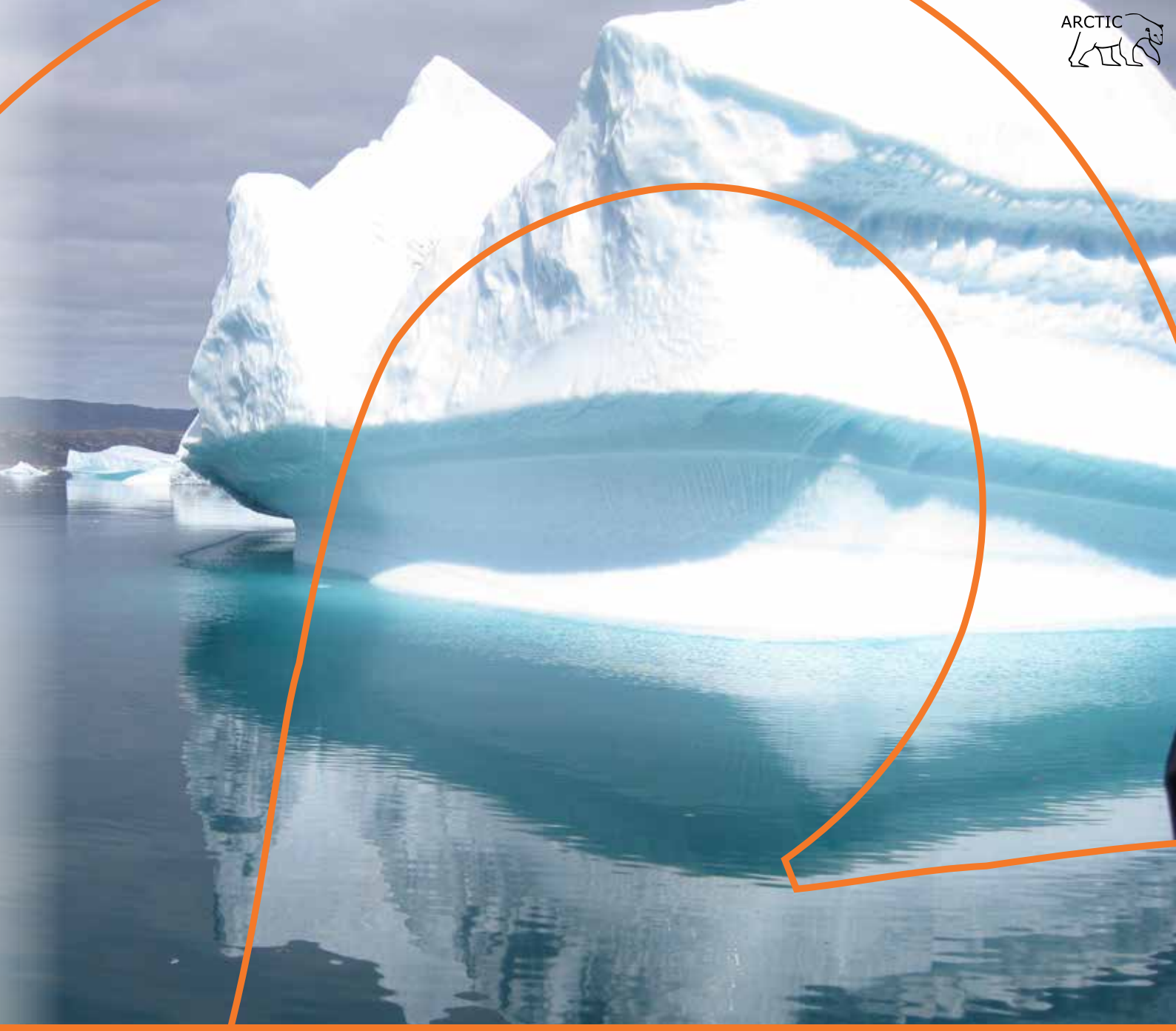



# Arctic Range

## Proven Oil Spill Technology



DESMI

# The Arctic
# *(pronounced arktik)*

The Arctic is a region located at the northernmost part of the Earth. The region consists of a vast, ice-covered ocean, surrounded by treeless permafrost. The area can be defined as north of the Arctic Circle (66° 33'N), the approximate limit of the midnight sun and the polar night. The region can have an average temperature for the warmest month of July, of below -10°C or 14°F. The northernmost tree line roughly follows the isotherm at the boundary of this region. Much of this territory is considered subarctic and is a unique area among Earth's ecosystems. The cultures in the region and the Arctic indigenous peoples have adapted to its cold and extreme conditions. Life in the Arctic includes organisms living in the ice zooplankton and phytoplankton, fish and marine mammals, birds, land animals, plants, and small, isolated human societies.

# DESMI are renowned for the design and manufacture of the toughest oil spill recovery systems

The first comprehensive assessment of oil and gas resources north of the Arctic Circle, carried out by geologists, revealed that underneath the ice, the region may contain as much as a fifth of the world's undiscovered yet recoverable oil and natural gas reserves. This includes 90 billion barrels of oil, enough to supply the world for three years at current consumption rates and 1,670 trillion cubic feet of gas, which is equal to about a third of the world's known gas reserves.

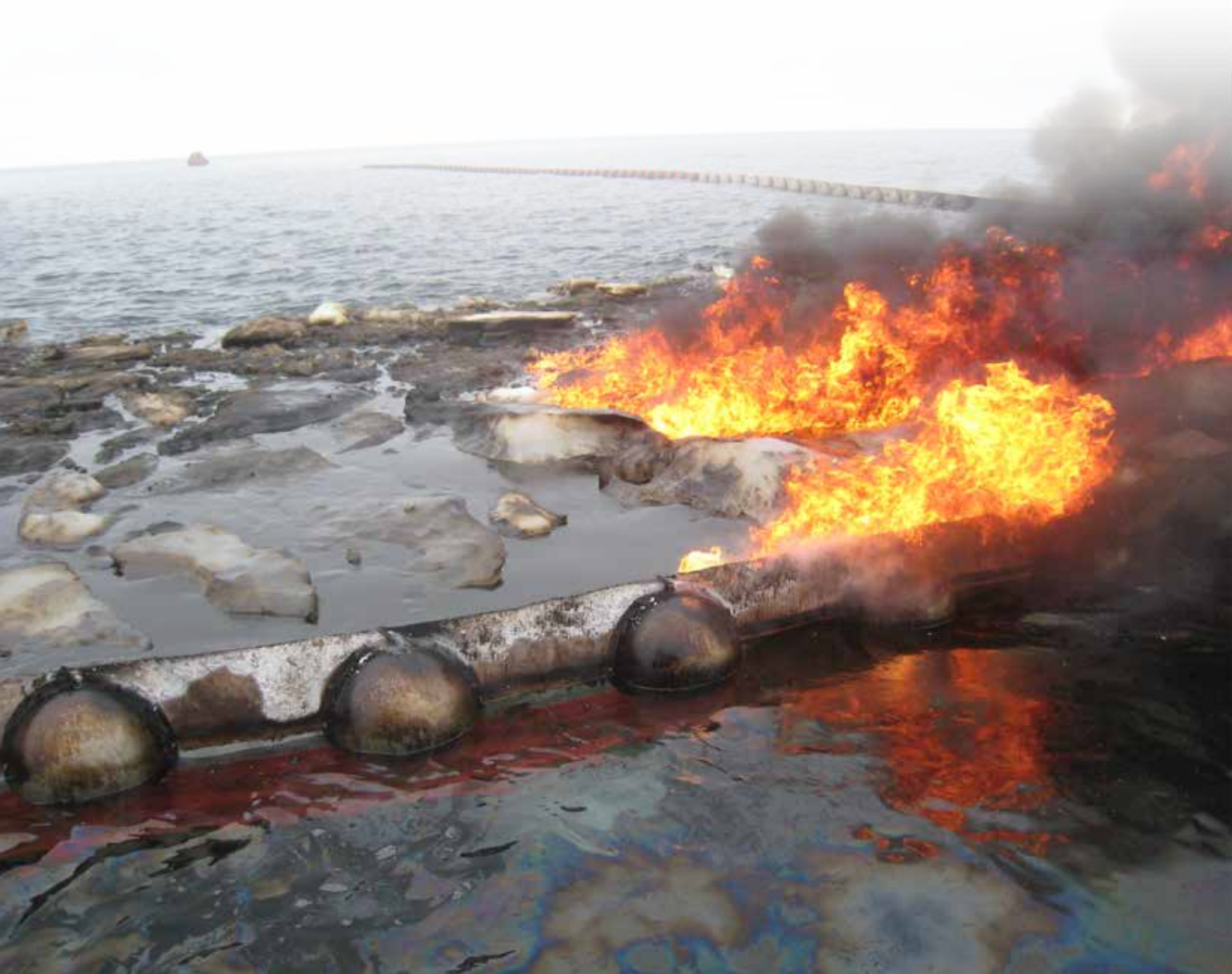
DESMI Ro-Clean are renowned for the design and manufacture of the toughest oil spill recovery systems and maintain this enviable position in the market today. Proven in the field and the first choice of equipment for the serious responder, DESMI Ro-Clean systems have been recovering oil from the marine environment for over 30 years.

Now, DESMI Ro-Clean are answering a new challenge and have developed a range of oil spill recovery systems to operate in the most difficult and harsh environments known to man. The equipment, based on past heritage, has been designated, DESMI Ro-Clean - ARCTIC.

This tool kit of equipment has been specifically developed and structured to offer users the ability to Contain, Recover and Store hydrocarbons in the Arctic environment. There is also a range of 'fail safe' boom for use in the controlled burning of oil in ice. This development has only been possible with the technology of our sister company, APPLIED FABRIC TECHNOLOGIES Inc. Where ever you see our ARCTIC logo, you have the confidence that our systems have been specifically developed for the challenges of the Arctic.

# PyroBoom™ ARCTIC

Proven in the Gulf of Mexico and the Arctic Svalbard in Norway. The right Boom for controlled burning in the Arctic



# PyroBoom™ ARCTIC - Proven Oil Spill Technology

PyroBoom™ is an essential component of any Arctic oil spill response kit. Developed at the request of Exxon Production Research in 1982, PyroBoom™ has been proven in numerous test burns and operational trials, and most notably, in the response to the spill in the Gulf of Mexico.

Together with the DESMI Ro-Clean ARCTIC equipment, PyroBoom™ is one of the few viable oil spill response techniques for the Arctic environment.

It is logistically straightforward and, with adequate planning and training, rates as the fastest, least expensive and most complete oil removal method available today. This is a system of oil removal that does NOT require hydraulic power packs, inflators, water pumps or indeed temporary storage. A single, typical PyroBoom™ system can remove up to 200m³/Hr of hydrocarbons from the surface of the water and can be used over and over again. In addition, the system is easy for training purposes because of its fence boom, fail safe design.

When required, PyroBoom™ is easily reconditioned by the client without any special tools and the storage options on offer should suit all operations.
In order to burn, spilled oil must be sufficiently thick so that enough heat is retained in the slick to generate vapor, thus fuelling the fire. Since oil normally spreads and thins with time, an effort must be made to concentrate and confine the oil and permit its heating and subsequent ignition. This is typically accomplished in a sweep operation. To do this in ice choked conditions, a very robust and strong boom is required. PyroBoom™ is the ideal solution for these conditions. Based only on the barrier fabric by itself, PyroBoom™ has a tensile strength in excess of 130 kN. Combine this with the strength of the top tension cable (28 kN) and the ballast chain (29 kN), and you will appreciate that PyroBoom™ is capable of sweeping operations with huge masses of ice.

The stainless steel float shells, silicone coated barrier fabric above the waterline and nitrile coated fabric below the waterline all allow this boom to endure repeated extremes of sweeping through broken ice followed by burns at temperatures in the range of 1300°C / 2372°F.

Proven in the test tank, proven in the Gulf of Mexico, proven in the Arctic.

| PyroBoom® Specifications | US | Metric |
|---|---|---|
| Total height | 30 in. | 76 cm |
| Freeboard | 11 in. | 28 cm |
| Draft | 19 in. | 48 cm |
| Weight | 8.9 lb/ft | 13.3 kg/m |
| Operational temp | <-40°F to >2400°F | <-40°C to >1315°C |
| B/W ratio | 3.3 : 1 | 3.3 : 1 |
| Tensile strength | >1,000 lb per in. width<br>>30,000 lbs total | >1.75 kN per cm width<br>>133 kN total |
| Refractory barrier | Inconel interwoven with stainless steel and Fiberfrax®<br>refractory fibers, then coated with silicone | |
| Subsurface skirt | Nitrile rubber | |
| Floatation | Stainless steel hemispheres filled with<br>high-temperature glass foam | |
| Ballast | Hot-dipped galvanized chain | |
| | 3/8 in. | 9.5 mm |

Pyro
- before a vowel,
pyr- combining form denoting fire, heat, or high temperature

# RO-BOOM ARCTIC

Ro-Boom has become synonymous with containment around the world as the serious responder recognizes the host of qualities Ro-Boom brings to the oil spill arena. Not least is the heritage and proven operating performance of a system that has enjoyed continued success for over 30 years. During this time, the boom has undergone subtle but significant design changes to further enhance its operational footprint and maintain the pole position as the toughest, most durable and reliable boom system in the market today.

To endorse this position DESMI Ro-Clean have introduced Ro-Boom ARCTIC which builds on the subtlety of continued improvement in a product that is already the world's leader. Ro-Boom ARCTIC has exceeded all design expectations and has completed three years of testing and operations within Norwegian and Arctic Circle waters in the most arduous conditions. The following parameters are by no means exhaustive but give an insight to the differentiators that make Ro-Boom ARCTIC unique in the market and why it is used with confidence in such sensitive environments.

# Ro-Boom ARCTIC builds on the subtlety of continued improvement in a product that is already the world's leader

Ro-Boom ARCTIC is available in various sizes up to 3200mm / 132 inches. There is no other manufacturer who can offer this size of a fully vulcanized neoprene/hypalon boom. The industry focus is shifting to offshore operations and hence it is important to have this size available.

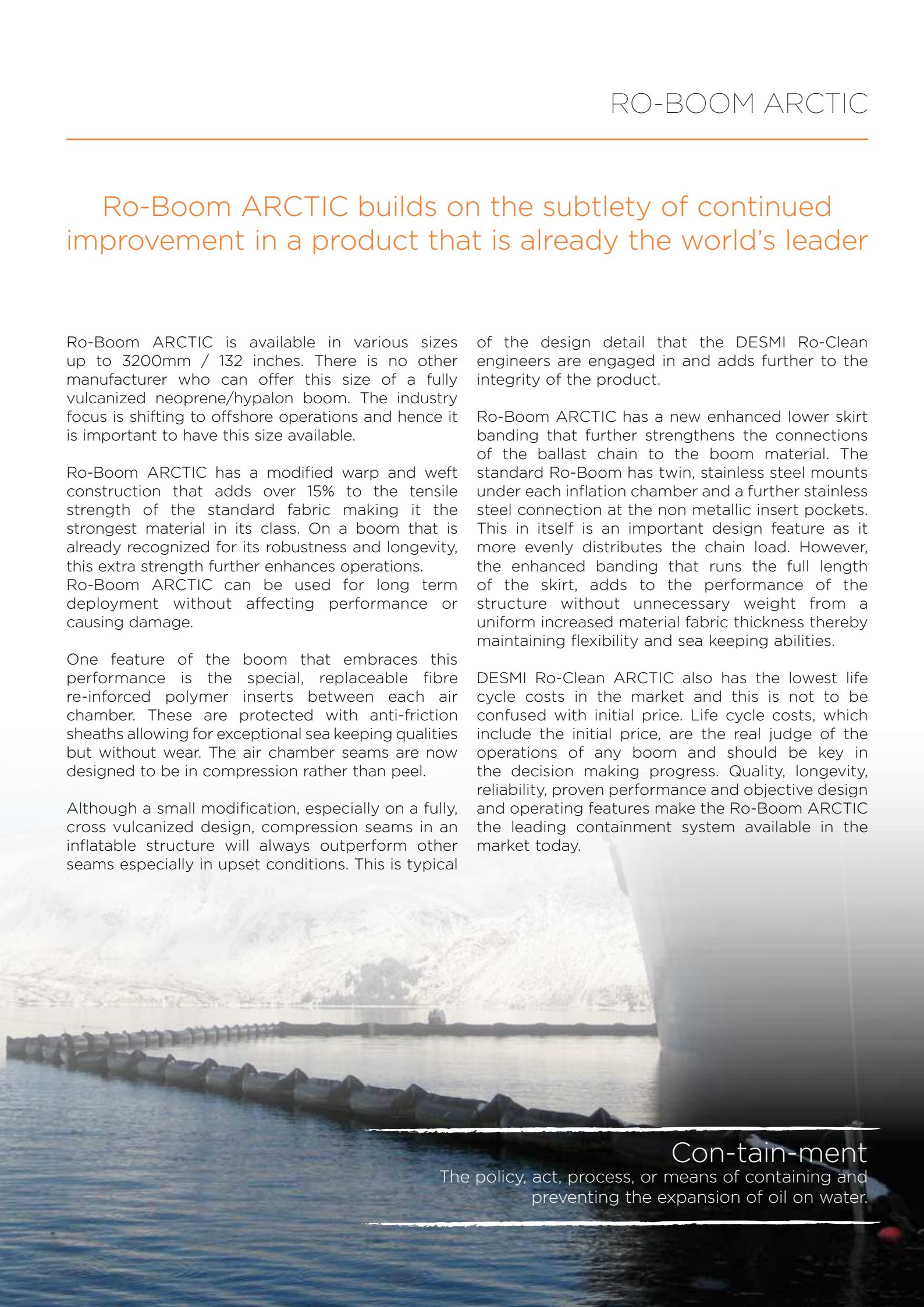
Ro-Boom ARCTIC has a modified warp and weft construction that adds over 15% to the tensile strength of the standard fabric making it the strongest material in its class. On a boom that is already recognized for its robustness and longevity, this extra strength further enhances operations.
Ro-Boom ARCTIC can be used for long term deployment without affecting performance or causing damage.

One feature of the boom that embraces this performance is the special, replaceable fibre re-inforced polymer inserts between each air chamber. These are protected with anti-friction sheaths allowing for exceptional sea keeping qualities but without wear. The air chamber seams are now designed to be in compression rather than peel.

Although a small modification, especially on a fully, cross vulcanized design, compression seams in an inflatable structure will always outperform other seams especially in upset conditions. This is typical of the design detail that the DESMI Ro-Clean engineers are engaged in and adds further to the integrity of the product.

Ro-Boom ARCTIC has a new enhanced lower skirt banding that further strengthens the connections of the ballast chain to the boom material. The standard Ro-Boom has twin, stainless steel mounts under each inflation chamber and a further stainless steel connection at the non metallic insert pockets. This in itself is an important design feature as it more evenly distributes the chain load. However, the enhanced banding that runs the full length of the skirt, adds to the performance of the structure without unnecessary weight from a uniform increased material fabric thickness thereby maintaining flexibility and sea keeping abilities.

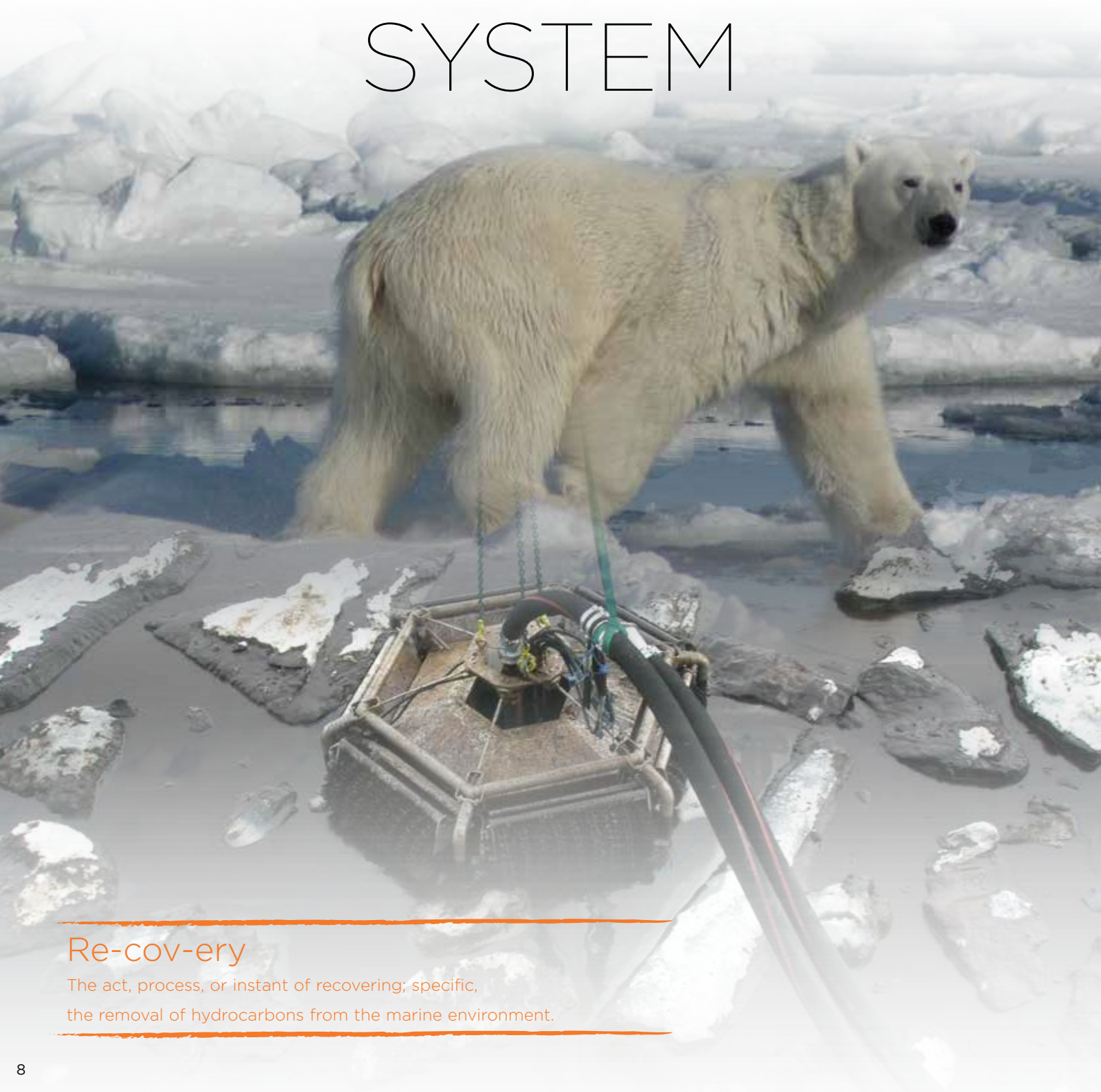
DESMI Ro-Clean ARCTIC also has the lowest life cycle costs in the market and this is not to be confused with initial price. Life cycle costs, which include the initial price, are the real judge of the operations of any boom and should be key in the decision making progress. Quality, longevity, reliability, proven performance and objective design and operating features make the Ro-Boom ARCTIC the leading containment system available in the market today.



Con-tain-ment

The policy, act, process, or means of containing and preventing the expansion of oil on water.

# POLAR BEAR ARCTIC SKIMMER SYSTEM



## Re-cov-ery

The act, process, or instant of recovering; specific,
the removal of hydrocarbons from the marine environment.

# Polar Bear is an Arctic upgrade of DESMI Helix to resist the heavy mechanical impact when skimming in broken ice

DESMI Ro-Clean has been designing, manufacturing and commissioning a wide range of recovery systems for various environments for over 30 years. These have included technologies such as weir, disc, brush, belt and the revolutionary brush rail found in the Giant Octopus. However, the design brief to develop a true ice skimmer created unique challenges which tested the DESMI Ro-Clean engineering department beyond traditional boundaries. After a three year programme developed in cooperation with SINTEF including some of the most demanding tests and simulations, DESMI Ro-Clean have pioneered a new generation of skimmer systems for the Arctic regions called the Polar Bear – Ice Skimmer.

One of the technical briefs for the Polar Bear Ice Skimmer was to encourage the maximum 'flow' of cold viscous oil to the recovery banks with the minimum of obstruction. In this regard, the Polar Bear employs one central floatation chamber with the recovery banks mounted around the outside of this chamber for maximum effect. This also gives a 360 degree angle of influence and presentation to the hydrocarbons for a more efficient recovery within the given space.

The Polar Bear is immensely strong with a unique rigid stainless steel space frame design. This allows for the skimmer to resist substantial pressure loads from two or more ice blocks should they converge and compete for space with the skimmer during operations.

These two features also give rise to significant operational flexibility that allows the Polar Bear Ice Skimmer to be deployed and operated in two distinctive ways. The first is to be launched by ships or others jib crane where the skimmer can be positioned between ice flows. The central floatation chamber also supports the discharge and hydraulic hoses for a 'top' discharge in the middle of the skimmer. This allows for skimmer dipping without fear of damaging the umbilicals. It also creates a smaller operational footprint which is key when working in the ice flows and using the water pockets for oil skimming.

The Polar Bear can be fitted with powerful hydraulic thrusters which allows the skimmer to be manoeuvred from rest and also driven into very viscous oils which have non Newtonian flow characteristic. These combinations of operations allow for a very flexible mode of deployment, operation and recovery which have been tailored to work in the harsh and demanding climate of the Arctic.

DESMI Ro-Clean invested heavily in the correct brush technology for this specific application right down to the colour of the bristle itself. It has been found that significant degradation occurs to coloured bristles through the ultra violet (UV) effects of the sun. The Arctic is a region that has a very high UV concentration and hence the Polar Bear – Ice skimmer has black bristles to most effectively counter this natural occurrence. The brush is made up of various diameters of bristles which have been shown to enhance oil recovery of different viscosities. In addition, the recovery process uses a soft comb and high weir lip on the inside of the recovery bank area. This creates a pumping action and adds to the efficiency and recovery capacity of the skimmer for its given size.

There must also be a mention of the DOP pump unit which is onboard and a true positive displacement pump. It has been proven to handle oils up to 1 million cSt but with the operation of the water injection ring it can also accommodate hydrocarbons of up to 3 million cSt. The unique Archimedes screw and large suction opening also means it can handle solids and ice with ease. If it can enter the pump, it will pass through without clogging. The DOP pump has long been recognized as the first choice in oil spill recovery operations and its performance is unequalled.

All these features conspire to create a true oil recovery system designed specifically for operation in ice. The DESMI Ro-Clean Polar Bear is not a modification of some other skimmer model but a three year development programme in cooperation with SINTEF. The proven design, testing and operation of the Polar Bear offer the industry a true solution to oil recovery in ice.

# DESMI Skimmers durable in Arctic climate; Sea-Mop, Helix, Terminator, RO-Disc, Polar Bear

Among many other skimmers in the market, the DESMI Sea-Mop has been successfully tested at Ohmset. The result of the test showed a very unique recovery efficiency. The headline of the test was:

"**Skimmer Tests in Drift Ice : Ice Month 2013 at Ohmsett**" prepared for Bureau of Safety and Environmental Enforcement Herndon, VA and prepared by **SL Ross Environmental Research Limited Ottawa, ON and MAR, Inc. Leonardo, NJ August 2013**

**Text From Conclusion of the Test:**
In 30% concentration ice is not a significant impediment for most skimmers, although ice can interfere with the flow of oil periodically even in this coverage.

In 70% concentration, ice is a significant impediment to skimming with most skimmers having dramatically lower rates and efficiencies in the denser ice compared with the 30% ice.

The exception was the DESMI Sea-Mop. Its skimming principle is somewhat unique in that the skimmer remains suspended above the ice and water during operation so the device is less affected by ice than other skimmers. Additionally, it does not disturb the ice which is helpful in dense ice concentrations when oil would be moved along with the ice.

# POWER PACKS ARCTIC

DESMI Ro-Clean have been engineering a wide range of rugged diesel hydraulic power packs to suit all environments and operations. The units have been supplied with wheel or skid mountings and multiple flow controls to operate single or equipment packages. The power packs have even been classified to work in explosive atmospheres. However, the Arctic has raised many different challenges for operations, especially for internal combustion engines where the low temperatures can impact on the flow and physical characteristics of fluids we would normally take for granted.

In this regard, DESMI Ro-Clean have launched a range of diesel hydraulic power packs specifically designed for this operation and are identified with the ARCTIC logo. The range can offer many unique features that include but not limited to,

- Hydraulic and spring starting
- Heated diesel fuel tanks
- Heated hydraulic oil tanks.

## Power Packs

From 5 to 240 kW

# RO-TANK ARCTIC

Temporary storage is often overlooked and sometimes under-estimated in the real world. Options can include dedicated barges of various sizes and onboard ship tanks. Alternatively temporary, flexible storage tanks are available in various forms but are often made of very thin materials. These are prone to physical, chemical and environmental damage and totally unsuitable for the Arctic regions.

## tem-po-rary stor-age

For a time only; not permanent, storing or being stored.

A place or space for storing.

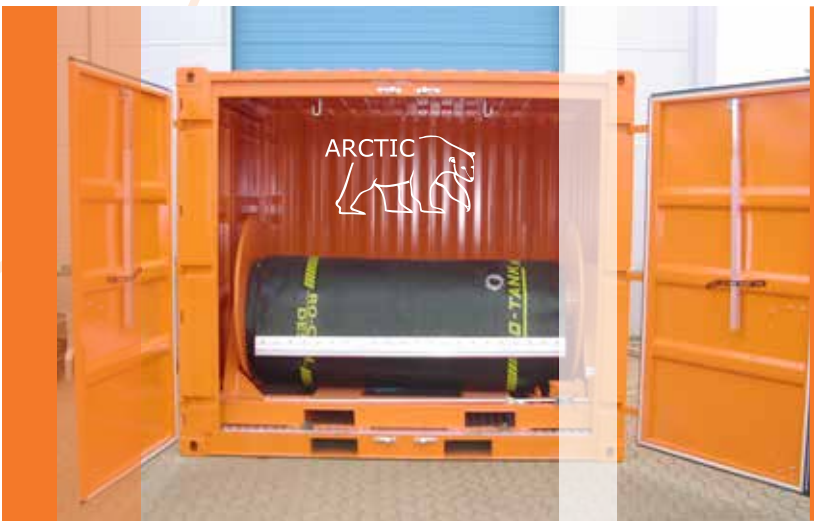
## The RO-TANK ARCTIC is the answer to flexible storage solutions in some of the world's harshest environments.

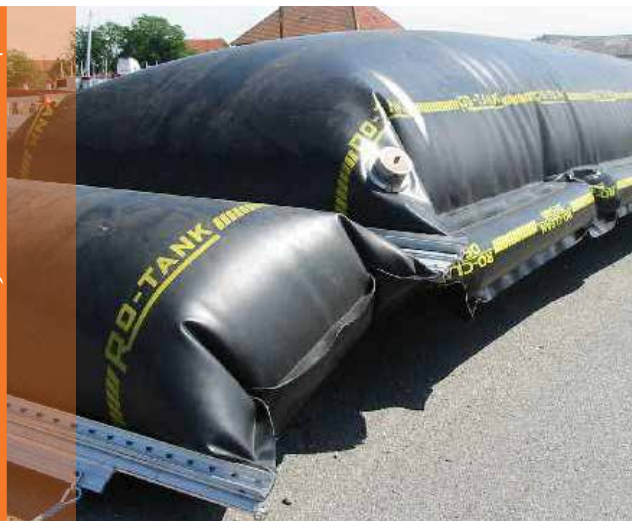
DESMI Ro-Clean have introduced a new range of highly durable and flexible, fluid storage tanks that can be used on sea or land. Called the Ro-Tank ARCTIC, they are manufactured from the same material as the Ro-Boom ARCTIC and offer an unequaled range of tough storage solutions specifically for the arduous Arctic conditions.

Aside the high abrasion, tear, puncture and UV resistance, the material is fully vulcanized which out performs any weld or glue joint. The Ro-Tank ARCTIC has a tensile fabric strength of 500N/mm and a material thickness in excess of 3.5mm / 0.14 inches which is higher than any other material on the market today and reflects the seriousness with which DESMI Ro-Clean have approached solutions for the Arctic environment.

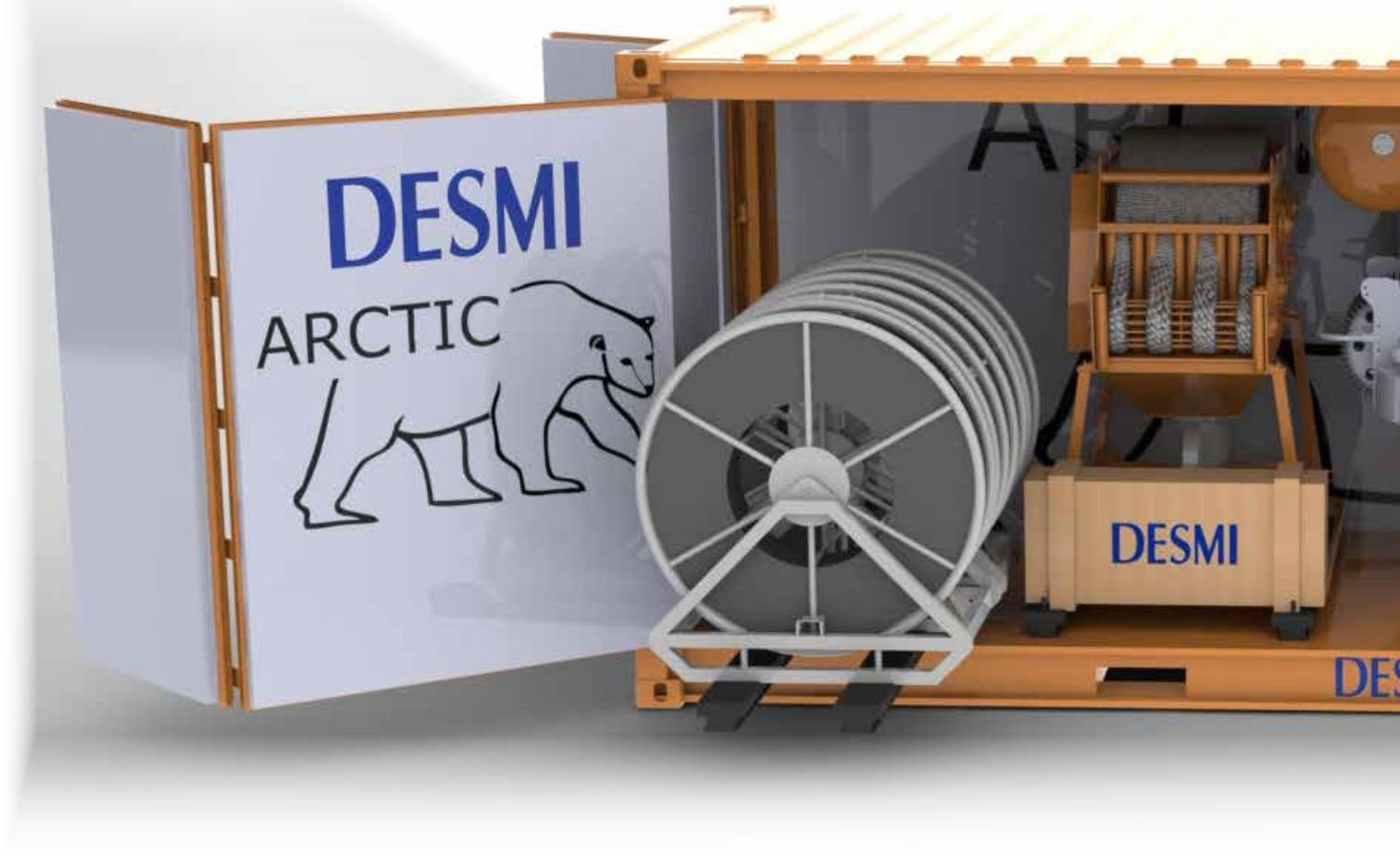
The standard range of tank capacities are from 5 to 50m$^3$ / 1321 to 13.209 gallons with containers or reel systems for storage, deployment and recovery. The tanks are completely flat when empty and this makes for easy deployment on land or sea. The marine version has the addition of an air chamber to aid buoyancy and has an empty tow speed of up to 10 knots. The simple design also allows for easy cleaning and handling. DESMI Ro-Clean can supply auxiliary pumps, pipework, couplings and tow bridles to complement the system and ensure the interface.

The Ro-Tank ARCTIC is the answer to flexible storage solutions in some of the world's harshest environments. It is unmatched for life cycle costs.



# DESMI ARCTIC STORAGE SYSTEM



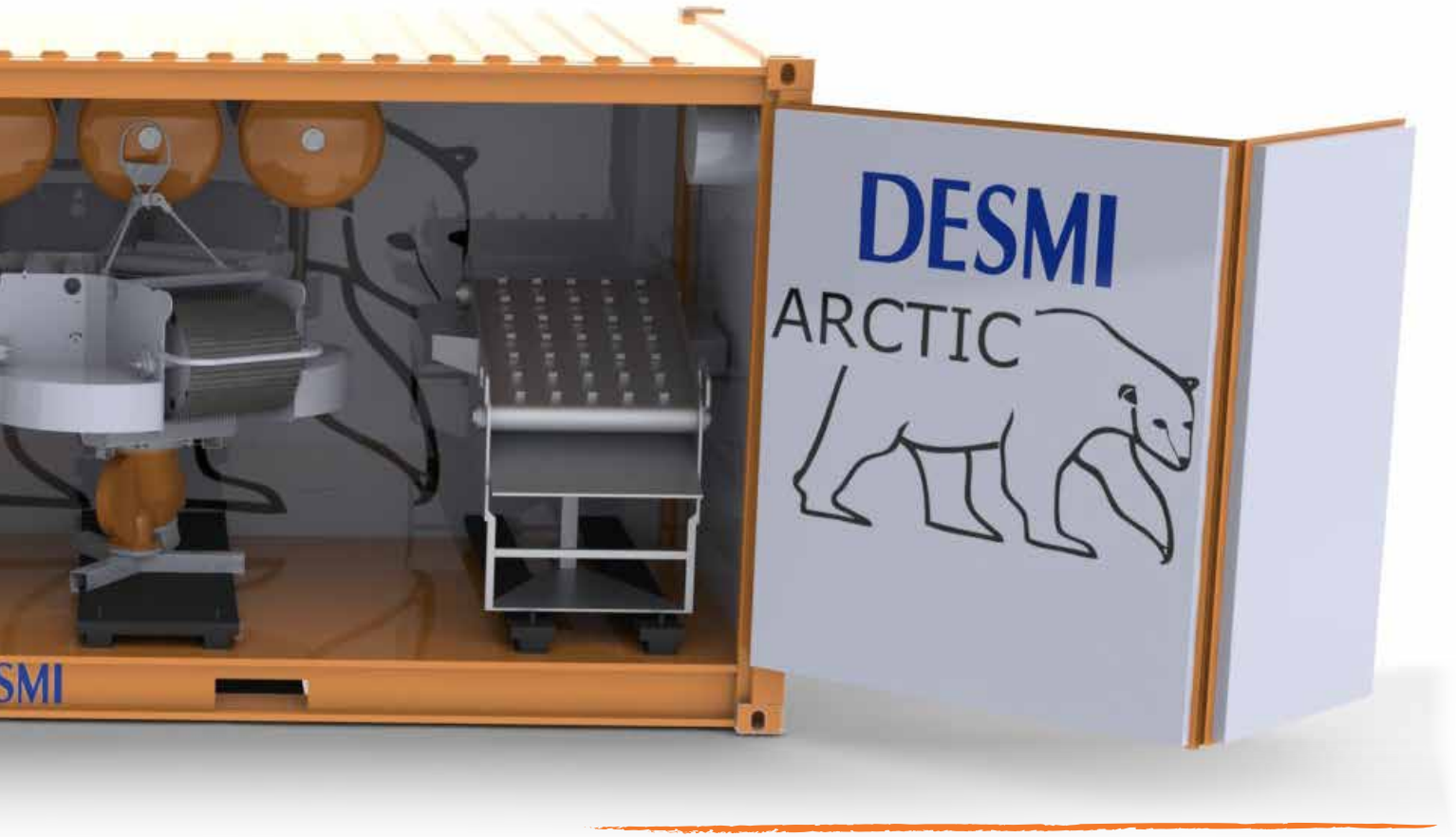
# Easy access to the container for handling and launching of the skimmers

The Storage container is a 20' CSC approved with insulated walls and doors. The container has connections for heating further electrical plugs for having light and power for working.

The skimmers stored in the container are able to recover any type of oil: light oil with the Sea- Mop and Disc Skimmer, medium viscous oil with the Brush Skimmer, and the Belt unit to fit on the Terminator weir skimmer will recover heavy oil and emulsified oil.

The DESMI Archimedes screw pump fitted in the skimmers is able to discharge oil with viscosities up to 1 million cPoise.

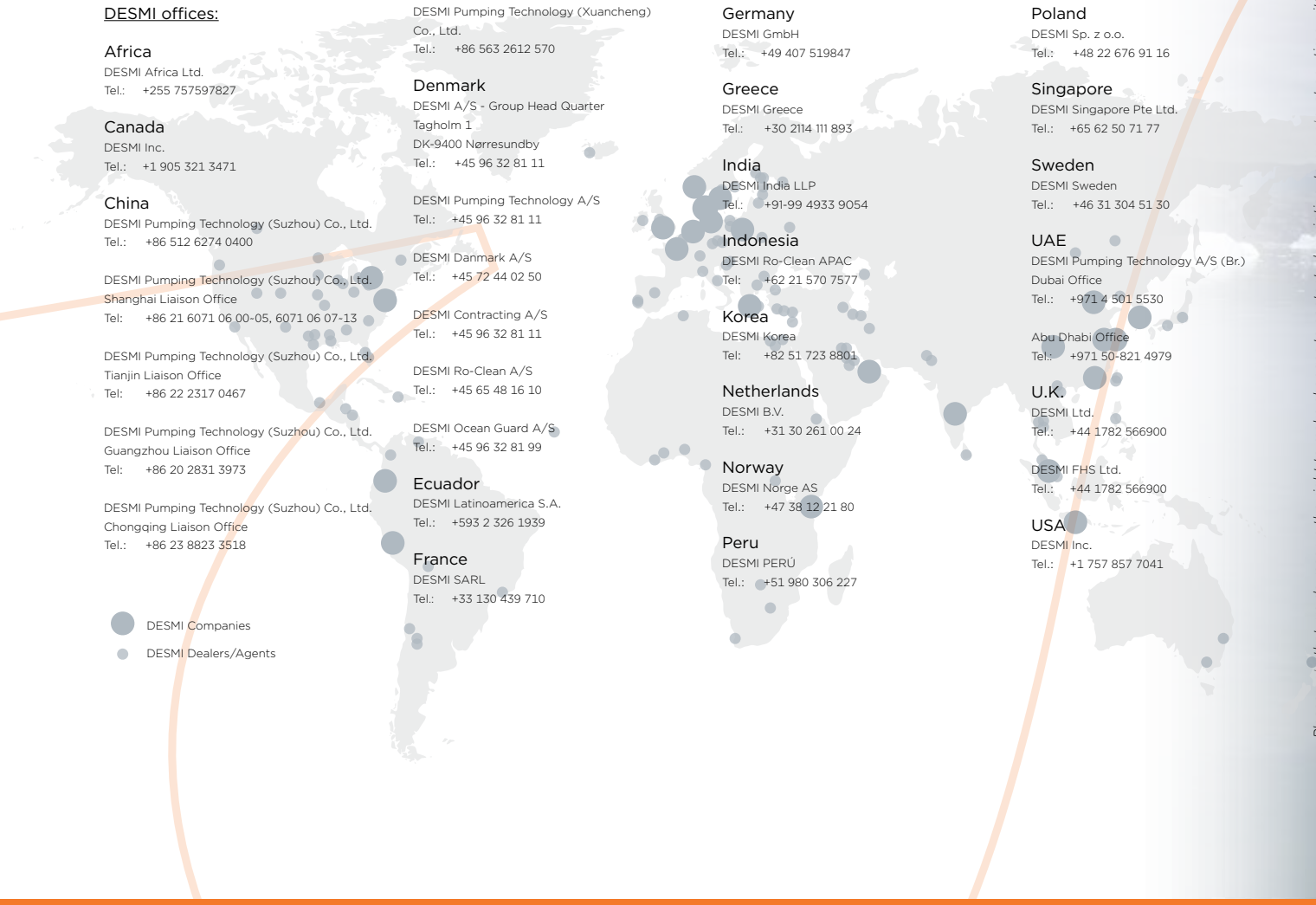
The hydraulic hoses and discharge hoses have been unified so all skimmers are using same type of connectors and the discharge hose have same size for all types of skimmers.




DESMI Ro-Clean

*- Proven Oil Spill Technology*

# Your DESMI contact for Oil Spill Response



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