Bulletin for Yarway™ AT-37/47 Cryogenic Injector

This bulletin was prepared by Emerson.

Do not install, operate or maintain this product without being fully trained and qualified in valve, actuator and accessory installation, operation and maintenance.

To avoid personal injury or property damage it is important to carefully read, understand, and follow all of the contents of this manual, including all safety cautions and warnings.

If you have any questions about these instructions, contact your Emerson sales office before proceeding.

Installation

WARNING

Always wear protective gloves, clothing, and eyewear when performing any installation operations. Check with your process or safety engineer for any other hazards that may be present from exposure to process media.

Personal injury or equipment damage caused by sudden release of pressure may result if the desuperheater is installed where service conditions could exceed the limits given on the product nameplate. To avoid such injury or damage, provide a relief valve for over-pressure protection as required by government or accepted industry codes and good engineering practices.

CAUTION

When ordered, the desuperheater configuration and construction materials were specified to meet particular pressure, temperature, pressure drop, and fluid conditions. Do not apply any other conditions to the desuperheater without first contacting your local Emerson sales office .

Maintenance

⚠ WARNING

Avoid personal injury or property damage from sudden release of process pressure or bursting of parts. Before performing any maintenance operations:

- **Do not remove the actuator from the valve while the valve is still pressurized.**
- **Always wear protective gloves, clothing, and eyewear when performing any maintenance operations.**
- **Disconnect any operating lines providing air pressure, electric power, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.**
- **Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure from both sides of the valve. Drain the process media from both sides of the valve.**
- **Safely vent the power actuator loading pressure.**
- **Use lock-out procedures to be sure the above measures stay in effect with you work on the equipment.**
- **The valve packing box may contain process fluids that are pressurized, even with the valve has been removed from the pipeline. Process fluids may spray out under pressure when removing the packing hardware or packing rings.**
- **Check with your process or safety engineer for any other hazards that may be present from exposure to process media.**

CAUTION

When adjusting the travel stop for the closed position of the valve ball or disk, refer to the appropriate valve instruction manual for detailed procedures. Undertravel or overtravel at the closed position may result in poor valve performance and/or damage to the equipment .

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EMERSON

YARWAY NARVIK MODEL 37 AND 47 CRYOGENIC INJECTOR

Cryogenic injector for LNG applications

FEATURES

- Fabricated construction
- High quality stuffing box with PTFE Chevron rings
- Variable nozzle type
- Wide range of K_V (C_V) available
- Special nozzle combinations available
- Yarway pneumatic actuator available
- Wide choice in positioners and other actuator ancillaries
- Pressure class and connections
  - ASME B16.34 class 150 thru 900
  - DIN 2401 Class PN 25 thru PN 100
- Materials
  - ASTM-A 312 TP 316 (L) and 304 (L)
  - ASTM-A 182 F316 (L) or 304 (L)
  - Other materials on request

GENERAL APPLICATION

Cooling of process gas in cryogenic conditions such as LNG, Butane, Propane etc.

TECHNICAL DATA

Size: Process connection 3"or DN 80
Injection fluid connection 1"-1½" (DN 25-40)
Process connection 4"or DN 100
Injection fluid connection 1½"-2" (DN 40-50)

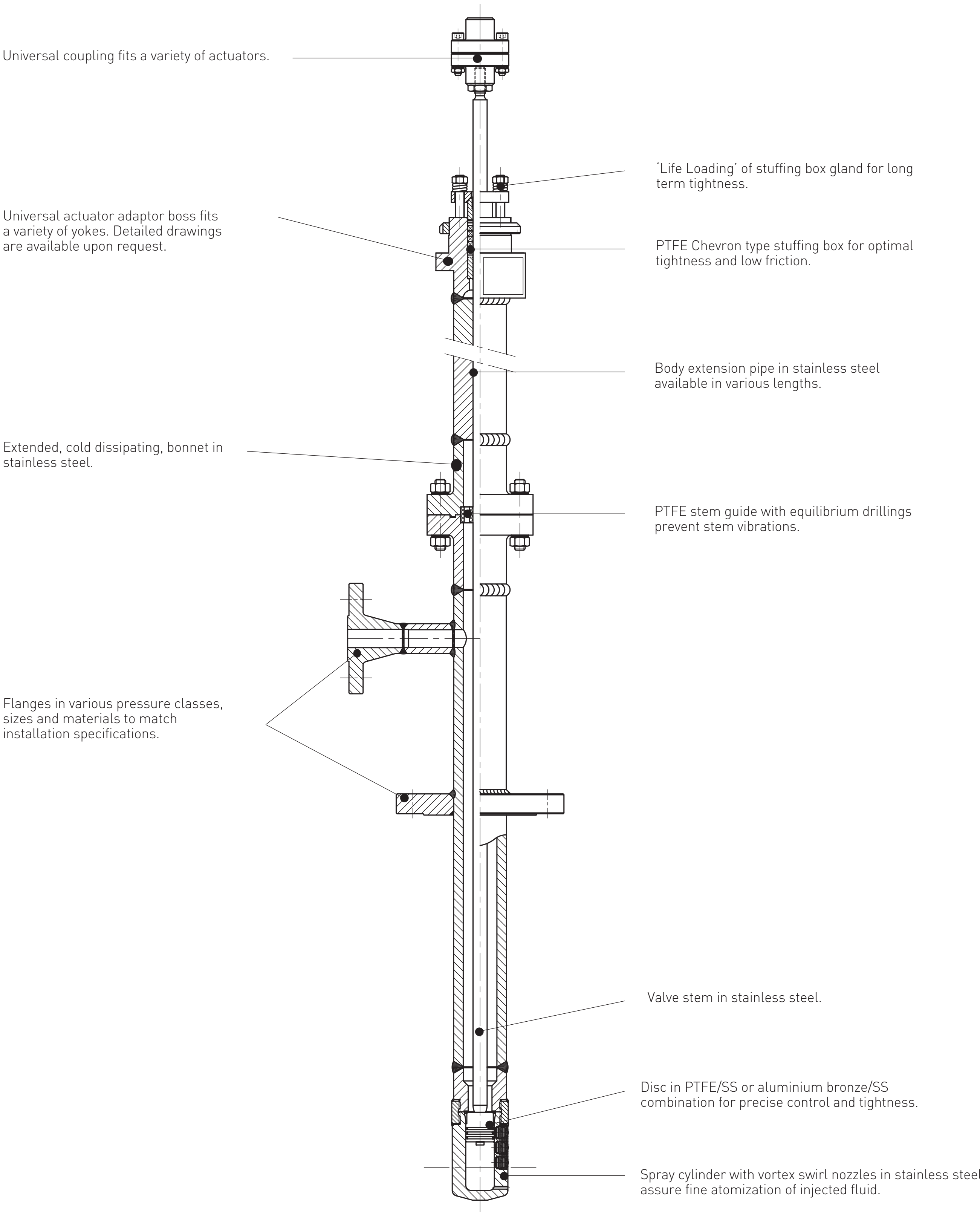


FIG. 1

NOTE

All stainless steel used is of the austenitic type.

The Yarway cryogenic injector is specifically developed to inject process fluids into process gases under cryogenic conditions.
The fabricated construction makes it easy adaptable to meet various codes and standards and offers the possibility to use a wide range of materials of construction.
The vital trim components as well as the pressure bearing parts are selected from grades of austenitic stainless steel and virgin PTFE.
The valve stem is rolled to achieve a finish of Ra < 0.1 μ.
The combination of the 'life loaded' PTFE packing with Chevron type rings and this finished surface results in high sealing integrity and low friction.
The piston (disc) is a combination of stainless steel for the seat and PTFE with a labyrinth type seal or aluminium bronze plug with aluminium bronze piston rings for the control of the fluid to be injected.
The piston runs in a spray cylinder of all austenitic stainless steel construction.
The well proven swirl nozzle design as applied in the Yarway A.T.-Temp steam desuperheaters is used in the cryogenic design as well.

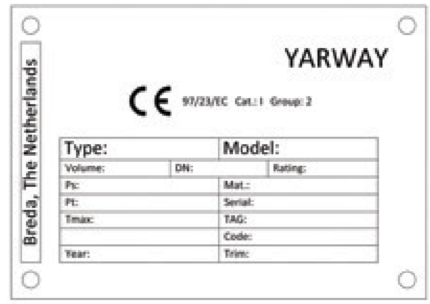


FIG. 2

SYSTEM COMPARISON

Conventional

Conventional injection control systems consist of:
- Fixed capacity spray nozzle
- Control valve
- Process pipe section

The fluid injection quantity is regulated by the control valve. As consequence of this flow regulation the downstream liquid pressure P2, varies as a function of the valve plug position.
At reduced capacity the control valve starts to throttle, reducing P2 and hence the available liquid to gas Δp, resulting in droplets of large size with poor atomization.
The liquid evaporation rate slows down and temperature control becomes troublesome.
This typical system problem becomes compounded as nozzles and valves are usually sized for the design capacity but normally operate significantly below these design conditions.
This oversizing results in a partly open control valve, even at normal operating conditions.
With reducing load, downstream fluid pressure P2 decays rapidly resulting in larger droplet size.
Conventional systems will therefore work satisfactorily only at relatively steady load conditions, near the design parameters.

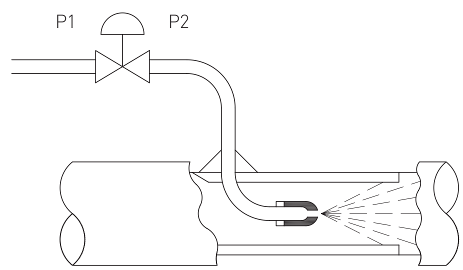


FIG. 3

Cryogenic injector

The cryogenic injector regulates the amount of process fluid to be injected by varying the number of injection nozzles.
This enables the fluid pressure to remain constant, independently of the number of injection nozzles in operation.
This results in an excellent and near uniform spray quality over the entire operating range.
Control of nozzle opening is achieved by the positioning of a piston which is operated directly by an actuator mounted onto the valve.
Through this simple, yet effective, design there is no separate water control valve necessary.

APPLICATIONS

Used for the temperature control in:
- LNG plants
  - Vapor return to ship
  - Compressor inlet
- Propane systems
- Butane systems

SUPERIOR SPRAY NOZZLE

Yarway has incorporated the latest technology in the spray nozzle design.
The high quality surface finish minimizes frictional losses, thereby ensuring that the total fluid to gas Δp is available for atomization of the fluid (see Fig. 4).
The nozzle consists of two components A) the orifices and B) the nozzle body. Each nozzle is served by individual feed holes in the cylinder wall. Fluid enters the chamber behind the orifice plate through these openings.
The relatively large volume of this chamber ensures that fluid is proportioned evenly through each orifice.
The Δp across this orifice plate results in an increase in the fluid velocity. The fluid is subsequently rotated in the nozzle chamber before being emitted through the central hole.
The combination of splitting the feed flow, increasing velocity and rotating effect, ensures that the fluid is injected into the system in a fine symmetrical hollow cone spray.

The nozzles are assembled with the spray cylinder and sealed by a vacuum brazing process. This maintains the integrity of these components even under the most extreme conditions.
Material compatibility of spray cylinder and piston is well proven for cryogenic conditions.
The construction is an all stainless steel of the austenitic type. This enables reliable operation over an extended period.
Surfaces are finely machined to reduce frictional losses and internal contours are so designed as to optimize fluid swirl action, ensuring uniform and consistent droplet size.

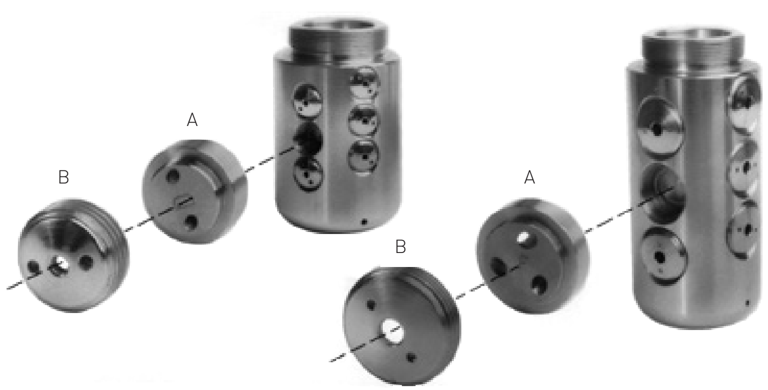
Minimum Δp available from the cryogenic injector inlet flange to gas pressure must be:
Nozzles A through Dx: 1 bar
Nozzles E through K: 2 bar

CODES AND STANDARDS

The cryogenic injector is designed to meet a wide variety of international codes and standards. The valve construction complies with ASME B 16.34.
The Process Piping Code ASME B 31.3 accepts valves to ASME B 16.34 as being listed items.

The injector therefore can be applied under its construction code into a plant built to ASME B 31.3.
If specific codes or standards are required by your local authorities, we would be pleased to discuss them.

FIG. 4



MULTIPLE NOZZLE HEADS

The cryogenic injector may be equipped with a variety of spray heads.
The uniform body threading accepts spray cylinder heads with a wide range of C_v (K_v) values.
Standard configurations are with either 6 or 9 equally sized spray nozzles but combinations are available.

This feature enables the injector to be customized to specific system requirements. Consult Yarway or your local representative for details.

Size	A.T.-Temp standard capacity range:					
16	6A	C_V = 0.0752	K_V = 0.0648	9A	C_V = 0.1128	K_V = 0.0972
	6B	C_V = 0.1587	K_V = 0.1368	9B	C_V = 0.2380	K_V = 0.2052
	6C	C_V = 0.3007	K_V = 0.2592	9C	C_V = 0.4510	K_V = 0.3888
	6D	C_V = 0.5860	K_V = 0.5052	9D	C_V = 0.8790	K_V = 0.7578
	6Dx	C_V = 1.1602	K_V = 1.0002	9Dx	C_V = 1.7403	K_V = 1.5003
25	6E	C_V = 1.9022	K_V = 1.6398	9E	C_V = 2.8533	K_V = 2.4597
	6F	C_V = 2.8397	K_V = 2.4480	9F	C_V = 4.2595	K_V = 3.6720
	6G	C_V = 6.0322	K_V = 5.2002	9G	C_V = 9.0483	K_V = 7.8003
	6H	C_V = 9.3960	K_V = 8.1000	9H	C_V = 14.0940	K_V = 12.1500
	6K	C_V = 13.4885	K_V = 11.6280	9K	C_V = 20.2327	K_V = 17.4420

Flow capacity limitations are:

- Model 37 with a maximum fluid flow capacity of 50 m^3/hr. in continuous service.
- Model 47 with a maximum fluid flow capacity of 100 m^3/hr. in continuous service.

Definition

$$K_V = Q\sqrt{\frac{S.G.}{\Delta p}}$$

Q= m³/hr.
S.G.= kg/dm³
Δp= bar

or

$$C_V = Q\sqrt{\frac{S.G.}{\Delta p}}$$

Q= GPM
S.G.= specific gravity
Δp= psi

SIZING

For the calculation of the valve capacity (K_V or C_V) Yarway appreciates to receive the following fluid/process data for design. Maximum, normal and minimum conditions.

- Quantity of fluid to be injected
- Specific gravity or specific mass of the fluid
- Pressure of the injection fluid at the injection point
- Pressure of the process gas at the injection point
- Process gas pipe size at the injection point
- Design pressure/temperature of process gas and fluid.

Yarway will calculate the required K_V (C_V) values for all conditions.
Upon the results of the calculations a nozzle head will be selected. Experience has learned that the selection of compounded nozzles, giving a near equal percentage characteristic to the cryogenic injector, results in excellent downstream temperature control.

IMPORTANT SYSTEM PARAMETERS

Straight length
LNG systems are by standard design provided with knock-out vessels behind the injection point.
The distance from the injection point to this vessel can be around 7-8 meters.

Distance to sensor
Distance to the temperature sensor downstream can be as close as 6-7 meters.
It is advised to provide the temperature sensor with a well with time lag.
This will stabilize the reading of the temperature.

ACTUATORS

Pneumatic diaphragm
The Yarway pneumatic actuators are specifically developed for the Yarway manufactured desuperheaters for use on low-, medium- and high pressure applications. The actuator models: 20-55 for a stroke of 55 mm and 20-90 for a stroke of 90 mm are suitable for operation under severe environmental conditions, e.g. at low or high temperatures or humidities. The actuator sets the valve in the closed position in the event of air failure.
Other proprietary makes, and/or 'failsafe' requirements are available upon request.
Valve positioners are available in pneumatic or electro-pneumatic operation, depending upon customer preference. Additional options are, for example, feedback transmitters and limit switches.

FIG. 5
model 20-55

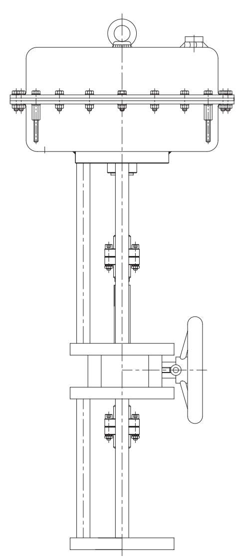
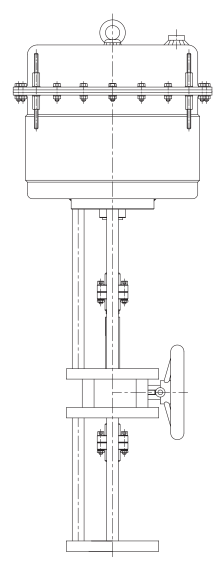


FIG. 6
model 20-90



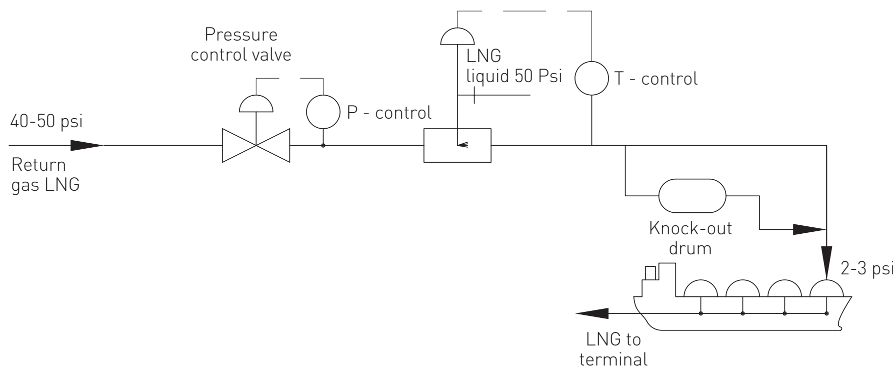
Vapor return to ship system

When unloading the LNG carrier, natural boil-off gas is returned to the ship to fill the volume above the LNG surface inside the ship's cargo tanks. This gas shall be cooled, otherwise the surface equilibrium of the LNG is disturbed and sudden boiling could occur.

The return gas is cooled by the injection of LNG. By maintaining the return gas temperature within its limits the system will allow undisturbed and safe discharge of the LNG carrier.

Yarway cryogenic injectors inject, over a wide load range, LNG to control the temperature of the return gas.

FIG. 7 Vapor return to ship system



Gas compressor inlet temperature control

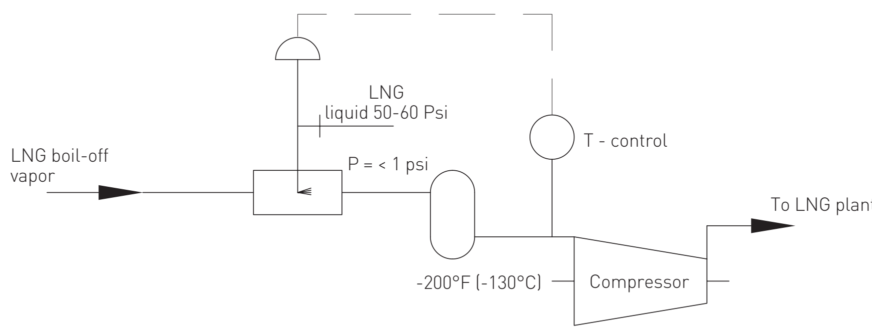
During transport and unloading part of the LNG will boil-off and becomes natural gas.

The quantities vaporizing in LNG storage plants are too high for immediate useful applications. This gas shall be converted to the liquid state, ready for storage.

A compressor plant will provide this but the gas at the suction side of the compressor shall be cooled to the extent that the outlet temperature of the compressor remains within desirable limits.

Yarway cryogenic injectors inject, over a wide load range, LNG to control the outlet temperature of the compressed gas.

FIG. 8 LNG compressor inlet temperature control



The fluid shall be injected in the direction of the gas flow.

To facilitate the installation of the liquid supply line, 4 different spray head positions are available in relation to the to the liquid connecting flange.

Specification of this spray head orientation is required with the ordering data.

Yarway will always prepare order specific drawings per cryogenic injector with this spray orientation depicted as above.

In LNG systems, cleanness is of the essence. Although a strainer upstream of the cryogenic injector is recommended, systems that have been thoroughly cleaned before start-up can do without this ancillary.

FIG. 9 Liquid flange positions

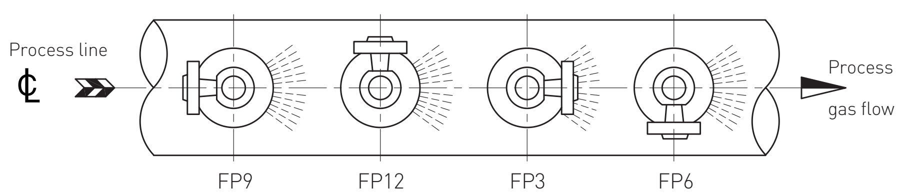


TABLE 1 - STANDARD MATERIALS

Item	Name	Material
1	Spray cylinder	SA 182 F304L
2	Nozzle assy	SA 182 F304L
3	Spiral would packing	PTFE/316L
4	Piston	PTFE 25% reinforced / aluminium bronze*
5	Fastener ring	Incoloy 800H (nitrided)
7	Stem	SA 182 F316L
8	Seat housing	SA 182 F304L
9	Body	SA 312 TP304L
10	Liquid flange	SA 182 F304/F304L dual certified
11	Adaptor	SA 182 F304L
12	Stem bushing lower	Aluminium bronze
13	Packing box	SA 182 F304L
14	Nut	SA 194 8MA
15	Packing set	PTFE V-rings
16	Stud	SA 320 B8 CL.2
17	Stem bushing upper	Aluminium bronze
18	Gland plate	SA 182 F304L
19	Name plate	AISI 316
20	Lock nut	Stainless steel
21	Coupling	SA 182 F304L
23	Securing washer	Stainless steel
24	Vapor flange	SA 182 F304/F304L dual certified
25	Guiding	PTFE
26	Spring	AISI 631 17-7 PH
27	Shoulder bolt	SA 320 B8 CL.2
28	Securing washer	Stainless steel
29	Flange female	SA 182 F304L
30	Flange male	SA 182 F304L
31	Extension pipe	SA 312 TP304L
32	Piston rings	Aluminium bronze*

NOTE

Other materials are available upon request.
* for valve design class 600/900

Certification:

The cryogenic injector complies with the rules of ASME B 16.34.
EN standard flanges are available as a standard option.
If applied within the E.C. a certificate of conformity to PED will be issued.
The nameplate will bear the CE-marking as applicable for the product.

Materials and data of units supplied, may deviate from this brochure.
Please consult order documents in case of doubt.

FIG. 10

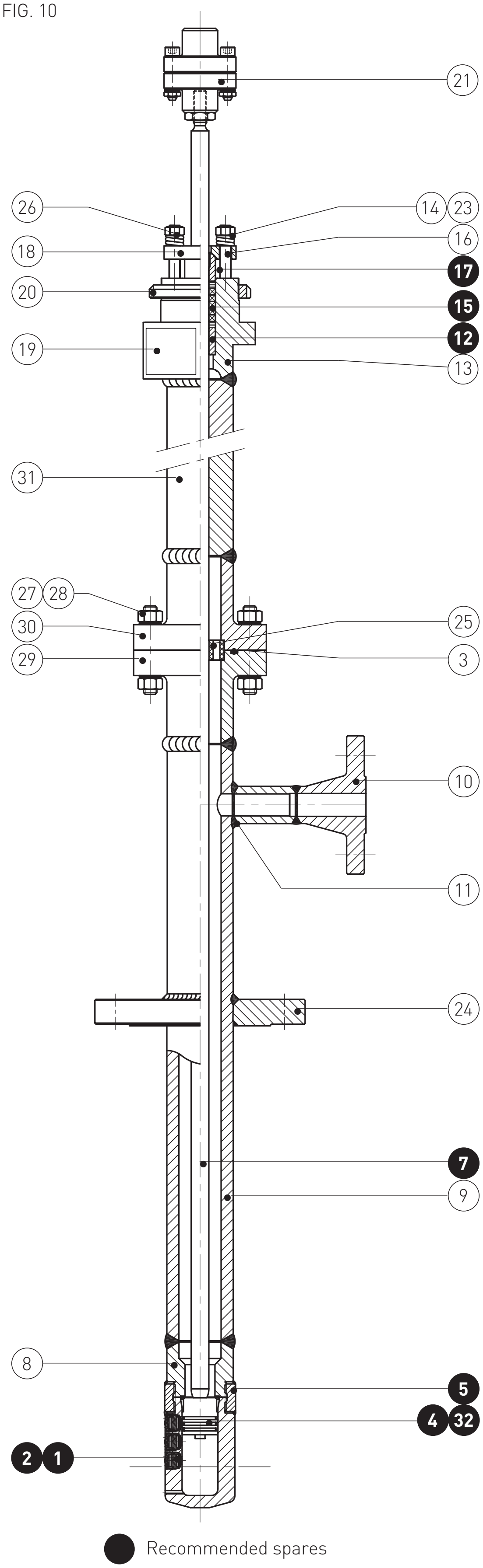


TABLE 2 - DIMENSIONS (mm)

	Standard length for steam line sizes up to 12" (DN 300)	
	Model 37 Qmax = 50 m³/ hr.	Model 47 Qmax = 100 m³/ hr.
A	To be agreed upon	To be agreed upon
B	To be agreed upon Maximum dimension for 'B' = 1000 mm	To be agreed upon Maximum dimension for 'B' = 1000 mm
C	200	200
D	845	845
E	210	236
F	32	32
G	M12 x 1.75	M16 x 2.00
H	M70 x 2.00	M90 x 2.00
K	71 +0 / -0.2	91 +0 / -0.2
L	Depending on size and class min. 150	Depending on size and class min. 200
M min.	66.0	80,0
N	60.3 x 11.1	73.0 x 14.0
P	64.0	78.0
R	210	236

NOTE

Dimensions may be subject to change without prior notification. Yarway will provide a certified dimensional drawing upon request.

TABLE 3 - FLANGE CONNECTIONS

	Model 37 Qmax = 50 m³/ hr.		Model 47 Qmax = 100 m³/ hr.	
Gas flange	NPS 3	class 150 class 300 class 600 class 900	NPS 4	class 150 class 300 class 600 class 900
	DN 80	PN 25/40 PN 64 PN 100	DN 100	PN 25/40 PN 64 PN 100
Liquid flange	NPS 1 - 1½ DN 25 - 40		NPS 1½ - 2 - 3 DN 40 - 50 - 80	
	Pressure classes as per fluid data requirements		Pressure classes as per fluid data requirements	

STROKE

- For nozzles A - B - C - D - Dx: 55 mm
  Pipeline diameter min. 6"
- For nozzles E - F - G - H - K: 90 mm
  Pipeline diameter min. 8"

In case of deviating line size, consult Yarway.

FIG. 11