Certificate No:
TAK000025S

TYPE APPROVAL CERTIFICATE

This is to certify:

That the Insulation Materials for Gas Carriers

with type designation(s)
VESPOL WR5077

Issued to
Woojo Hightech Co., Ltd.
Chungju-si,, Chungcheongbuk-do, **Republic of Korea**

is found to comply with
DNV rules for classification – Ships

Application :

Spray foam for LNG/LGP/LEG independent cargo and fuel tanks.

Product(s) approved by this certificate is/are accepted for installation on all vessels classed by DNV.

Issued at **Høvik** on **2022-10-14**
This Certificate is valid until **2027-10-13**.
DNV local station: **Gimhae Station**

Approval Engineer: **Gisle Hersvik**

for **DNV**

Gustav Heiberg
Head of Section

This Certificate is subject to terms and conditions overleaf. Any significant change in design or construction may render this Certificate invalid.
The validity date relates to the Type Approval Certificate and not to the approval of equipment/systems installed.

LEGAL DISCLAIMER: Unless otherwise stated in the applicable contract with the holder of this document, or following from mandatory law, the liability of DNV AS, its parent companies and their subsidiaries as well as their officers, directors and employees ("DNV") arising from or in connection with the services rendered for the purpose of the issuance of this document or reliance thereon, whether in contract or in tort (including negligence), shall be limited to direct losses and under any circumstance be limited to 300,000 USD.

Product description

VESPOL WR5077: Insulation Material (Polyurethane Spray Foam Systems) for Cryogenic Liquefied Gas Tanks. Marine (Cargo/Fuel Tank Insulation for LNG, LEG and LPG)

- Nominal density: 43 kg/m^3.
- Mixing ratio (Isocyanate:Polyol) is 1:1 (by volume)

General properties of Polyurethane Spray Foam System

Properties	Test Method	Manufacturer's Specification	Test results	Units
Density	ISO 845 / ASTM D1622	43±7	41.8	kg/m^3
Dimensional stability	ASTM D2126	±2.0	-30°C: -0.2 70°C: -0.2	%
Aging	ASTM C518	≤0.023	Before: 0.02113 30 days: 0.02236 60 days: 0.2176 4 months: 0.02291 6 months: 0.02202	W/mK
Thermal conductivity	ASTM C177	≤0.023	-163°C: 0.01225 -100°C: 0.01428 -50°C: 0.01742 20°C: 0.02087	W/mK
Thermal conductivity	ASTM C518	≤0.023	20°C: 0.021	W/mK
Bending strength (RT)	ASTM C203	≥0.200	255	MPa
Bending strength (-170°C)	ASTM C203	≥0.300	499.9	MPa
Compressive strength (RT)	ISO 844 / ASTM D1621	≥0.170	308	MPa
Compressive strength (-170°C)	ISO 844 / ASTM D1621	≥0.400	631.3	MPa
Tensile strength (RT)	ASTM D1623	≥0.250	440	MPa
Tensile strength (-170°C)	ASTM D1623	≥0.150	270.1	MPa
Shear strength (RT)	ASTM C273	≥0.200	210	MPa
Abrasion	-	≤2.0	0.75	%
Thermal expansion	ASTM E228	≤80	50.65	µm(m°C)
Cohesion	ASTM D1623	≥0.180	0.520	MPa
Closed Cell Content	ISO 4590 (Method 1) / ASTM D6226	≥90	99	%
Resistance to vibration	ISO 10055	≤1.0	0.13	%
Resistance to fire and flame spread	DIN 4102-1	B2	B2	-
Water absorption	KS M 3809	≤3.0	0.6	g/100 cm^2

Properties of Polyurethane Spray Foam System after immersion in LNG (28 days)

Properties	Test Method	Manufacturer's Specification	Test results	Units
Bending strength (-170°C)	ASTM C203	≥0.300	0.372	MPa
Compressive strength (-170°C)	ASTM D1621	≥0.400	0.639	MPa
Tensile strength (-170°C)	ASTM D1623	≥0.150	0.219	MPa
Shear strength (-170°C)	ASTM C273	≥0.200	0.292	MPa
Solubility in the cargo (*)	DIN 53428	±2.0	0.33	%
Absorption of the cargo (*)	DIN 53428	±2.0	0.33	%
Shrinkage (*)	DIN 53428	±2.0	0.33	%

(*) Comparative values before and after immersion in LNG.

Tensile strain at break (-170°C): 2.43% average. LNG Dipping: 4.33% average
Bending strain at break (-170°C): 3.69% average. LNG Dipping: 4.79% average

Other properties may need to be documented for specific installations.

Application/Limitation

Insulation material for LNG/LGP/LEG independent cargo and fuel tanks and pipeworks for marine applications. It should be noted that the 'reaction to liquids' is only documented for LNG immersion.

For each installation on DNV classed vessel the complete insulation scheme shall be reviewed and approved by DNV prior to installation.

Depending on the thickness of the spray foam the need for any crack arrestors or similar must be evaluated by the insulation system designer.

The spray foam applicators must have adequate training and relevant experiences in accordance with manufacturer's recommendations.

Storage, handling and installation of the insulation material shall be in in accordance with manufacturer's recommendations.

When installed, the insulation material shall be adequately protected against penetration of water vapor and mechanical damage.

Where the thermal insulation is located on or above the exposed deck, and in way of tank cover penetrations, it shall have suitable fire resistance properties in accordance with recognized standards or be covered with a material having low flame-spread characteristics and forming an efficient approved vapor seal.

Any significant changes in design and / or quality of the material will render the approval invalid.

Type Approval documentation

Tests carried out

Type Testing carried out in accordance with **Type Approval documentation**, including:

- Type test for General Properties
- Type test for LNG immersion. Note that the compatibility testing has been carried out only for LNG. Compatibility testing with the actual kind of cargoes or fuels must be carried out prior to installation on DNV classed ships.
- Solubility in the cargo: DIN 53428.
- Compatibility with the cargo: DIN 53428, ASTM C203, ASTM D1621, ASTM D1623, ASTM C273.

DIN 53428	Absorption of the cargo [Reaction to liquids, vapors, gases and solid materials]
DIN 53428	Shrinkage
ASTM C518	Aging
ASTM C203	Flexural (Bending) Strength
ASTM D1621	Compressive Strength
ASTM D1623	Tensile Strength
ASTM C273	Shear Strength
ASTM E831	Thermal expansion
ASTM D1623	Cohesion
ASTM D6226	Closed cell content
ASTM D1622	Density
ASTM C177, ASTM C518	Thermal conductivity
ISO 10055	Resistance to vibration
DIN 4012 Part 1 B2	Flammability (Resistance to fire and flame spread)
KS M 3809	Water absorption
ASTM D2126	Thermal and Humid Aging [Dimensional stability]

Marking of product

Product/package shall be marked with *manufacturer's name* and *type designation;* ***VESPOL WR5077***.

The marking is to be carried out in such a way that it is visible, legible and indelible. The marking of product is to enable traceability to the DNV Type Approval Certificate.

Periodical assessment

The scope of the Periodical Assessment is to verify that the conditions stipulated for the Type Approval is complied with and that no alterations are made to the product design or choice of materials.

Periodical assessments (for Certificate Retention / Certificate Renewal) shall be performed according to DNV-CP-0338.

This certificate is only valid if required Periodical assessments are carried out with satisfactory results. To check the validity of this certificate, please look it up in https://approvalfinder.dnv.com

END OF CERTIFICATE