

# High Temperature Superconductor Degaussing Coil System

## Highlights

- 20% the weight of copper
- Support hangers and fixtures also lighter and less expensive
- 40% lower installed cost, significantly fewer connections
- Feed currents of up to 200A at voltages below 1VDC
- Single cable runs to above 4,000 Amp-turns
- Off the shelf robust cable cooling systems and economical junction boxes
- Instrumentation and control interface to standard monitoring systems
- Low circuit reactance, faster dynamic response
- Easier to bend and feed through smaller conduits

## Overview and Key Benefits

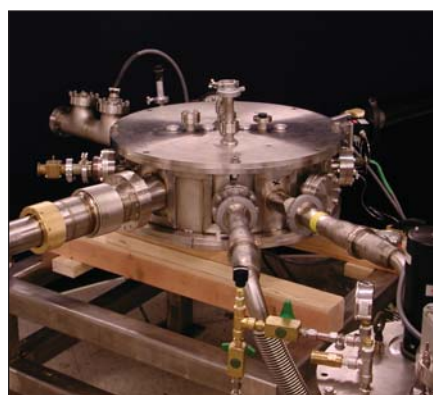
Degaussing coils are a vital part of today's military ships. Degaussing coils are utilized in most navy ships to reduce their magnetic signature, thereby making them much more difficult to be "seen" by magnetic sensors and by magnetically activated mines. Since ships are mainly constructed of steel, they disturb the earth's magnetic field as they pass which allows for their detection by sensors in weapons. Degaussing systems are widely used as a countermeasure to the threat of magnetic influence mines, thus increasing ship survivability.

Current degaussing systems consist of a series of field-generating loops and their installation involves running heavy copper cables around the perimeter of the ship's hull. A controlled electrical current is then passed through the cable which provides a magnetic field to minimize the ship's disruption of the earth's magnetic field.

High temperature superconductor-based degaussing coils provide many benefits as a replacement for conventional, copper-based degaussing systems:

**Lighter weight:** High temperature superconductor (HTS) degaussing coils are only 20% of the weight of conventional, copper-based degaussing cables.

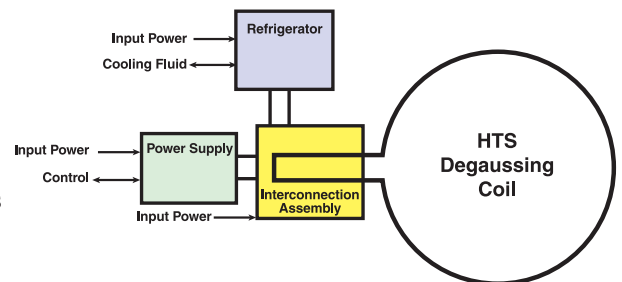
**Operating voltage:** HTS coils accommodate much higher currents and lower voltages in a much smaller space than conventional copper cables.



The HTS degaussing coil junction box for entry and exit for the HTS wires, refrigeration cooling lines and monitoring.



Degaussing coils have been used since World War II; HTS degaussing cable reduces weight and cost and enables performance improvements.



**Lower installation costs:** the substantial reductions in weight, size and number of terminations are expected to yield a reduction in total installed cost of 40% compared with copper-based degaussing systems. Because the size and weight of HTS degaussing systems are much lower, the infrastructure needed to support, route and house the coil is lower in cost, weight and complexity.

**Energy efficient:** HTS degaussing coils operate with near-zero resistance, and very high efficiency, thereby reducing power supply requirements while enhancing the dynamic response of the system.

**Smaller size:** HTS degaussing coil can feed through smaller conduits.



AMSC's proprietary coil design for the degaussing system takes full advantage of the properties of superconductors, which conduct high electrical currents in a small wire with little or no energy losses due to electrical resistance. AMSC produces HTS wires today that conduct more than 150 times the electrical current of copper wires of the same dimensions. This "power density" advantage reduces the weight of an HTS degaussing system to 20% of today's copper-based systems on typical military ships such as the U.S. Navy's LPD 17 class amphibious warships.

AMSC announced in March 2006, that it had demonstrated the successful operation of the world's first full-scale HTS degaussing coil for military ships. The 130 foot (40 meter) long HTS degaussing loop incorporating AMSC's HTS wire is based on a proprietary cabling technique that allows the wires to remain flexible within their containment jacket and conforms to installation requirements for integration into typical naval ships. The cables are housed in commercial cryostats that provide the necessary thermal insulation to allow the coil to operate at needed temperatures. The coil is cooled by AMSC's patented gas circulation system utilizing a commercial refrigerator. The coil produced 4,100 Amp-turns — a typical level of performance of conventional copper-based degaussing cables deployed in military ships today — with a significant decrease in operating

## Specifications

AMSC degaussing coils are fabricated to specifications with the following components:

- Refrigeration system: compressor, fan, cold box, transfer line
  - Typical service requirements:
    - Compressor: 7.5kW, 230/460VAC 3-phase 60Hz
    - Refrigerator: 110VAC 60Hz
  - Dimensions and weight:
    - 110 x 80 x 110 cm
    - 220 kg
    - 3 m long flexible, robust transfer lines

- Junction box: access for cable, power, instrumentation, refrigeration and vacuum port
  - 75 cm diameter x 30 cm
  - 120 kg

- Instruments and control: 50 cm (20 in) rack mount panel for RTD and control interface
- Coils: many rated diameters; current level and length as specified
  - Common cable diameter: 48mm (~2 in)
  - HTS wires: in excess of 20 within the proprietary AMSC coil
  - Current rating: 1500 to 5000 amp-turns
  - Lengths: from 20 meters to 200 meters (660 ft)
  - Bend rating: 700mm (~2.75ft)
  - Weight: less than 4 kg per meter (3 lbs per foot)
- Coil current supply: 0-200 A, +/- 5 VDC

voltage to less than 0.5 volts, or 1000 times lower than copper-based systems. Importantly, this HTS degaussing coil is only 20% of the weight of conventional degaussing cables. The substantial reductions in weight, size and number of terminations are expected to yield a reduction in total installed cost of 40% compared with copper-based degaussing systems. In addition to its physical advantages, an HTS-based degaussing system provides lower reactance and improved performance relative to equivalent copper cable systems in use today. This characteristic, in turn, offers improved performance relative to current systems in use today.

AMSC offers a range of HTS degaussing systems capable of operating at in excess of 4,000 Amp-turns in diameters of 48mm (2 in), weighing about 4 kg per meter (3 lbs per foot) and operating at well below one volt! Even the most advanced copper-based degaussing systems require at least 5 times the weight and voltages of 300 to 500 VDC. HTS degaussing coils may be applied in one loop, where copper systems take multiple loops. The numbers of terminations are significantly lowered, resulting in faster and less expensive installation.



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