

HIPAC™



**insulated supports for
cold and cryogenic applications**

The LISEGA Experts for Experts

LISEGA has long been recognized as the leading worldwide specialist in pipe support technologies. Starting in 1964 with a program of standardized pipe supports, the company grew fast, becoming the international market leader as early as the 1980s. LISEGA currently employs close to 1000 employees in its international facilities. Backed by the company's experience of

methane (LNG), propane, butane (LPG), ethylene, nitrogen and ammonia. LISEGA's HIPAC™ insulated pipe supports are designed in accordance with recognized international standards and engineering specifications for pipe sizes ranging from 1/2" diameter to OD 72" diameter with insulation thicknesses from 0.98" / 25mm up to 9.84" / 250mm.



more than 40 years, this staff collectively represents the industry's leading lights by providing specific expert knowledge. For LISEGA's customers, this ensures highly qualified cooperation and professional communication on every occasion.

Pipe Supports for Cryogenic Applications

LISEGA added pipe supports for cold and cryogenic applications to the product program in 2001 (LISEGA catalog Standard Supports 2010). In order to ensure state of the art products LISEGA has redeveloped and reorganized this business line. More than 20 years of specific manufacturing and the field experience of highly qualified specialists were incorporated. As a result LISEGA has now introduced the advanced product concept HIPAC™ into the market. Under this brand name LISEGA offers a complete range of insulated pipe supports for all types of cold and cryogenic piping applications.

Typically, these include industrial processes involving the production, distribution and transportation of liquefied gases, including

The supports are manufactured using materials suitable for specified loads and for temperatures ranging from +302°F / +150°C to -321°F / -196°C.

Insulating Material

The insulation material that forms the central part of the insulated pipe support assembly is manufactured using fire-retarding, water-blown high density polyurethane foam (HD-PUF). The PUF is monolithically molded in heavy duty molds under carefully controlled conditions in respect of temperature and humidity, a process that provides uniform properties and ensures dimensional stability with no warping. Each standard PUF density is color coded.





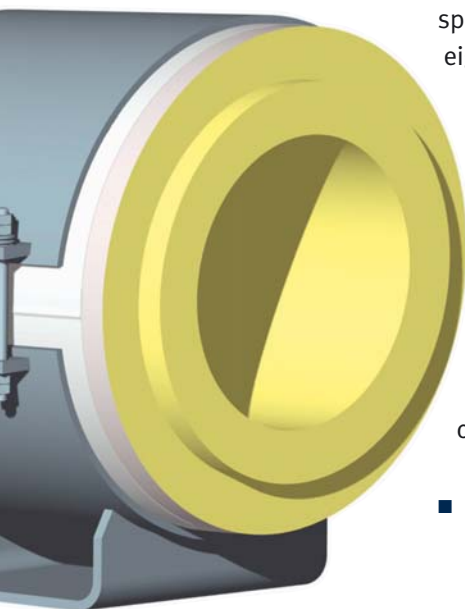
HIPAC – High Density Overpack

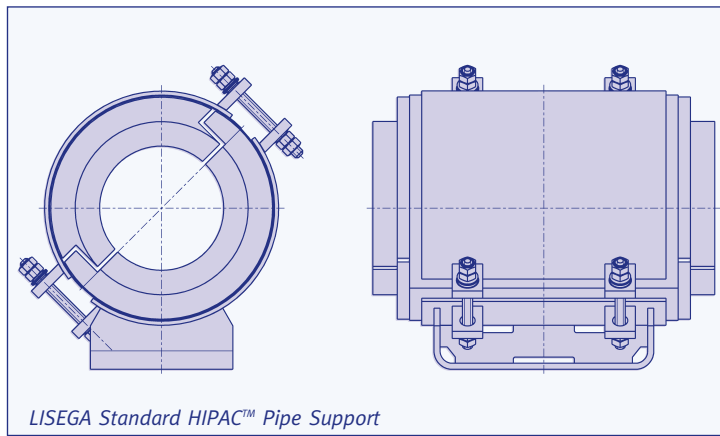
LISEGA's HIPAC™ is a unique high pressure overpack molding process that utilizes the exothermic heat of the reaction between polyol and isocyanate to build internal pressure within the confined space of the high precision molds.

LISEGA's unique foam formula has been specially developed to expand up to eighty percent more than the volume of the mold. The high pressure generated when the expanding foam is confined within the mold during the molding process produces the outstanding qualities of LISEGA's HIPAC™ molded cryogenic pipe supports.

The HIPAC™ concept offers multiple advantages, especially over PUF cradles cut from "free rise" blocks:

- It provides clean, sharp edges that fit neatly with the adjacent line insulation material on site.
- It produces foam with a fine cell structure that is completely uniform.
- It provides high cryogenic thermal stress/shock resistance (CTSR 3.5 – 5).
- It maintains dimensional stability throughout the full range of service temperatures from -321°F / -196°C through +302°F / +150°C.
- HIPAC™ foam cradles retain their shape when cut into half cylinders.
- HIPAC™ foam cradles are environmentally friendly, with 100% material recovery, no waste urethane offcuts.
- HIPAC™ foam cradles provide additional water vapor and mechanical protection with a thin, yet very high density molded skin, which is 99% closed cell.





HD-PUF DENSITY	
kg/m ³	lbs/ft ³
120	7,5
160	10
224	14
240	15
320	20
500	31

LISEGA PUF cradles are available in the above listed range of densities including **three standard densities**.



Project Management

Design, engineering and project management are all executed by the LISEGA Head Office in Germany.

Manufacturing

The complete product range of LISEGA pipe supports for cold and cryogenic applications is manufactured at LISEGA's wholly owned subsidiary in Shanghai, China. The specially designed production facilities for LISEGA's cryogenic product line operate under German supervision. LISEGA also manufactures its standard pipe supports, such as spring and constant hangers, pipe shoes and pipe clamps in the same facilities.

Quality Control

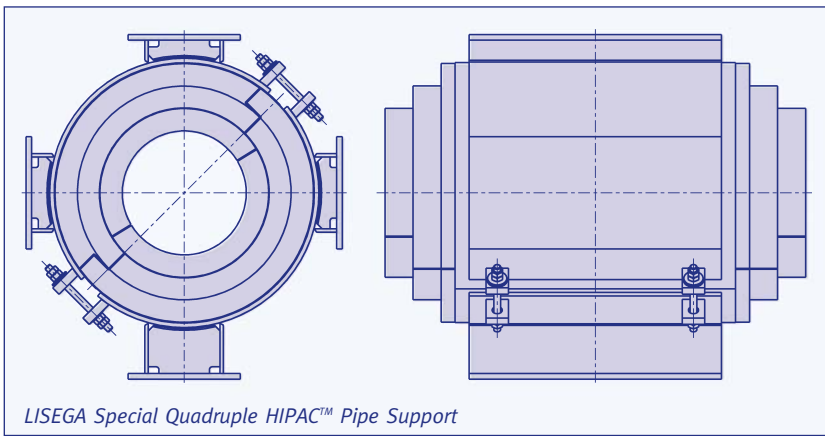
All LISEGA production facilities are approved and certified in accordance with ISO 9001. All activities in the facilities follow written procedures, under the strict surveillance of the quality assurance management system, which is in compliance with the ISO 9001 and ASME codes.

Cryogenic Prequalification Testing

LISEGA's HIPAC™ molded cryogenic pipe supports have been tested in accordance with the test procedures of several leading international EPC companies on LISEGA's test bench, which is especially designed to simulate cool-down and load application for insulated pipe supports. Axial, lateral and vertical loads of up to 30 tons can be applied to the complete pipe and support assembly under cryogenic temperatures as low as -321°F / -196°C.

PUF Cradle Assembly

Both single and multi-layer systems are manufactured to meet clients' standards as required. The moldings incorporate carefully sized step joints (radial and longitudinal) to match the layering of the adjoining line insulation. This method, also known as "shiplapping", provides a reliable interlocking interface with each layer and prevents a direct heat path from the surface of the insulation through to the surface of the pipe.



To prevent moisture ingress, all cut PUF surfaces are vapor sealed with cryogenic fire-retarding elastomeric vapor-barrier mastic. A laminated aluminum / polyester foil is factory bonded to the outermost surface of the outer layer of the PUF assembly. In a multi-layer system, bonding of PUF layers in the lower part can be achieved with cryogenic adhesive, if required.

This adhesive remains flexible under operating conditions and compensates for the differential movements within the PUF assembly caused by the temperature contractions in the foam layers. Finally, a protective metal shield is provided as a jacket over the outer vapor barrier. It forms part of the PUF cradle assembly and provides additional support and insulation protection during installation on site.

LISEGA HIPAC™ Material Properties for HD-PUF

PERFORMANCE CRITERIA	UNITS	HD-PUF DENSITY		
		160 kg/m ³	224 kg/m ³	320 kg/m ³
Ultimate Compressive Strength ASTMD1621 @20°C*	MPa	2,0	4,0	7,0
Ultimate Compressive Strength ASTMD1621 @-165°C	MPa	3,6	6,0	11,0
Thermal Conductivity @20°C	W/(mK)	0,032	0,035	0,041
Thermal Conductivity @-165°C	W/(mK)	0,022	0,025	0,034
Coefficient of Thermal Expansion/Contraction	1/k	65 x 10 ⁻⁶	65 x 10 ⁻⁶	65 x 10 ⁻⁶
Closed Cell Content	%	>90	>90	>90
Fire Resistant Properties Weight Retention	%	Self Extinguishing >90	Self Extinguishing >90	Self Extinguishing >90
Cryogenic Thermal Stress Resistance Factor (CTSR)	---	>4,6	>4,1	>3,6

* Design Compressive Strength Properties are based on a safety factor of 5:1



LISEGA Dynamic Clamping Design

LISEGA HIPAC™ insulated cold pipe supports are specifically designed to clamp onto the pipe and to travel with the pipe during all phases of line operation, including cool-down, normal operation and warm-up cycles. HIPAC™ cold pipe supports are precision-molded to provide non-interference fitting on site. The designs provide engineered clearance gaps between the mating

If required, guides at the base of the support are designed to act as lift-off restraints.

Line Stop & Fixed Supports

LISEGA supplies all line stop and fixed supports with solid single-layer HD-PUF cradles for all sizes of supports. Line stop supports allow lateral movements



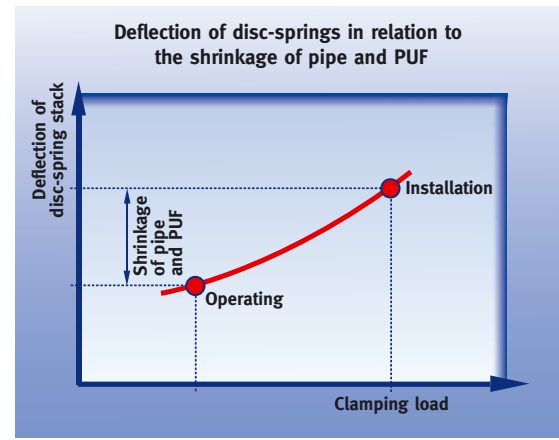
half-cradles. This ensures that the dynamic clamping force applied by clamping mechanisms is always applied to the pipe without any bridging between the HD-PUF cradles. Disc-springs are used to compensate for shrinkage of the pipe and insulation during cool-down and operation and to ensure that the required clamping force is maintained at all times. The required clamping force in the bolts is determined by the diameter of the pipe, the thickness of the insulation, the difference in temperature and the loading on the support. All volume shrinkages in the PUF and additional components caused by the operating temperature are considered as factors in the dynamic clamping design. A clash-free lug design assures proper functioning during all stages of installation and operation.

Rest & Guide Supports

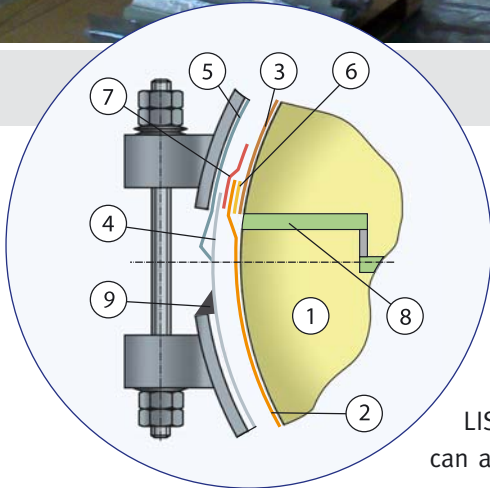
LISEGA supplies clamped supports for vertical loads that act as rest-and-guide supports. The coefficient of friction used by LISEGA in the clamping load calculation for steel on steel is 0.3 between shoe and steel structure. For additional lateral loads, up to three extra guiding shoes can be added.

but prevent axial movements of the pipe. Fixed supports prevent axial and lateral movements of the pipe. Line stop & fixed supports cannot absorb torsional moments. The benefits of the LISEGA HIPAC™ line stop support are the following:

- Easy to install even if supporting structure (frames, beams) exists.
- No or only minimal lifting of pipes required, as support can be brought into position before fixing thrust rings via shear lugs.
- Thrust rings can be installed after the support is placed in its final position (high flexibility).
- No hoop stress and less deformation of the pipe due to shear lugs welded to the pipe, instead of the complete thrust ring.
- Only small welds are required for fixing the lugs to the pipe.
- The thrust ring is covered by low density insulation with better thermal conductivity than HD-PUF.



A multiplex laminated aluminum/polyester-foil vapor-barrier is bonded to the outer surface of the PUF cradle assembly. A protective metal shield is supplied as part of the PUF cradle assembly and fits over the multiplex vapor-barrier foil to provide insulation protection.



Anchor Supports

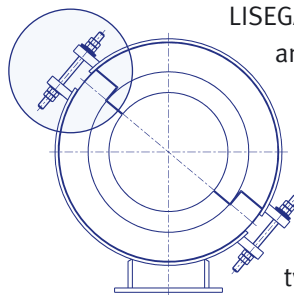
In the case of additional torsional load absorption LISEGA provides a special anchor support design.

Vertical Guides

LISEGA HIPAC™ line stop supports can also act as vertical guides.

Delivery Condition

- 1 High density PUF
- 2 Shop-bonded vapor barrier to HD-PUF
- 3 Shop-bonded vapor barrier to HD-PUF
- 4 Lower metal protective shield
- 5 Upper metal protective shield
- 6 Field-applied double-sided adhesive tape
- 7 Field-applied vapor barrier tape
- 8 Gap filler, field-applied
- 9 Field-applied joint sealant



LISEGA's pipe supports for cold and cryogenic applications are supplied with detailed installation instructions. Each pipe support is clearly marked in accordance with the LISEGA type-designation system described in product group five in the LISEGA Standard Supports catalog. All cut PUF cradle surfaces are sealed with a cryogenic fire-retarding elastomeric vapor barrier to prevent moisture ingress. A standard installation kit is available on request. The kit contains suitable quantities of cryogenic adhesives, mastics, sealants, etc., as required, for joining the insulation materials on site.

To facilitate the allocation of supports, a specific customer identification number can be added. The complete product range of LISEGA's pipe supports for cold and cryogenic applications is supplied fully assembled and packed to protect the finished product from superficial damage and moisture ingress during transportation and storage. HIPAC™ supports should be stored under cover and kept away from water.

LISEGA's HIPAC™ supports should be installed onto clean dry piping free from any oils, greases or other contaminants, only in dry weather, and should be protected from ingress of moisture with a vapor-stop coating right after installation. LISEGA takes pride in servicing their clients and provides broad technical support from quote right through to installation and beyond.

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