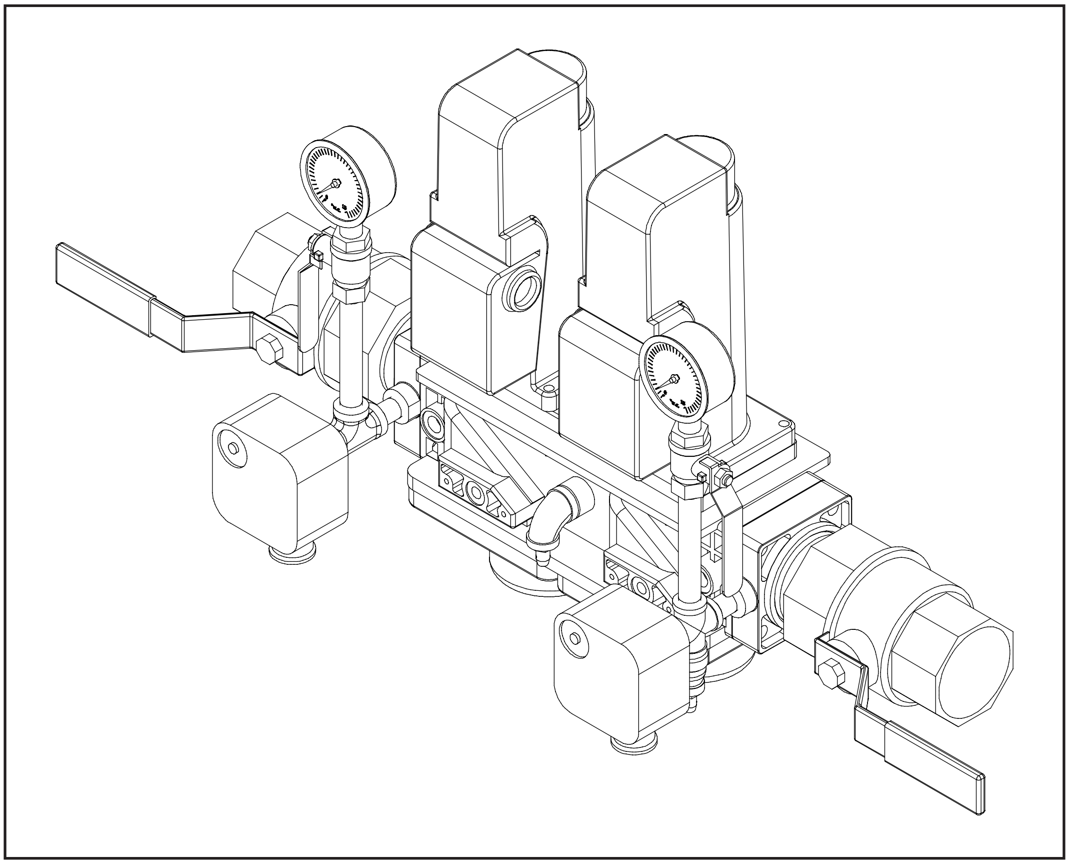
Design Guide 791
10/5/07

Eclipse Standardized Valve Train Segments

NFPA and CE Models

Version 1



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About this manual

Audience

This manual has been written for people who are already familiar with all aspects of gas valves, safety devices and piping components, also referred to as "the valve train."

These aspects are:
- Design/selection
- Use
- Maintenance.

The audience is expected to have had experience with this kind of equipment.

Valve Train Documents

Design Guide No. 791
- This document

Data Sheet No. 791-1 and 791-2
- Available for NFPA or CE models
- Required to complete design calculations in this guide

Installation Guide No. 791
- Used with Data Sheet to complete installation

Price List No. 791
- Used to order valve trains

Related Documents

- EFE 825 (Combustion Engineering Guide)
- Eclipse bulletins and Info Guides

Purpose
The purpose of this manual is to make sure that the design of a safe, effective and trouble-free combustion system is carried out.

Document Conventions

There are several special symbols in this document. You must know their meaning and importance.

The explanation of these symbols follows below. Please read it thoroughly.

Danger:
Indicates hazards or unsafe practices which WILL result in severe personal injury or even death.

Only qualified and well trained personnel are allowed to carry out these instructions or procedures.

Act with great care and follow the instructions.

Warning:
Indicates hazards or unsafe practices which could result in severe personal injury or damage.

Act with great care and follow the instructions.

Caution:
Indicates hazards or unsafe practices which could result in damage to the machine or minor personal injury. Act carefully.

Note:
Indicates an important part of the text. Read thoroughly.

How to Get Help

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Introduction

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Product Description

The Eclipse Standard Valve Train Segments are sub-assemblies that may be used for many different global applications. Standardization results in quicker throughput and a reduction of errors from the beginning stages of quotations through the stages of commissioning, operation and maintenance. These segments include:

- Double safety shut off valves
- High and low gas pressure switches
- Permanent and ready means for leak testing
- Inlet and outlet manual isolation valves
- Connection ports with isolation valves for pressure measurements

To fully meet the requirements of local codes, these sub-assemblies will require additional components, such as a drip leg, strainer, filter, dryer, regulator and overpressure protection depending on the end-use application.

Where this document refers to NFPA 86, it is for the 2007 edition. For EN 746-2, it is for the 1997 edition with foresight of the 2006 draft document.

Safety

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Introduction

Important notices about safe operation will be found in this section. Read this entire manual before attempting to start the system. If any part of the information in this manual is not understood, then contact your local Eclipse representative or Eclipse, Inc. before continuing.

Safety

Danger:

The valve trains covered in this manual are designed to deliver fuel gas to a burner. All fuel burning devices are capable of producing fires and explosions when improperly applied, installed, adjusted, controlled or maintained

Do not bypass any safety feature. You can cause fires and explosions.

Never try to light the burner if any devices show signs of damage or malfunctioning.

Note:

This manual gives information for the use of these valve trains for their specific design purpose. Do not deviate from any instructions or application limits in this manual without written advice from Eclipse, Inc.

Capabilities

Adjustment, maintenance and troubleshooting of the mechanical and the electrical parts of this system should be done by qualified personnel with good mechanical aptitude and experience with combustion equipment.

Operator Training

The best safety precaution is an alert and competent operator. Thoroughly instruct new operators so they demonstrate an adequate understanding of the equipment and its operation. Regular retraining must be scheduled to maintain a high degree of proficiency.

Replacement Parts

Order replacement parts from Eclipse only. Any customer-supplied valves or switches should carry UL, FM, CSA,CGA and/or CE approval where applicable.

System Design

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Design

The design process is divided into the following steps.

1. Pipe Size Selection
2. Model Size Selection
3. Model Type Selection
4. Additional Required Components
   a. Drip Leg or Sediment Trap
   b. Y-strainer or Filter
   c. Regulator
   d. Overpressure Shut-Off and Relief Valve
   e. Valve Proving System

Step 1: Pipe Size Selection

Selection of the proper size for a valve train segment requires knowledge of the maximum flow demand and the maximum allowable pressure drop. Maximum flow is determined by the capacities of the burner or burners fed by the valve train. The maximum pressure drop is determined by the available source pressure, the pressure requirement at the burner, and the other pressure drops caused from other series connected components such as piping, fittings, and valves.

Sizing and selection of piping and valves for most combustion systems is simplified because the fuel gas normally has a consistent chemical composition, the pressures are normally at 2 psig (14 kPa) or less and its temperature does not vary significantly from ambient.

Gas piping and valve systems must be sized to deliver flow at a uniform pressure distribution and without excessive pressure losses in transit. Pressure loss and pressure variation are caused by friction from surface roughness within the pipe, bends in piping runs, changes in pipe diameters, changes in direction and flow through orifices of valves.

Step 1: **Pipe Size Selection**

Combustion applications normally have relatively short piping runs but with many bends. The velocity of the gas exerts a force on the upstream face of an object, such as the wall of a bend. This velocity pressure, Vp, is essentially dissipated and lost at each change of direction. The goal is to keep the gas velocity to 0.5 in. wc (1.2 mbar) or less. The following chart relates this velocity pressure to velocity, for various gasses.

***Table 3.1:* Flow Velocity for Vp of 0.5 in.wc (1.2 mbar)**

Gas	Specific Gravity	Velocity	
		fpm	m/s
Natural Gas	0.6	3600	18
Air	1	2700	14
Propane	1.5	2400	12
Butane	2	1980	10

The velocity in a pipe is the flow divided by the internal diameter. To keep the velocity pressure at the recommended levels, the allowable flow depends on the pipe size. The following chart can be used to select a pipe size based on the needed flow. With these values, the pressure drop calculation is simplified by adding 0.5 in. wc (1.2 mbar) for each bend of the pipe.

***Table 3.2:* Maximum Flow Rates based on a 0.5 in. wc (1.2 mbar) Velocity Pressure**

Pipe Size		Natural Gas 0.6		Air 1.0		Propane 1.5		Butane 2.0		Friction Loss	
inches	mm	cfh	m3/hr	cfh	m3/hr	cfh	m3/hr	cfh	m3/hr	in.wc /100ft	mbar /10m
½	15	456	13	342	10	304	9	251	7	31	25
¾	20	800	23	600	17	533	15	440	12	21	17
1	25	1296	37	972	28	864	24	713	20	15	12
1-1/2	40	3054	86	2290	65	2036	58	1680	48	9	7
2	50	5033	143	3775	107	3356	95	2768	78	7	5
2-1/2	65	7182	203	5386	153	4788	136	3950	112	5	4
3	80	11089	314	8317	236	7393	209	6099	173	4	3
4	100	19095	541	14322	406	12730	360	10502	297	3	2
6	150	43335	1227	32502	920	28890	818	23834	675	2	1
8	200	75041	2125	56280	1594	50027	1417	41272	1169	1	1

The above guidelines apply in general to gas pipe from the valve train to the burner. In some cases where required flows are high and the lengths are long, the economics of an installation becomes unreasonable when staying at the recommended velocity pressure. The following table gives flows for a reasonable 10 in. wc pressure drop per 100 feet of standard pipe (25 mbar / 30 m). The chart starts at pipe sizes 1-1/2 inch (40 mm) and above where the flows start to exceed those of the above table. When using the chart below, the pressure drop calculation requires looking up published tables of equivalent lengths of pipe for each type of fitting in the pipe run.

Table 3.3: **Maximum Flow Rates based on 10 in. wc per 100 ft (25 mbar / 30 m)**

Pipe Size		Natural Gas 0.6		Air 1.0		Propane 1.5		Butane 2.0	
inches	mm	cfh	m3/hr	cfh	m3/hr	cfh	m3/hr	cfh	m3/hr
1-1/2	40	3239	92	2591	73	2115	60	1832	52
2	50	6326	179	5061	143	4132	117	3579	101
2-1/2	65	10401	295	8321	236	6794	192	5884	167
3	80	18386	521	14709	417	12009	340	10401	295
4	100	37209	1054	29767	843	24305	688	21049	596
6	150	110083	3117	88066	2494	71906	2036	62272	1763
8	200	221462	6271	177170	5017	144659	4096	125278	3547

Manifolds are large sections of pipe feeding several smaller pipes coming off at a right angle. The balancing of pressures across the multiple outlet feeder pipes is critical for achieving equal flow rates. When sizing pipe for manifolds, a much lower flow rate is required and should not exceed 0.5 in. wc per 100 feet (1.2 mbar / 30m) pressure drop or a velocity of 1500 fpm (8 m/s), equivalent to a velocity pressure of 0.1 in. wc (0.22 mbar).

There are special considerations with high pressures and long lengths. High pressures compress the gas volume at the source and it expands as it travels the pipe run. Long lengths create loss of pressure and friction heating of the gas, both resulting in expansion of the gas. Therefore precise calculation of pressure drop becomes difficult because the properties of the gas are varying. Estimated values are available in published tables in references such as the Eclipse Engineering Guide (EFE825).

It may be necessary to exceed the recommended flow rates for a particular pipe size in some applications. Such cases should be reviewed by a qualified combustion engineer for:

- Total system pressure drop at both maximum and minimum flow rates
- Pressure ratings of components when the flow is stopped
- The wear and stresses resulting from the higher velocities
- The generation of audible noise.

Step 2: **Model Size Selection**

Refer to the capacity charts in Data 791-1 or Data 791-2 to select the model size. Locate the required flow and follow it up to the line that provides the highest pressure drop that is still less than the maximum allowed. Other factors besides flow and pressure drop may influence proper selection for a particular application. These factors may include supply pipe size, available pressure and its variations, maximum and minimum flow, component and labor costs.

Step 3: **Model Type Selection**

The location of final installation determines the selection of either the NFPA or CE types. In general most installations in the Americas require NFPA types and those in European countries require the CE types. Contact the local authority where the equipment will operate to determine which type is accepted.

Step 4: Additional Required Components

Other components are needed to fully meet the requirements of NFPA 86 or EN746-2 for the complete gas train. The following paragraphs list these components, explain their function and advise when it is required according to each standard. Eclipse offers fully configured valve trains in Data 790.

Drip Leg or Sediment Trap

The drip leg collects water, larger sediments and contaminants. NFPA 86 requires it located upstream of the filter or strainer to catch the larger particles and reduce their maintenance intervals. EN746-2 has no requirements for this feature.

Y-strainer or Filter

Both European and American standards require a means of protection for regulators and safety devices against harmful contaminants. Both standards require the device to provide suitable protection, but neither states a specific particle size. Therefore the designer must consult the recommendations of the manufacturers of the downstream devices. Note that some manufacturers provide built-in strainers, however these must be considered easy to service to be acceptable by the standards.

Regulator

A gas pressure regulator is required by both standards when the supply pressure can exceed the maximum allowed by the components in the system. Often a single regulator at the building entrance will provide sufficient regulation. However if the plant has various equipment with several different gas pressure levels, the lower pressure equipment will need the additional regulator.

Overpressure Shut-Off and Relief Valve

Overpressure protection is required by both standards if the upstream pressure of the regulator is greater than the ratings of the downstream equipment. NFPA 86 does not state the specific type of protection and the responsibility belongs to the system designer. EN746-2 requires a cut-off device upstream of the regulator and a relief valve downstream. The cut-off must comply with EN14382 or could be an EN1854 pressure switch used with an EN161 safety shutoff valve.

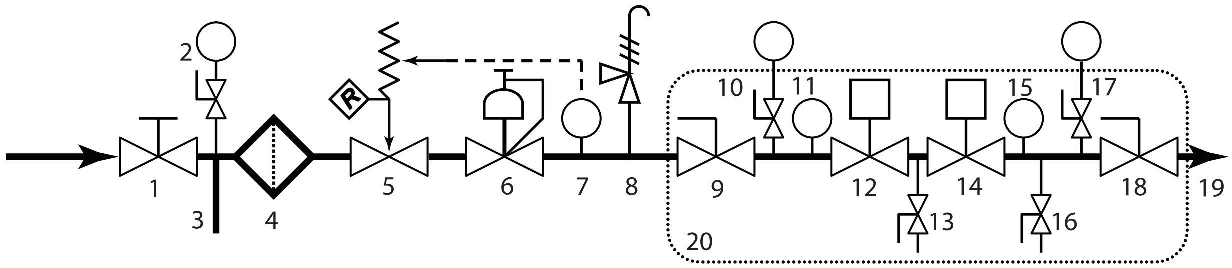
Valve Proving System

Safety shut off valves can fail to close due to a sudden mechanical problem or an obstruction. Also the gradual wear of their seats can eventually develop a leak large enough to cause a hazard. A valve proving system checks for these conditions and sends a signal to the control system to prevent burner operation. NFPA 86 requires at least one of the safety shut off valves are proved closed when the capacity through the valve exceeds 400,000 Btu/hr (117kW). The method can be from a proof-of-closure switch or a valve proving system. EN 746-2 requires valve proving when the capacity exceeds 1200kW (4MMBtu/hr). The method must comply with EN 1643 or give an equivalent level of safety.

Piping Diagram

The following diagram shows the typical locations of the gas valve train components as described .

Figure 3.1: **Piping Diagram**



1. Gas Inlet Valve	6. Regulator	11. Low Gas Pressure Switch	16. Downstream Valve Leak Test Port
2. Pressure Gauge with Valve	7. Overpressure Sensing Switch	12. Upstream Safety Shut Off Valve	17. Pressure Gauge with Valve
3. Drip Leg	8. Relief Valve	13. Upstream Valve Leak Test Port	18. Manual Valve
4. Strainer or Filter	9. Manual Valve	14. Downstream Safety Shut Off Valve	19. To Gas Flow Control and Burner
5. Overpressure Cut-Off with Manual Reset	10. Pressure Gauge with Valve	15. High Gas Pressure Switch	20. Eclipse Standard Valve Train Segment

Appendix

Conversion Factors

Metric to English.

From	To	Multiply by
cubic meter (m^3)	cubic foot (ft^3)	35.31
cubic meter/hour (m^3/h)	cubic foot/hour (cfh)	35.31
degrees Celsius (°C)	degrees Fahrenheit (°F)	(°C x 1.8) + 32
kilogram (kg)	pound (lb)	2.205
kilowatt (kW)	Btu/hr	3414
meter (m)	foot (ft)	3.28
millibar (mbar)	inches water column ("wc)	0.401
millibar (mbar)	pounds/sq in (psi)	14.5×10^{-3}
millimeter (mm)	inch (in)	3.94×10^{-2}

Metric to Metric.

From	To	Multiply by
kiloPascals (kPa)	millibar (mbar)	10
meter (m)	millimeter (mm)	1000
millibar (mbar)	kiloPascals (kPa)	0.1
millimeter (mm)	meter (m)	0.001

English to Metric.

From	To	Multiply by
Btu/hr	kilowatt (kW)	0.293×10^{-3}
cubic foot (ft^3)	cubic meter (m^3)	2.832×10^{-2}
cubic foot/hour (cfh)	cubic meter/hour (m^3/h)	2.832×10^{-2}
degrees Fahrenheit (°F)	degrees Celsius (°C)	(°F – 32) ÷ 1.8
foot (ft)	meter (m)	0.3048
inches (in)	millimeter (mm)	25.4
inches water column ("wc)	millibar (mbar)	2.49
pound (lb)	kilogram (kg)	0.454
pounds/sq in (psi)	millibar (mbar)	68.95

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