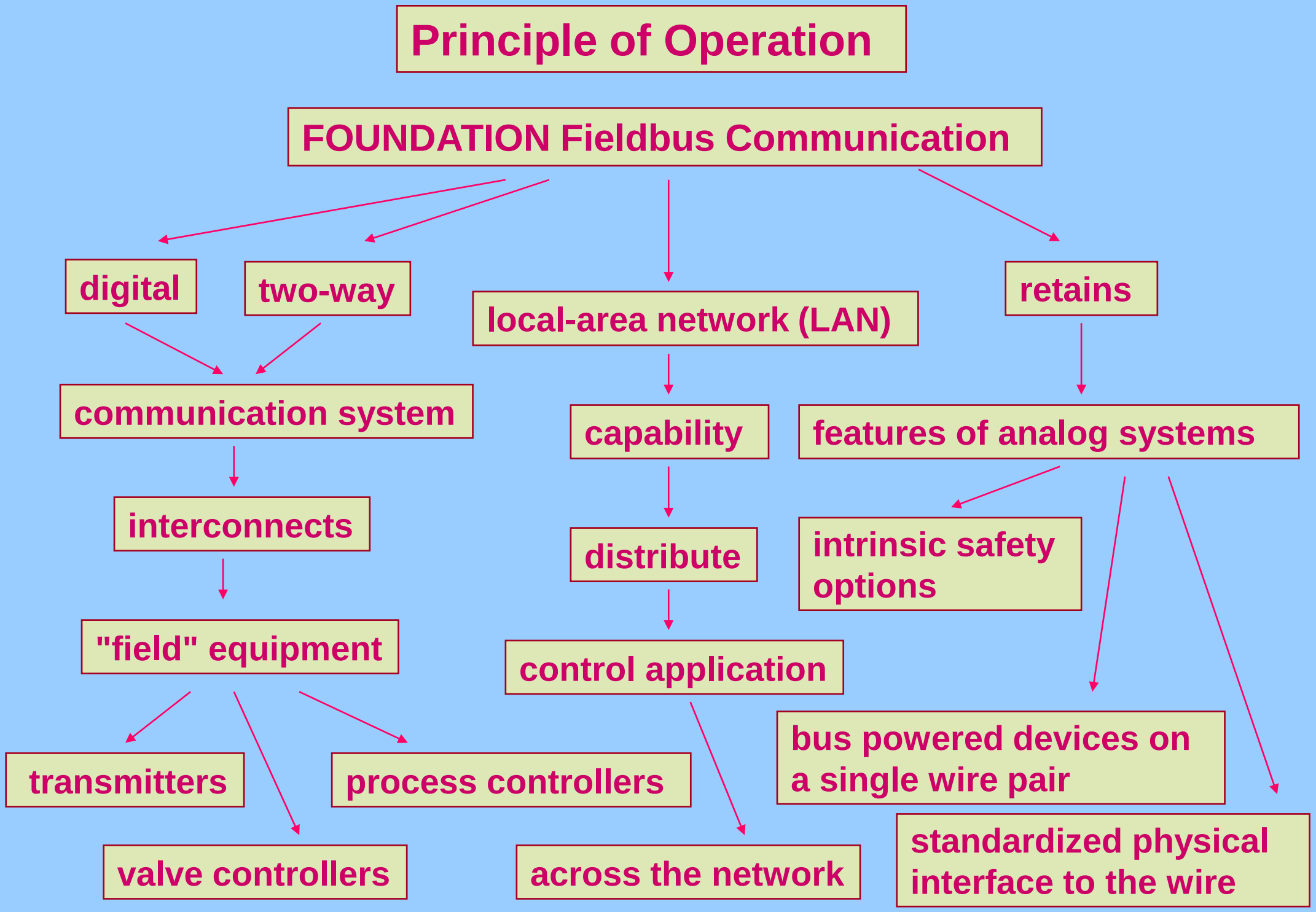
valve

control valve

process control

critical to process operation

principal component of the process


Principle of Operation
FOUNDATION Fieldbus Communication
digital
two-way
local-area network (LAN)
retains
communication system
capability
features of analog systems
interconnects
distribute
intrinsic safety options
"field" equipment
control application
bus powered devices on a single wire pair
transmitters
process controllers
valve controllers
across the network
standardized physical interface to the wire

Digital Valve Controller Operation

DVC5000f Series digital valve controllers

have

single master module

easily replaced

without disconnecting

wiring

tubing

submodules

current-to-pneumatic (I/P) converter

pneumatic relay

printed wiring board assembly

can be rebuilt by

replacing the submodules

Digital Valve Controller Operation

input

routed

terminal box

single pair of wires

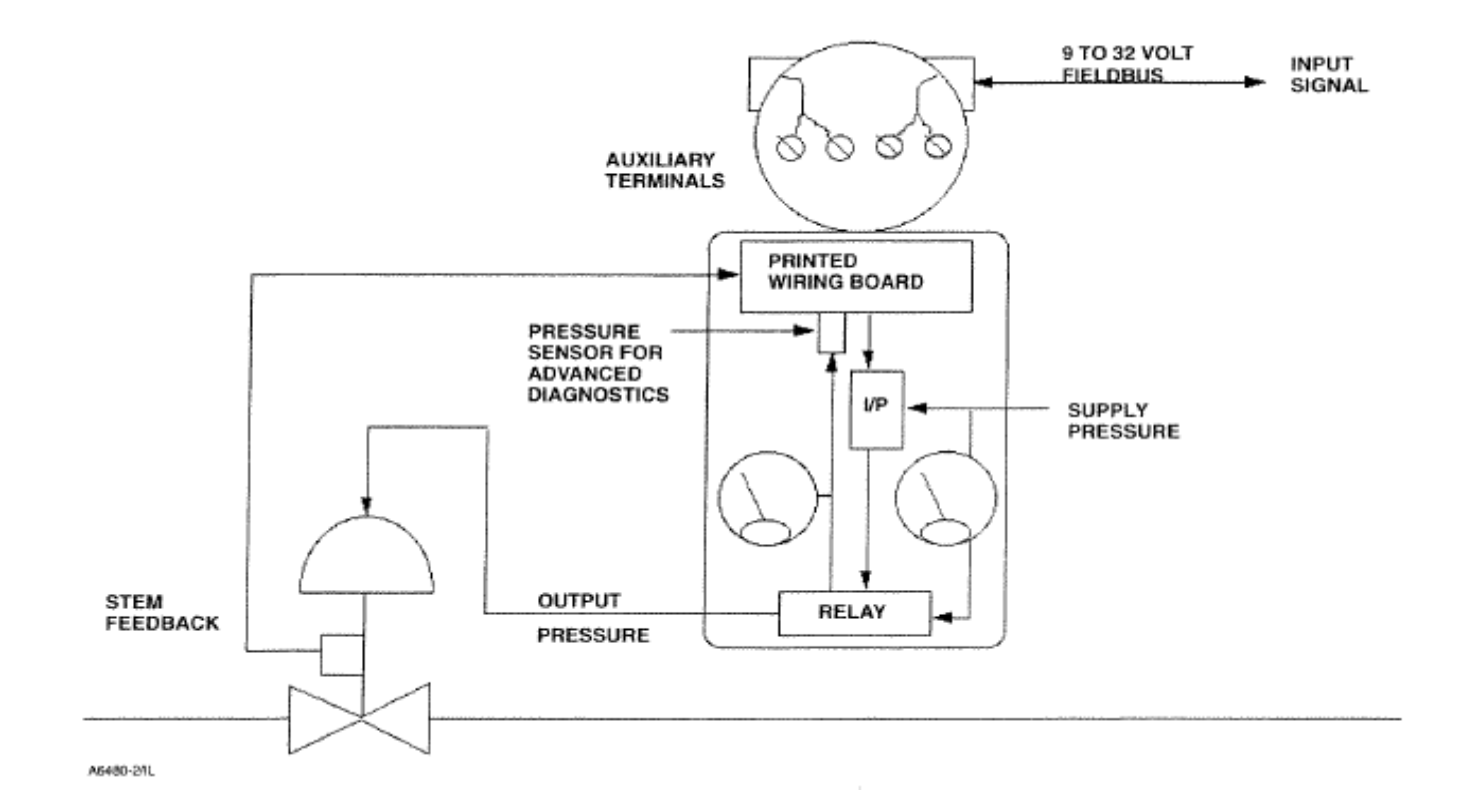
printed wiring board

read by the microprocessor

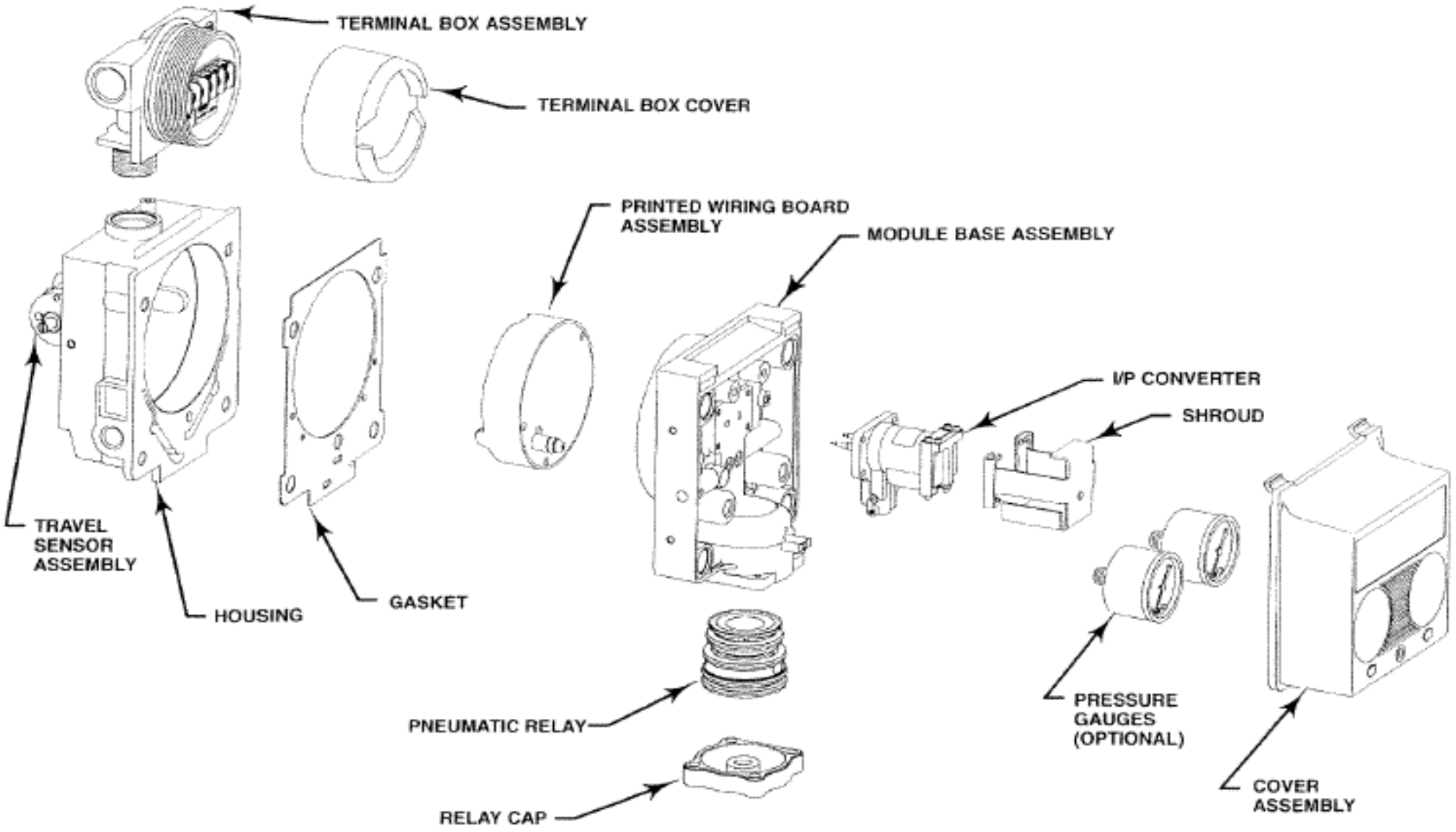
processed by a digital algorithm

converted

analog I/P drive signal



DVCSOOOf Series Digital Valve Controller Assembly



Rotork IQ & IQT Range electric valve actuators

Fit for Life

- double sealing
- infra-red set-up
- Design simplicity
- watertight enclosure
- comprehensive protection systems

Rotork IQ & IQT Range electric valve actuators

Simple commissioning

using

"point and shoot" IQ Setting Tool

settings

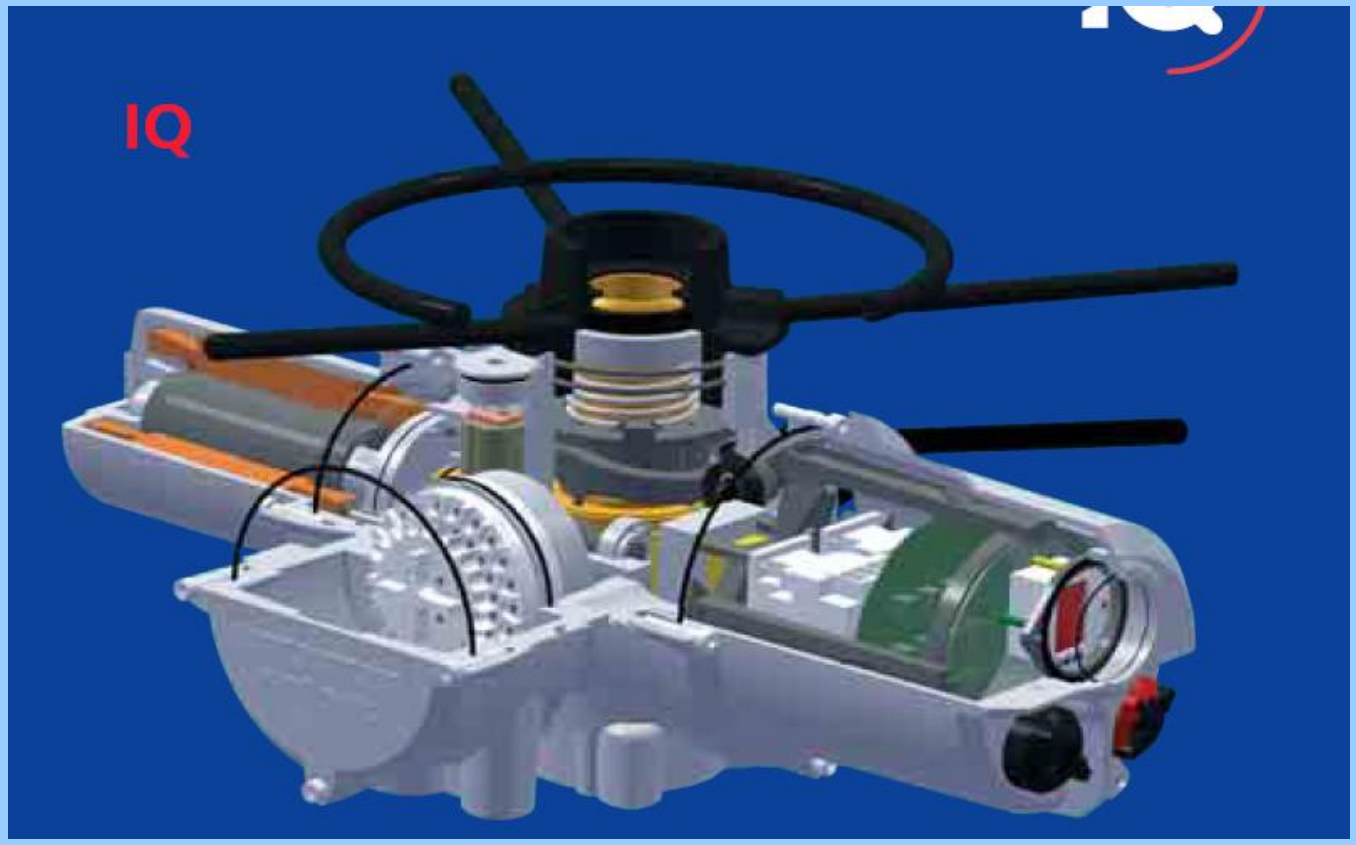
torque levels

position limits

functions

control

indication



Rotork IQ & IQT Range electric valve actuators

Simple troubleshooting

Access

comprehensive

real-time

diagnostic help screens

on-board data

alarm

Logger records

valve torque profile

IQ 3 phase performance summary

Performance data

	Actuator output speeds							
rpm at 50 Hz	18	24	36	48	72	96	144	192
rpm at 60 Hz	21	29	43	57	86	115	173	230
Actuator size	Torque** Nm / Ft lbf							
IQ10	34	34	34	34	34	34		
	25	25	25	25	25	25		
IQ12	81	81	81	68	48	41		
	60	60	60	50	35	30		
IQ18	108	108						
	80	80						
IQ20	203	203	203	203	176	142	102*	
	150	150	150	150	130	105	75*	
IQ25	400	400	298	244	244	230	149*	
	295	295	220	180	180	170	110*	
IQ35	610	610	542	474	474	366	257*	
	450	450	400	350	350	270	190*	
IQ40	1020	1020	845	680	680	542	406*	
	750	750	625	500	500	400	300*	
IQ70	1490	1490	1290	1020	1020	745	645*	542*
	1100	1100	950	750	750	550	475*	400*
IQ90	2030	2030	1700	1355	1355	1020	865*	730*
	1500	1500	1250	1000	1000	750	640*	540*
IQ91							1355*	1355*
							1000*	1000*
IQ95		3000						
		2200						