Cold Facts

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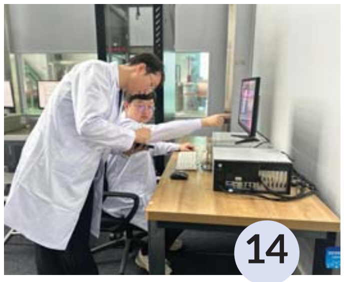

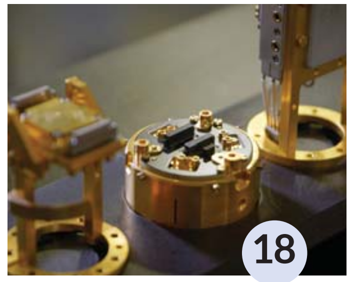

2026 BUYER'S GUIDE

FEATURES

ON OUR COVER

Stralis Bonanza "Clyde" ground technology demonstrator during 1-hour mission profile test.
Credit: Steve Holden / Stralis Aircraft

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COLUMNS

SPOTLIGHTS

Danaher Cryo
Pursue the near impossible

Danaher Cryo was CSA's newsletter sponsor for November.

Cold Facts (ISSN 1085-5262) is published six times per year by the Cryogenic Society of America, Inc.

From the Executive Director

It's that time of year again! We're excited to share the 2026 edition of our printed Buyer's Guide – a go-to resource for products and services designed for cryogenic applications. We hope you find this year's edition helpful throughout 2026 and beyond. And don't forget, the online Buyer's Guide is always available and updated regularly at **www.csabg.org**.

As 2025 wraps up, I've enjoyed looking back on everything CSA has accomplished this past year. We kicked things off with our much-anticipated trip to Lake Tahoe for the 31st Space Cryogenics Workshop in May. The Hyatt Regency Lake Tahoe offered a beautiful setting for two full days of oral and poster sessions. Attendees shared great feedback about the strong technical content, the range of participation from industry, academia and government, and the many networking opportunities that have become a trademark of this workshop.

Right after SCW, our team headed down the mountain to Reno to host CSA's Short Courses in conjunction with CEC/ICMC 2025. These courses continue to be one of our most popular programs, giving attendees both solid fundamentals and practical insights across many cryogenic topics. It was also wonderful to meet so many of you at our exhibit table and throughout the conference.

While at CEC/ICMC 2025, we were proud to present this year's CSA Awards to an exceptional group of honorees:

Fellows of the Cryogenic Society of America: Dr. Wei Dai and Michael Meyer

William E. Gifford Award: Ryan Snodgrass

George T. Mulholland Memorial Award for Excellence in Cryogenic Engineering: Santhosh Kumar Gandla

Award for Excellence in Cryogenic Operations and Support: Swapnil Shrishrimal

Throughout the year, CSA continued working to strengthen our community and expand the resources we offer. ***Cold Facts*** highlighted impactful research and industry advancements, we welcomed new corporate sustaining members, and we continued building educational opportunities for both early-career professionals and longtime experts in cryogenics and superconductivity.

Looking ahead to 2026, planning is underway for upcoming workshops, short courses and new digital resources that will make CSA membership even more valuable. We look forward to sharing updates throughout the year and hope to see many of you at our events.

As always, I hope you enjoy this special Buyer's Guide issue of ***Cold Facts***. Happy New Year!

Brookhaven Expands Cryogenic Capabilities for the Electron-Ion Collider Project

by Chintan Sheth, Mechanical Engineer, PMP, Brookhaven National Laboratory

The Relativistic Heavy Ion Collider (RHIC) has been running successfully since the year 2000 at the U.S. Department of Energy's (DOE) Brookhaven National Laboratory (BNL). 2025 will be RHIC's final run, and the facility will be decommissioned after the run ends in December 2025. The existing infrastructure will then serve as the foundation for the Electron-Ion Collider (EIC), a first-of-its-kind facility designed to enable high-precision studies of the internal structure of protons and nuclei.

The RHIC-to-EIC transition will require removal of the existing "Blue" magnet ring and beam line from the tunnel and modifications of many portions of the "Yellow" magnet ring. Additionally, a new electron storage ring (ESR) will be installed in the tunnel to circulate the electron beam, enabling collisions between polarized electrons and ions at designated interaction points, including the future ePIC detector. One major modification will involve installing high-power superconducting radio frequency (SRF) cavities, which are used for energy recovery and to accelerate charged particles to very high energies with high efficiency. Each SRF cryomodule houses one or two SRF cavities, allowing for optimized thermal insulation, efficient cryogenic cooling and streamlined integration into the accelerator beamline, while maintaining the high-field stability required for particle acceleration.

These cavities are being produced at DOE's Thomas Jefferson National Accelerator Facility, where they will be tested at half-power capacity. Then they will be shipped to BNL and tested at full-power capacity before being installed inside the EIC tunnel. This testing will ensure that no damage occurred to the sensitive components — such as high-power couplers, tuners, cryo lines and RF connections — during their travel. Since it is a mammoth task to remove cryomodules and cavities from inside the tunnel, it's crucial to verify that these will perform as per their design prior to installation. To support this effort, BNL has designated a facility, the Horizontal Test

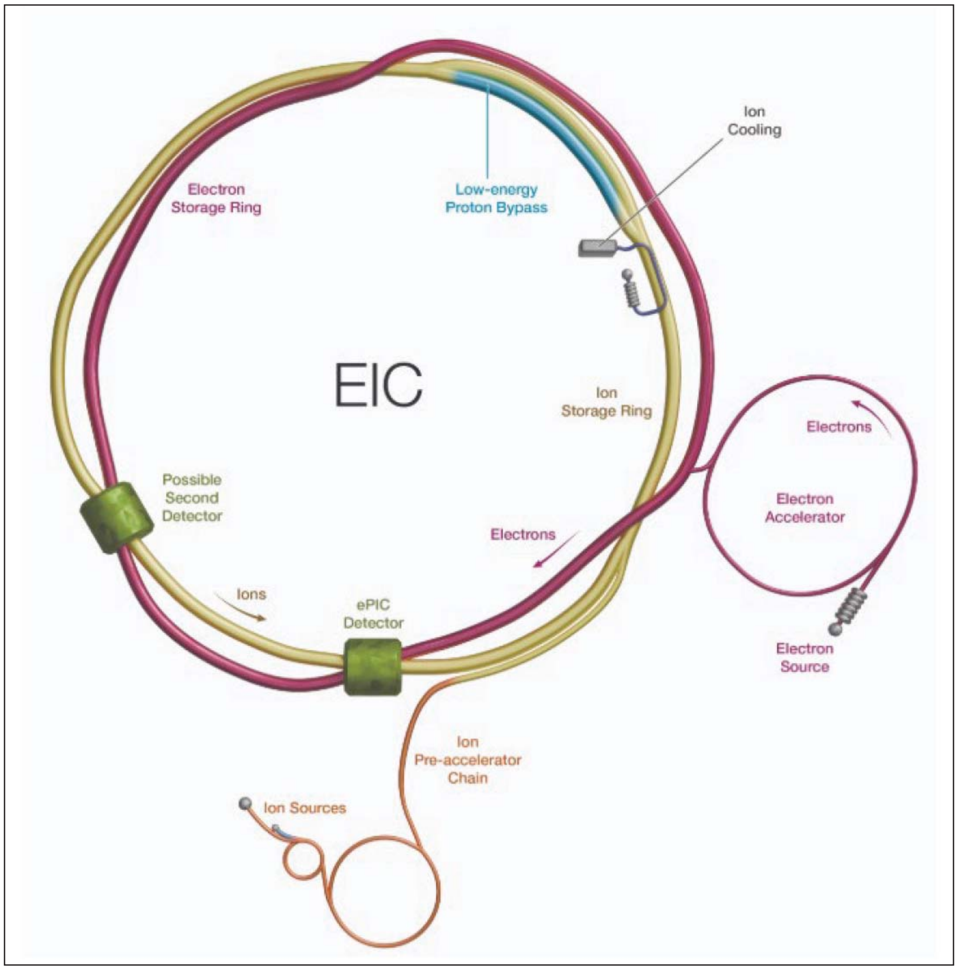

Figure 1: Electron Ion Collider. *Credit: Brookhaven*

Facility (HTF), for conducting these high-power tests. This article presents the cryogenic upgrades required within and around the HTF to successfully support the testing of these vital SRF components.

The scope for this upgraded HTF will be to enable high throughput (1-2 tests per month), multi-frequency, long-term 2.0 K testing capabilities for the EIC project and for BNL in general. The diagram in Figure 2 gives a cryogenics perspective of how new and existing cryogenic equipment is coming together to satisfy testing needs of these cavities.

Purple-colored equipment signifies new procurements. Black-colored equipment already exists and is located in the building near the HTF. Green-colored equipment is currently being utilized for RHIC operations and will be brought in after the final RHIC run ends.

As seen in the diagram, there is currently an existing Helium Liquefier with a liquification capacity of 2 grams/sec that produces inventory in the existing 3,500-liter helium dewar. Procurement of a new helium liquefier from Air Liquide (Helial 280) with liquification capacity of 10 g/sec is underway, along with a new 3,500-liter helium dewar from Wessington Cryogenics that will have a subcooler coil. Warm helium gas supply comes in from the outside 46,000-gallon warm helium tank that is also connected with the RHIC gas tank farm for additional inventory and inventory management. A recently installed liquid nitrogen cooled purifier loop uses a pair of open neck purifiers to help clean the “dirty” gas in the warm helium tank and from the sub-atmospheric warm helium pumps. Procurement of a new 85 g/sec purifier will significantly upgrade the capacity to clean helium in future.

The top view of the facility can be seen in Figure 3. Existing equipment is in black boxes; new procurements are in purple boxes, and green box equipment is currently being used for RHIC operations.

The different SRF cavities are in various design phases. There can be single or a dual SRF cavities inside a cryomodule. The goal of this cryogenic equipment upgrade is to fulfill the test requirements provided by the RF group. Based on their initial design and estimates, Table 1 shows the preliminary heat load estimate for a cryomodules carrying two RF cavities under full high power with a cryogenic valve box.

Cryomodule with RF ON	2K	4.5K	80K
Static (W)	75	0	102.0
Dynamic (W)	36.8	308	0
Total (W)	111.8	308	102

Table 1: SRF Cavities Load. *Credit: Brookhaven*

The RF group plans on simultaneously operating one cryomodule under full power (static + dynamic) and the second cryomodule under static power only. Based on these requirements, the Cryo group has come up with preliminary liquid helium usage estimates shown in Table 2.

Cryomodule Status	Liquefaction Load (g/s)
Static Power	4.4
Full Power	7
Distribution Load	0.3
TOTAL	11.7

Table 2: Liquid Helium Usage- One Cryomodule Full Power and Second with Static load. *Credit: Brookhaven*

Since the new helium liquefier produces 10 g/sec of liquid helium, the existing liquefier with 2 g/sec will also need to be running if the test load remains above the new liquefier capacity for an extended amount of time. The new 3,500L liquid helium storage dewar for the new liquefier will have a subcooler built in to utilize the inventory for capacity assist when the load exceeds the liquefier capacity. Inventory from the existing dewar can be transferred to the new dewar via an interconnecting liquid helium jumper line if required.

In coming months, the Cryo group will work on finalizing the design of the cryo distribution from the liquefier to the valve boxes that will feed the SRF cryomodules located inside the HTF. The HTF combines the use of existing cryo equipment, repurposed RHIC cryo-systems equipment, and new equipment being procured to minimize cost while meeting the RF test requirements.

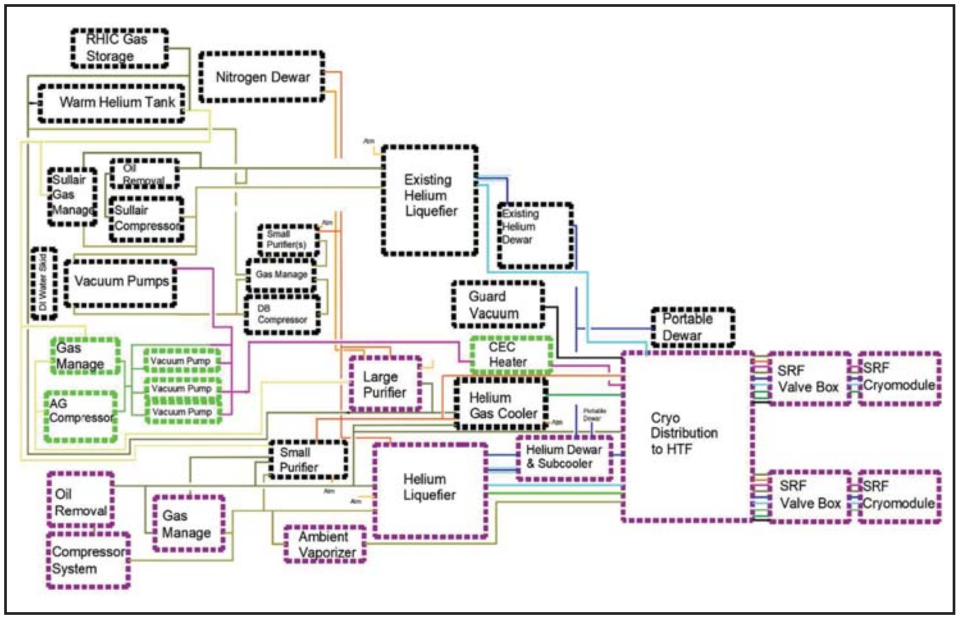

Figure 2: Cryo Process Diagram. *Credit: Brookhaven*

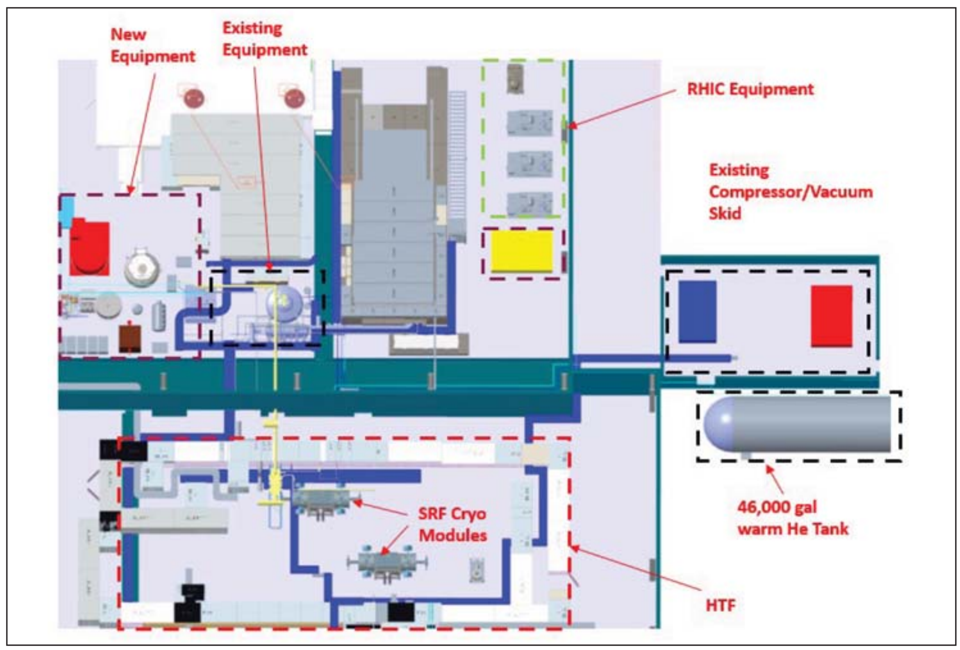

Figure 3: Cryo Equipment for HTF. *Credit: Brookhaven*

Acknowledgments:

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Yatming (Roberto) Than (Deputy C-AD Cryogenics): Cryogenic calculations and system requirements

Jennifer Maceiko (Piping Designer) and Cliff Britus (Mechanical Engineer): 3D CAD Modeling Support

Operational Weather Is a Hidden Driver in Helium Purification

by Prabhat Kumar Gupta, SCRF Cavity Characterization and Cryogenics Section, Raja Ramanna Centre for Advanced Technology (RRCAT), Indore (MP), India and Homi Bhabha National Institute (HBNI), Mumbai, India

Introduction

Helium purification is central to stable cryogenic operation—whether in superconducting magnet facilities, accelerator test stands, quantum computing labs, or helium liquefaction plants. Even a few hundred ppm of air contamination can degrade liquefaction capacity, reduce refrigeration performance and, in severe cases, block cold channels with frozen nitrogen or oxygen. Experience across laboratories consistently shows that ppm-level impurities can accumulate inside cold boxes, damage expansion turbines and reduce system availability.

Helium becomes contaminated at multiple stages in recovery and processing. Common pathways include:

- Air ingress at compressor suction during sub-atmospheric operation or imperfect sealing
- Vacuum pumping system leaks or oil back-streaming
- Helium storage bags and buffer tanks exchanging moisture with ambient air
- Experimental facilities during warm-up, venting, or maintenance
- Inadequate purging during installation and commissioning
- Thermal breathing during night–day transitions

While these impurity mechanisms are well recognized, an important and often underestimated factor is regional climate, particularly in India and other tropical countries. Any air that leaks into the helium system—whether through suction leaks, storage bags, recovery lines, or experimental equipment—enters at the ambient temperature and relative humidity of the surrounding environment. In tropical regions, ambient temperatures routinely reach 308 to 320 K (35 to 47°C) with relative humidity often above 60-80%, creating much wetter air compared to temperate climates.

Typical climate envelopes:

Region	Ambient Temperature	Relative Humidity	Effect on Water in Leaked Air
India (summer)	308-315 K	50-90%	**Very high water mole fraction**
Middle East (Gulf)	310-325 K	40-80%	**Extremely high latent moisture**
Europe (temperate)	285-295 K	40-70%	Moderate
USA (northern states)	275-295 K	30-60%	Low to moderate
Japan (varies)	285-305 K	40-70%	Moderate to high

Because the moisture-holding capacity of air increases exponentially with temperature, the moisture mole fraction in leaking air is intrinsically higher in tropical climates. Thus, for the same 500 ppm(v) air leak, a helium purifier in India, Southeast Asia, Brazil, or the Middle East receives three to four times more water vapor than a purifier operating in Europe or North America. This climate-driven increase in water load is the core reason why purifier operation, regeneration frequency, and LN_2 consumption differ significantly across regions. The remainder of the article explains this effect in thermodynamic terms and provides guidance for designing and operating purifiers in weather-intensive environments.

Why ambient weather – especially in tropical regions – controls the water load

Water vapor in air is governed by saturation thermodynamics. The saturation vapor pressure rises exponentially with temperature (Clausius–Clapeyron relation). For example:

- At 40°C (313 K), saturated air holds >10× more water than at 0°C (273 K).

Warm climates inherently inject more water into the helium system for the same air leak rate.

Key Physical Fact

When moist air enters helium:

$$y_w = RH.\frac{p_{sat}(T_{ambient})}{p_{atm}}$$

This water fraction is fixed at the moment of leakage and is independent of what happens to the helium afterward. Thus, every cubic centimeter of leaked air is effectively a fixed package of moisture determined solely by the climate at the leak point.

- Why tropical climates are fundamentally different

Thus:

- India and the Middle East represent worst-case purifier loads globally.
- Europe and North America operate under much more forgiving humidity envelopes.

The compressor does NOT create the water

Even though air-cooled compressors show higher discharge temperatures in tropical climates, the water is determined by the ambient leaking air, not by the helium temperature after compression. Compressor discharge temperature correlates with weather, but does not create water; it merely reflects the ambient conditions that determine moisture content.

Operational Consequences in Tropical Regions

Because tropical ambient air contains more water:

- Dryer breakthrough is faster
- Regeneration frequency is higher (2-3× compared to temperate countries)
- More load reaches LN_2 adsorbers, reducing N_2/O_2 capacity
- LN_2 consumption increases
- Purifier stability becomes strongly seasonal, especially during monsoon humid peaks in India

This is why many helium plants in India report:

- Summer dryer cycles of 6-12 hours instead of 18-24 hours
- LN_2 bed breakthrough during monsoon seasons
- High dew-point excursions during hot weather

These are direct outcomes of tropical climate-induced moisture, not equipment malfunction. During monsoon, relative humidity routinely exceeds 80-90%, which directly increases water carryover into dryers even if air-leak ppm is unchanged.

Weather-Aware Purifier Design Recommendations

1) Design for the hottest, most humid day in the region—not annual average.

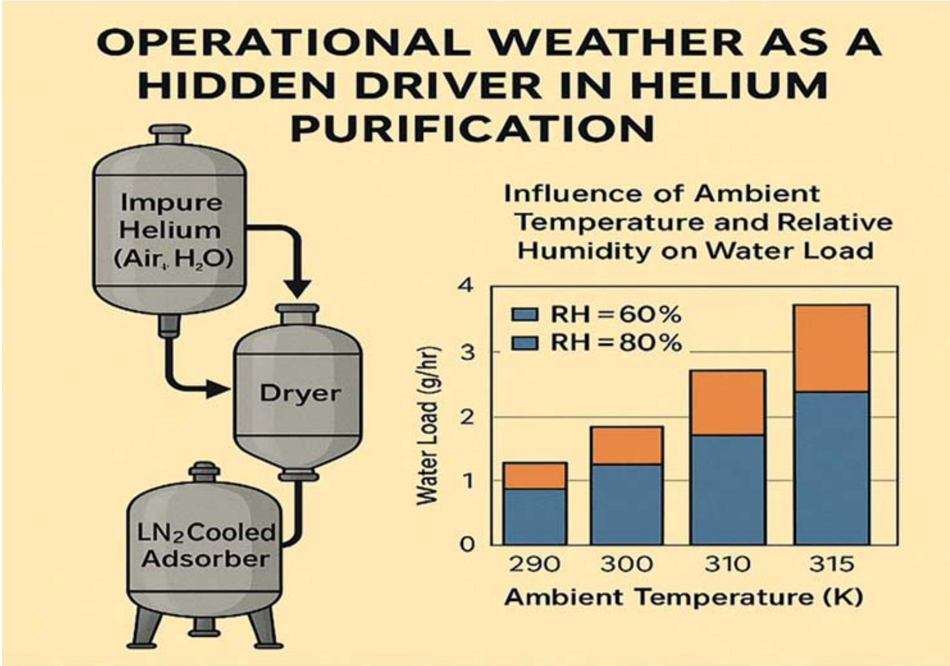


Figure 1. Helium purification train (left) and influence of ambient temperature and relative humidity on water load (right) for a 10 g/s helium stream with 500 ppm(v) air contamination. Warmer climates—typical of India, Southeast Asia and the Middle East—dramatically increase water loading, shortening dryer breakthrough time and raising operating cost. Credit: RRCAT

2) Use dry-air ppm(v) specification when describing helium purity.

3) Condition and ventilate compressor rooms where possible (India: 3-5 K cooling increases dryer life ~20%).

4) Monitor dew point continuously at compressor discharge and purifier inlet.

5) Reserve LN_2 adsorbers for N_2/O_2 removal only, not for moisture.

6) Apply a climate factor (≥2×) for desiccant sizing in tropical installations.

Conclusion

Helium purification performance is strongly shaped by ambient weather, especially in India and other tropical countries. Any air entering the helium system brings a moisture content determined solely by local temperature and humidity. A constant 500-ppm(v) air leak introduces up to 4× more water in Indian summer conditions than in European winter conditions. This effect is thermodynamically unavoidable and must be considered in purifier sizing.

As helium recovery and liquefaction infrastructure expands across tropical regions, weather-aware purifier design and operation are essential to ensure reliable, year-round performance. Ignoring climate leads to underestimated dryer loads, frequent regenerations and compromised LN_2 adsorber performance—a pattern consistently observed in high-temperature, high-humidity regions worldwide.

Phoebus is Keeping the Smallest Molecule in the Universe Contained

Update by ESA Communications

Progress on European Space Agency's (ESA) Phoebus project is bringing the future of rocket propulsion a step closer to reality. Engineers are developing carbon-fiber hydrogen tanks for potential use on Ariane 6 and for industrial applications beyond spaceflight. Smaller-scale prototypes have already demonstrated that this world-first technology works, and now a full 2,600-liter carbon-fiber reinforced plastic hydrogen tank is nearing completion.

At the same time, a new hydrogen test facility is being prepared in Trauen, Germany, where the tank will undergo testing from April 2026. This marks a significant milestone in a programme that could transform the way Europe's rockets are built.

Artist's impression of the Phoebus upper stage in orbit. The project explores replacing metallic propellant tanks with lightweight carbon-fiber composites for Ariane 6. *Credit: ESA*

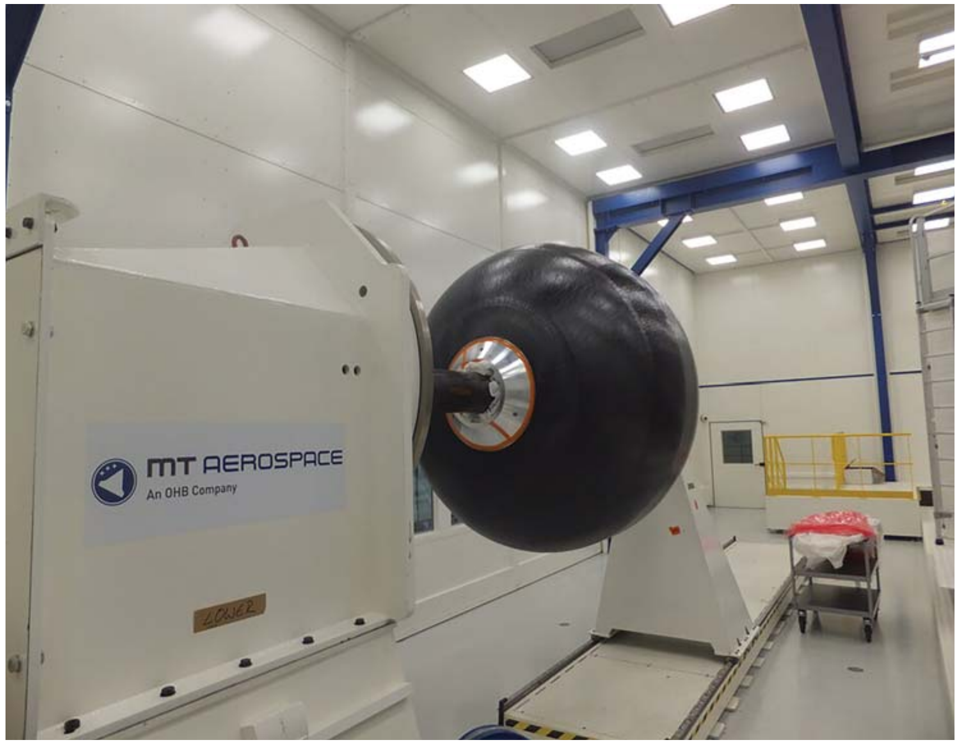
Reinventing the Rocket Tank

Phoebus is a joint endeavor between the European Space Agency, ArianeGroup and MT Aerospace. The project explores the replacement of traditional metallic tanks on the Ariane 6 upper stage with lighter, carbon-fiber reinforced-plastic structures. Shedding mass means saving fuel and boosting payload capacity, but it also means tackling one of the toughest material challenges in space engineering.

Liquid hydrogen, one of Ariane 6's key propellants, is the smallest molecule in the Universe. To store it as a liquid, it must be cooled to an astonishing –253°C, just 20 degrees above absolute zero. Most materials, including carbon fiber composites, become brittle at such temperatures. Like skin exposed to harsh winter air, they can develop tiny cracks as they contract. For a rocket fuel tank, that's simply not an option.

Overcoming these challenges required not only innovative materials and manufacturing techniques, but also brand-new measurement systems. Existing instruments couldn't detect the minuscule leak rates that occur at cryogenic temperatures, so engineers developed their own.

The 2,600-liter Phoebus hydrogen tank in the final stages of production at MT Aerospace, Augsburg, Germany. The carbon-fiber reinforced structure will undergo cryogenic testing in 2026. *Credit: ESA*



The two-meter-scale Phoebus hydrogen tank on an automatic fiber placement machine at MT Aerospace. Carbon fibers are precisely laid to create the lightweight pressure vessel. *Credit: ESA*

The Phoebus project aims to develop composite propellant tanks for future European launchers, reducing mass and improving performance. *Credit: ESA*

The breakthrough came when 60-liter demonstration tanks showed that carbon-fiber composites can indeed contain liquid hydrogen without leaking, a world first that validated years of research.

Scaling Up

The next milestone is ambitious: a full-scale tank nearly two meters in diameter and capable of holding 2,600 liters of hydrogen. The inner pressure vessel was completed at MT Aerospace in Augsburg, Germany, in September 2025, with final production expected by December. Testing will then move to ArianeGroup's facilities in Trauen, where a dedicated site is being built for the purpose.

Despite being kept at ultracold temperatures, hydrogen remains highly flammable. The test campaign, scheduled for April 2026, will therefore follow strict safety procedures. Engineers will gradually pressurize the tank to simulate launch conditions, pushing it close to its structural limits but stopping just before failure. The goal is to understand precisely when and where microscopic cracking begins.

Work on the Trauen site began in early 2025, with a preliminary design review completed in June and a critical design review planned for later this year. Construction of the test infrastructure will then commence, paving the way for the first cryogenic hydrogen trials next spring.

Testing to the Limit

During the tests, arrays of sensors will record pressure, temperature and strain in real time, giving engineers an unprecedented look into how the tank behaves as conditions mimic those on the launch pad and in flight. Each round of testing will be followed by detailed analysis to refine future designs.

These insights will inform not just Phoebus but a new generation of reusable, lightweight rocket stages, and it could influence storage and transport of hydrogen here on Earth.

A Glimpse of the Future

Phoebus is part of ESA's Future Launchers Preparatory Programme (FLPP), which supports the conception, design and demonstration of technologies that will shape Europe's next-generation space transportation systems. By developing such cutting-edge solutions today, ESA and its industrial partners are reducing the risks and costs of tomorrow's missions.

The progress of Phoebus demonstrates that even the smallest molecule in the Universe can be safely contained, and that big leaps forward often begin with the tiniest details.

China Sets World Record With 35.1-Tesla Superconducting Magnet, Advancing Fusion and Energy Research

by Chen Na, Chinese Academy of Sciences

The race to generate stronger, more stable magnetic fields has become a cornerstone of modern physics, driving innovations in medicine, energy, and materials science. China's latest breakthrough marks a major leap forward in this global quest and highlights the country's accelerating leadership in superconducting technology.

Chinese scientists have successfully generated a steady magnetic field of 351,000 gauss (35.1 tesla) using a fully superconducting magnet, setting a new world record. The achievement represents a milestone in high-field magnet research and is expected to significantly advance the commercialization of next-generation superconducting instruments such as nuclear magnetic resonance spectrometers. The accomplishment also provides crucial technical support for multiple cutting-edge fields, including fusion magnet systems, space electromagnetic propulsion, superconducting induction heating, magnetic levitation, and efficient power transmission.

The magnet was developed by the Institute of Plasma Physics under the Chinese Academy of Sciences (ASIPP), located in Hefei, Anhui Province, China, in collaboration with the Hefei International Applied Superconductivity Center, the Institute of Energy of the Hefei Comprehensive National Science Center, and Tsinghua University.

A Powerful Collaboration in Superconductivity

ASIPP is internationally known for operating the *Experimental Advanced Superconducting Tokamak* (EAST), often referred to as China's "artificial sun." The institute has long been a leader in fusion research and has developed an extensive domestic supply chain for superconducting materials and systems.

Tsinghua University contributed theoretical modeling and advanced materials engineering, while the Hefei International Applied Superconductivity Center provided technical expertise in coil design and cryogenic systems. Together, these groups form a national alliance that has transformed Hefei into a global hub for applied superconductivity and plasma research.

Researchers of the Chinese Academy of Sciences' Institute of Plasma Physics (ASIPP) record experiment data in Hefei, Anhui Province, China, Sept. 28, 2025. *Credit: Xinhua/Wu Huijun*

The Technology Behind the Record

Earth itself is a giant magnet, generating a geomagnetic field of about 0.5 gauss. By comparison, superconducting magnets, fabricated by winding superconducting materials, can generate fields hundreds of thousands of times stronger while enabling lossless transmission of large electrical currents.

According to Liu Fang, a researcher with ASIPP, the new magnet adopts high-temperature superconducting (HTS) insert-coil technology, coaxially nested with low-temperature superconducting magnets. The team overcame formidable challenges such as stress concentration, shielding-current effects, and multi-field coupling under low-temperature, high-field conditions. These innovations dramatically improved the magnet's mechanical stability and electromagnetic performance in extreme environments.

During the record-setting experiment, the magnet was energized to 35.1 tesla, operated stably for 30 minutes, and then safely demagnetized, fully verifying the reliability of the technical approach. The achieved field strength, over 700,000 times stronger than Earth's geomagnetic field, surpassed the previous world record of 323,500 gauss.

Implications for Fusion and Beyond

Superconducting magnets are key components in magnetic confinement fusion devices, forming a "magnetic cage" that confines high-temperature plasma long enough for sustained burning. The stronger and more stable the magnetic field, the more efficiently fusion reactions can occur.

ASIPP's success feeds directly into its role as China's main unit within the International Thermonuclear Experimental Reactor (ITER) project, the world's largest and most ambitious fusion experiment, currently under construction in southern France. As part of its ITER contributions, ASIPP is responsible for major procurement packages, including superconductors, correction coils, and magnet feeders.

An ITER spokesperson, in a statement welcoming the announcement, noted that "advances in high-temperature superconducting magnet technology contribute directly to ITER's long-term mission of achieving controlled fusion power. Each improvement in field strength and stability brings us closer to the conditions required for sustained fusion energy."

This photo, taken on Sept. 28, 2025, shows the superconducting magnet developed by the Chinese Academy of Sciences' Institute of Plasma Physics (ASIPP) in Hefei. *Credit: Xinhua/Wu Huijun*

Global Context and Future Prospects

The 35.1-tesla field achieved in Hefei represents not only a scientific record but also a strategic step toward fusion energy independence. Around the world, laboratories in Japan, the United States, and Europe are developing their own high-field superconducting systems, including MIT's SPARC project and Japan's NIFS LHD program, but China's combination of homegrown materials, full-scale engineering capability, and coordinated national investment gives it a unique edge. Beyond fusion, ultra-high-field superconducting magnets have transformative potential in other domains: they can enhance the resolution of magnetic resonance imaging (MRI), enable new particle-acceleration techniques, and open pathways for advanced propulsion and energy-storage systems. As global competition intensifies, breakthroughs like this signal a new era of scientific capability centered on superconducting technologies.

Ice Accelerates Iron Dissolution More Than Liquid Water, Study Finds

by Jean-François Boily, Angelo Pio Sebaaly, et al. Umeå University, Umeå, Sweden

In the frozen expanses of the Arctic, a subtle but profound chemical transformation is underway that challenges longstanding assumptions about the inertness of ice. Recent experimental research conducted at Umeå University reveals that ice, rather than merely acting as a static barrier, actively facilitates the dissolution of iron minerals in ways previously unrecognized. This discovery not only deepens our understanding of cryogenic geochemical processes but also bears significant implications for the changing landscape of Arctic ecosystems under the influence of climate warming.

Traditionally, the scientific consensus has held that chemical reactions tend to slow down drastically as temperatures drop below the freezing point, with ice serving mainly as a physical constraint that immobilizes reactants. However, this new study overturns this assumption by demonstrating that ice at −10°C can dissolve iron minerals more efficiently than liquid water at 4°C. This counterintuitive phenomenon arises from the unique microenvironment within freezing ice, where microscopic pockets of liquid water become concentrated chemical reactors, accelerating iron release even at temperatures as frigid as −30°C.

The scientists focused their investigations on goethite, a widespread iron oxyhydroxide mineral common in soils and sediments, exposed to organic acids naturally occurring in permafrost and soil environments. Using advanced microscopy techniques and controlled laboratory experiments, they elucidated the kinetic and mechanistic roles that ice plays during freeze-thaw cycles. Notably, these cycles enhance mineral dissolution by repeatedly liberating organic compounds trapped within the ice matrix, which then fuel subsequent chemical reactions, fostering efficient iron mobilization.

Salinity emerged as a pivotal factor modulating this dissolution process. Freshwater and brackish environments were found to facilitate increased iron release, whereas the presence of seawater tends to inhibit chemical reactivity. This distinction underscores the complex interplay between ionic strength, pH, and mineral-organic interactions within the partially frozen matrices, painting a nuanced picture of biogeochemical cycling in diverse aquatic systems impacted by seasonal freezing.

The implications of these findings extend well beyond academic curiosity, particularly given the accelerating pace of climate warming in Arctic and alpine regions. As permafrost thaws and freeze-thaw events become more frequent, the mobilization of iron into rivers and groundwater could alter water chemistry and provoke cascading effects on aquatic ecosystems. Iron, an essential micronutrient but potentially toxic in excessive quantities, influences the productivity and species composition of microbial communities, thus shaping broader ecosystem dynamics.

Moreover, the researchers emphasize that the environments affected are primarily acidic, such as those found in mine drainage areas, acid sulfate soils surrounding the Baltic Sea, and frozen dust in the atmosphere. In these contexts, the enhanced dissolution of iron minerals facilitated by ice has the potential to significantly alter element cycling and metal transport. Understanding these processes is vital for predicting the environmental fate of iron and associated contaminants in a warming world.

The study's findings also challenge the conventional paradigm that ice acts solely as a passive medium preserving materials in stasis. Instead, freezing and thawing are dynamic processes that instigate complex chemical reactions at the mineral–water interface. This realization opens new avenues for exploring the roles that cryogenic physicochemical conditions play in shaping the distribution and bioavailability of trace elements essential to environmental and climatic processes.

Foremost among the mechanisms involved is the creation of ultraconcentrated acidic microdomains within the ice matrix—tiny volumes of unfrozen liquid where organic acids and minerals reach reactive concentrations far exceeding those in bulk liquid water. These microreactors accelerate proton-promoted dissolution reactions, enhancing the breakdown of iron oxyhydroxides. This phenomenon helps explain the surprisingly high rates of chemical weathering and nutrient release observed in frozen soils and sediments.

Researcher Jean-François Boily, a professor at Umeå University and co-author of the study, highlights that ice should no longer be viewed as an inert barrier but as an "active player" in environmental chemistry. The capacity of ice to foster concentrated chemical environments and catalyze mineral dissolution at subzero temperatures provides essential insight into cryospheric geochemistry and its responses to ongoing environmental change.

Angelo Pio Sebaaly, the doctoral student and first author, indicates that the increase in freeze-thaw cycling due to rising global temperatures will lead to pulses of iron released from thawing permafrost and soils into adjacent waterways. This flux may contribute to altered water quality, influencing aquatic food webs, biogeochemical cycles, and ultimately, the health of polar and subpolar ecosystems—highlighting the far-reaching consequences of a warming planet.

Future research, as planned by the Boily laboratory, aims to explore whether similar dissolution dynamics occur across other iron-bearing minerals within ice and to elucidate the broader ecological ramifications. Unraveling these mechanisms will enhance predictive models that incorporate geochemical feedbacks between the cryosphere and biosphere, informing mitigation and adaptation strategies for vulnerable Arctic environments.

Originally published in Proceedings of the National Academy of Sciences, "Ice as a kinetic and mechanistic driver of oxalate-promoted iron oxyhydroxide dissolution," Aug. 26, 2025.

kiutra Secures €13 Million to Eliminate Bottlenecks from Quantum Supply Chains with Helium-3-Free Cooling

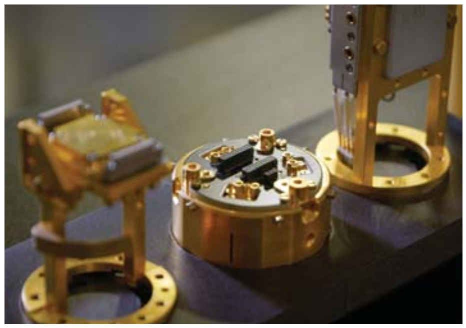
by kiutra GmbH Communications

kiutra, a provider of magnetic cooling for quantum technologies, has raised €13 million in a new equity round to accelerate its global scale-up and deliver helium-3-free cooling systems that strengthen quantum supply chain resilience. The round was co-led by NovaCapital of Italy and 55 North of Denmark, with participation from High-Tech Gründerfonds in Germany and other existing investors. With this financing, kiutra has secured more than €30 million in private and public funding, demonstrating strong confidence in its mission to build sustainable cryogenic infrastructure for the quantum era.

As Europe and its partners rapidly expand their quantum technology ecosystems, reliable and sustainable cryogenic infrastructure has emerged as a major bottleneck. Quantum computers and other cold quantum technologies depend on ultralow temperature operation, making them vulnerable to shortages of helium-3 — a rare and geopolitically sensitive resource. Initiatives such as the NATO Transatlantic Quantum Community and Quantum Delta NL have identified this dependence as a critical supply chain risk.

kiutra's proprietary magnetic cooling technology directly addresses this challenge. Instead of relying on helium-3, the company's systems use solid-state materials that are magnetized and demagnetized in a controlled process to reach ultralow temperatures. The technology enables safe, scalable refrigeration for quantum applications and is already deployed worldwide, supporting leading research institutions, quantum startups, and corporate partners. The systems provide the fastest and most user-friendly cooling solutions on the market, giving customers a clear advantage in development speed and reliability.

Dr. Alexander Regnat, CEO and co-founder of kiutra, said the investment will help expand the company's international footprint and further advance its portfolio of scalable cooling solutions. "These systems are vital for the rapidly growing quantum ecosystem," he said, "and essential for enabling practical deployment of quantum technologies."



kiutra's CryoFloor platform enables helium-3-free magnetic cooling for quantum technologies, providing sustainable ultralow temperature performance without reliance on scarce resources. *Credit: kiutra*

Building on its global success, kiutra is now expanding its portfolio with modular and powerful platforms designed for complex quantum chips and full-stack quantum computers. The company's technology lays the groundwork for a resilient quantum supply chain and ensures that quantum systems can be deployed without dependence on critical materials. Dr. Michael Jobst, investor at 55 North, the world's largest dedicated quantum fund based in Copenhagen, said kiutra is well positioned to provide one of the most essential enablers in quantum computing: reliable, scalable, and affordable access to cooling power. He noted that kiutra's product suite stands apart from conventional systems and emphasized that 55 North is proud to support the team's scaling journey.

Carlo Germano Ravina, managing director at NovaCapital, the Italian investment firm owned by Merloni Holding, said the fund backs bold engineering that shapes the future. "kiutra's magnetic cooling technology is not only foundational for quantum technology," he said, "but also exemplifies the kind of deep tech leadership Europe needs. We're proud to support their global scale-up." NovaCapital invests in innovative B2B companies across Europe and the United States, focusing on deep tech, energy transition, new materials, circular economy, industrial automation, and B2B SaaS.

Christian Ziach, principal at High-Tech Gründerfonds (HTGF), one of Europe's most active early-stage investors, said kiutra's new financing round highlights the strategic importance of cryogen-free cooling for scaling quantum technologies. He noted that the company addresses a rapidly growing global market with solutions that are technologically advanced and crucial for enabling real-world quantum applications. HTGF, which has invested in more than 790 startups and manages over €2 billion in funds, continues to support companies that strengthen Europe's technological sovereignty.

In 2024, kiutra secured a €4 million grant from the European Innovation Council to advance the development of its cryogen-free cooling technology. With the new private capital, the company is set to accelerate industrial scaling and commercialization. By making cryogenics simpler, safer, and more accessible, kiutra is helping democratize access to ultralow temperature technology and enabling its adoption at industrial scale.

This financing marks a major milestone in kiutra's evolution from an R&D-driven startup to a global industrial player. Its breakthrough approach not only supports Europe's technological independence but also strengthens the resilience of allied quantum supply chains. By removing one of the most critical bottlenecks in the field, kiutra is ensuring that the quantum technologies of tomorrow can move from laboratory innovation to industrial reality. **www.kiutra.com**

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Crane Cryogenics Advances Cryogenic Solutions for the Hydrogen Era

by Crane Communications

Crane Cryogenics, a division of Crane ChemPharma and Energy, has built its reputation by delivering reliable high-performance solutions for some of the most demanding cryogenic environments in the world. The company designs and manufactures advanced vacuum jacketed piping, valves and fittings that enable the safe and efficient transfer of liquefied gases such as hydrogen, nitrogen, oxygen, argon and liquefied natural gas.

The foundation of Crane Cryogenics is its engineering heritage. The company draws on more than a century of experience from Crane's long history in valve design, materials science and process control. This depth of experience allows it to apply proven mechanical principles to new challenges in cryogenic technology. Whether in a laboratory setting, an energy facility or an aerospace environment, Crane's products are developed to meet the highest standards of safety, purity and efficiency. The company emphasizes that cryogenic systems must maintain reliability and performance in extreme temperatures where even small fluctuations can affect pressure integrity and operational safety. Its vacuum jacketed piping systems are specifically engineered to minimize heat transfer, prevent leaks and ensure stable operation. Every component from fittings to globe valves is built with longevity and repeatability in mind.

As Crane explains in its technical materials, success in cryogenic service depends on understanding both the mechanical and thermal demands of low-temperature fluids. This dual expertise allows Crane Cryogenics to offer complete end-to-end solutions serving industries that rely on consistent cold performance for their processes.

One of the fastest-growing areas of focus for Crane Cryogenics is the hydrogen sector. As global industries shift toward cleaner energy sources, hydrogen has emerged as a promising alternative to fossil fuels but its safe handling requires specialized infrastructure. Crane has positioned itself as a key contributor to this emerging field.

Crane Cryogenics vacuum jacketed rigid piping system.
Credit: Crane Cryogenics

The company provides cryogenic pipe, valve and fitting systems that serve the full hydrogen lifecycle: production, liquefaction, transportation, transfer and storage. Its vacuum-insulated technologies and bellows-seal valves ensure that hydrogen remains at cryogenic temperatures while minimizing the risk of leaks or thermal losses. These systems are designed to handle the unique challenges of hydrogen, including its small molecular size and high permeability.

On its hydrogen applications pages, Crane Cryogenics highlights the importance of integrating advanced PVF (pipe, valves and fittings) technologies across every step of the hydrogen supply chain. The company's engineers collaborate with customers to develop systems that not only meet regulatory standards but also improve efficiency and safety in day-to-day operation. Crane's work also extends to liquefied natural gas and other industrial gases used in chemical processing, energy storage and transportation. By applying its deep cryogenic expertise to these sectors, the company contributes to a broader energy transition that depends on secure low temperature infrastructure.

In addition to energy-related projects, Crane Cryogenics has supported a growing number of installations in the life sciences. A recent feature on the company's website described how its engineers have guided biological laboratories and cryogenic storage facilities toward more effective use of liquid nitrogen systems. These systems help preserve biological samples and pharmaceutical materials while improving efficiency and reducing losses due to boil-off. Across each of these industries, the company's goal remains the same: to provide confidence that cryogenic systems will perform safely and consistently even under the most demanding thermal and mechanical stresses.

Crane Cryogenics approaches its work with a focus on collaboration and problem-solving. Many of the company's recent updates highlight how it partners with customers to tailor cryogenic solutions to unique operating conditions. Its engineers emphasize lifecycle performance, reliability under thermal cycling and ease of maintenance.

The company's testing and validation programs ensure that each product line performs as expected across years of use. Materials are selected for durability and compatibility with cryogenic fluids and every design is supported by rigorous quality control. These efforts reflect Crane's philosophy that cryogenic technology is not just about surviving extreme temperatures but about enabling systems to function with precision and predictability. Crane Cryogenics also invests in education and outreach within the cryogenic community. Through its participation in conferences and publications, it shares insights on best practices for hydrogen storage, vacuum insulation and valve design. The company's engineers often discuss the importance of proper material selection, clean assembly practices and long-term maintenance planning for cryogenic systems.

Crane Cryogenics advances precise, reliable solutions that bridge traditional industries with the emerging hydrogen economy and sustainable energy systems. Its commitment to technical excellence and customer needs supports cleaner energy development and the scientific progress that depends on cryogenic technology. **www.cranecpe.com**

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World-first Liquid Hydrogen Refueling Marks a Major Step Toward Zero-Emission Flight in Australasia

by Fabrum Communications Team

New Zealand and Australian innovators have taken a major step toward realizing hydrogen-electric aviation, completing the world's first liquid hydrogen refueling of composite aviation tanks on-site at an international airport. The refueling was carried out at Christchurch Airport by Fabrum, in preparation for upcoming pre-flight testing with partners AMSL Aero and Stralis Aircraft.

At Fabrum's liquid hydrogen test facility, hydrogen was produced, stored, and dispensed into advanced composite aviation tanks designed and built by the Christchurch-based company. The achievement demonstrates a complete end-to-end hydrogen system in action and signals a significant advance in zero-emission flight.

Christopher Boyle, Managing Director of Fabrum, said the milestone proves the readiness of hydrogen technology for aviation. He explained that the company's lightweight tanks, combined with Fabrum's liquefaction and refueling systems, make hydrogen-powered flight feasible. "By producing, storing, and dispensing liquid hydrogen on-site at an international airport, we've shown that all the pieces are now in place for hydrogen-electric flight in Australasia," he said. "This marks the transition from concept to reality."

Sydney-based AMSL Aero, developer of the hydrogen-electric vertical take-off and landing aircraft Vertiia, is one of the first companies to adopt Fabrum's composite tanks. AMSL Aero CEO, Dr. Adriano Di Pietro, said Vertiia is designed for long-range operations and relies on liquid hydrogen to reach its full potential. "Vertiia must be as light as possible to achieve its range and speed goals," he said. "Liquid hydrogen is the only zero-emission energy storage technology light enough for our aircraft. Today, together with Fabrum, we've demonstrated the crucial steps required to make that a reality. From producing liquid hydrogen to filling our ground transport container and transferring it into the aircraft tanks, every element is now proven. This milestone shows we're ready for the next phase of testing before our first liquid hydrogen flights next year."

Refueling Fabrum's lightweight composite liquid hydrogen tank at Fabrum's hydrogen test facility at Christchurch Airport. *Credit: Fabrum*

Stralis Bonanza "Bonnie" flight technology demonstrator in the Stralis hangar. *Credit: Stralis Aircraft*

Fabrum's testing also involved Brisbane-based Stralis Aircraft, which is developing a hydrogen-electric propulsion system for fixed-wing aircraft. CEO Bob Criner said seeing Fabrum's technology in action reinforced the progress toward flight readiness. "We're working with Fabrum on onboard tanks for our test aircraft to power our propulsion system," he said. "This successful refueling demonstrates the systems that will supply liquid hydrogen to our aircraft. It's a vital step toward our first test flights in Australasia, which we expect within six months."

Christchurch Airport CEO Justin Watson said the event marks another important step in the airport's commitment to sustainable aviation. "It's fantastic to host innovators like Fabrum, AMSL Aero, and Stralis Aircraft who are paving the way for low-emission aviation," he said. "Christchurch Airport continues to play a leadership role in building infrastructure that supports zero-emission technology, including liquid hydrogen."

The testing event also showcased Fabrum's triple-skin composite aviation tanks. Developed over two decades of research in cryogenics and advanced composites, the tanks provide enhanced thermal insulation and allow faster refueling compared to conventional designs. The innovation delivers up to 70 percent faster refueling and reduces hydrogen loss by 80 percent during transfer. Fabrum's proprietary approach has positioned the company as a global leader in cryogenic hydrogen systems.

Both AMSL Aero and Stralis Aircraft are expanding their hydrogen capabilities

Representatives from Fabrum, Stralis Aircraft, AMSL Aero, and Christchurch International Airport. *Credit: Fabrum*

as part of a broader regional collaboration. The three companies are members of the Hydrogen Flight Alliance in Australia, which aims to accelerate development of hydrogen-electric flight. AMSL Aero recently received a grant from the Australian Government's Cooperative Research Centres Projects program for a project focused on liquid hydrogen-powered aircraft for regional and remote operations, with Fabrum as a partner. Stralis and Fabrum have also received support from New Zealand's future energy center Ara Ake to advance liquid hydrogen aviation in Australasia.

The use of hydrogen in aviation offers significant advantages. Green hydrogen is produced through electrolysis of water using renewable electricity and has a specific energy more than three times that of sustainable aviation fuel and over 100 times greater than batteries. Hydrogen-electric propulsion uses a fuel cell to power an electric motor, releasing only water vapor. The systems are quieter and simpler than traditional engines, with lower maintenance costs and no emissions of carbon dioxide, sulfur oxides, or nitrogen oxides.

Boyle said the collaboration shows what can be achieved through shared vision and persistence. "We're not just developing technology. We're proving that hydrogen can transform aviation," he said. "With our partners across Australasia, we're showing the world that clean flight is possible now, not decades away." **www.fabrum.com**

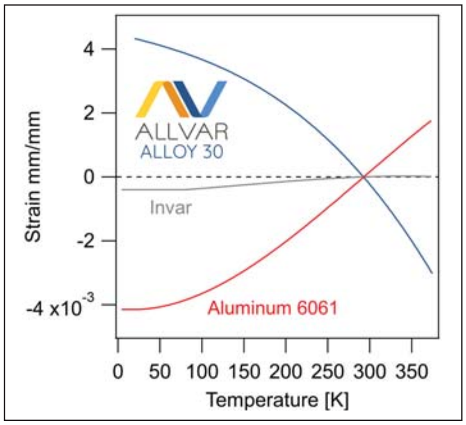
ALLVAR Alloys Solve Cryogenic Mismatch

by James A. Monroe, Ph.D., ALLVAR

Almost all materials expand when heated and contract when cooled, known as positive thermal expansion. Some materials expand and contract a lot while others expand and contract a little. This thermal expansion difference between materials can cause problems in assemblies when cooling to cryogenic temperatures. For example, aluminum fixtures are often fastened with stainless steel bolts. The steel bolt contracts less than the aluminum when cooled. The resulting thermal expansion mismatch can cause the bolt to loosen by more than 60 percent when cooling to liquid nitrogen temperatures. If this causes a failure in cryogenic instrumentation that takes days to cool, it can break testing schedules. If this occurs in on-orbit payloads or space environments, it can be catastrophic.

ALLVAR alloys are the only metals that shrink when heated and expand when cooled. This opens the door for engineers to overcome the cryogenic thermal expansion mismatch problem like never before. Over the last decade, ALLVAR alloys have been inserted into optics, aerospace systems, scientific equipment and specialty applications where compensating for thermal expansion mismatch is critical. For example, ALLVAR Alloy 30 washers can compensate for the mismatch between steel bolts and aluminum, as described above. Beyond bolts, ALLVAR alloys enable engineers to break free from traditional metals' thermal expansion properties and create components with thermal expansion properties to meet a specific application's needs. This new tool opens the current trade space for engineers designing and building cryogenic systems.

The negative coefficient of thermal expansion (CTE) of ALLVAR Alloy 30 is -30 ppm/K at room temperature. In comparison, regular titanium, steel and aluminum have positive CTEs of 9 ppm/K, 16 ppm/K and 23 ppm/K at room temperature respectively. ALLVAR Alloy 30's large CTE magnitude allows a small amount to easily compensate for CTE mismatch between traditional materials.



ALLVAR Alloy 30 expands when cooled, the opposite of invar and aluminum, and maintains negative thermal expansion properties at cryogenic temperatures. *Credit: ALLVAR*

For room temperature applications, the linear CTE assumption is fine, but the colder you go, the more non-linear the thermal response. The CTE of normal metals like aluminum, steel and titanium is non-linear and approaches zero CTE when approaching 0 K. ALLVAR Alloy 30's CTE is also non-linear when going to cryogenic temperatures but remains negative as it approaches zero CTE around 0 K. ALLVAR has recently collected CTE data down to 20 K so engineers can integrate Alloy 30 into their systems with confidence.

ALLVAR Alloy 30 offers three new engineering tools to design cryogenic systems: 1) control over displacements such as optics where lenses and mirrors need to maintain specific distances, 2) control over forces such as the bolts and mechanical assemblies described above and 3) control over passive actuation such as thermal switches.

ALLVAR Alloy washers are already helping cryogenic thermal straps maintain thermal conductance. For example, ALLVAR Alloy 30 washers have been integrated into the cryogenic sub-assembly in the Nancy Grace Roman Space Telescope's coronagraph payload. Alloy 30 washers enabled the use of very delicate thermal straps made from pyrolytic graphite. Pyrolytic graphite is a perfect thermal strap material for space applications because it has high thermal conductivity and low density but it is very delicate. ALLVAR Alloy 30 washers gently but firmly hold the pyrolytic graphite so thermal conduction can be maintained while cooling the coronagraph's detectors.

Elastomers and polymers lose their compliant elastic properties when cooled, presenting an issue with cryogenic seals. Alternative metal-to-metal seals require very tight tolerances where components are lapped or ground and gaps can form if a bolted seal loses its preload. Allvar Alloy washers can maintain bolt preload or even tighten a bolt to a desired clamping force when cryogenically cooled. The result is a tighter seal.

Passive thermal switches use thermal expansion mismatch between components to connect and disconnect a thermally conductive path. The large negative CTE magnitude and low thermal conductivity of Allvar Alloy 30 enable large reductions in switch size while maintaining large turndown ratios that approach 1200:1 in studies. This far exceeds currently available thermal switches with turndown ratios around 70:1.

Allvar Alloy 30 and its tunable variants provide a simple, reliable CTE-mismatch solution that enables cryogenic systems built at room temperature to perform predictably in extreme cold.

From seals and scientific instruments to space-based systems, the negative thermal expansion properties of ALLVAR Alloy 30 turn the design paradigm on its head. For the first time, engineers have a simple solution to the CTE mismatch problem. Engineers can assemble a system at room temperature and be confident it will work at cryogenic temperatures. The next generation of ALLVAR Alloys can even be tuned to match a desired CTE. These unique capabilities, unlock new thermal management architectures and materials to enable future cryogenic applications. **www.allvaralloys.com**


by Jonathan Demko, Le Tourneau University and Quan-Sheng Shu, cryospc.com

Thermal Shields and Anchors, Part 2: Anchors

To maintain components at cryogenic temperatures, a low-loss connection to the source of the cold must be made. The source of cooling can be a refrigerator or cryocooler, or from a supply of a cryogenic fluid such as helium, hydrogen or nitrogen. Thermal anchoring is the design feature that makes the thermal connection with minimal temperature difference, i.e. a low thermal resistance, between the cold heat sink and the component being kept cold, such as a thermal shield.

Thermal Anchors

Several methods have been employed to thermally anchor a system component to the cold sink. These include the use of thermal straps, direct connection to a cold head of a cryocooler or refrigerator or direct attachment of a coolant tube to a thermal shield. Anchors are used to remove conduction heat loads from structural components that directly transfer mechanical loads between a warm component and a cold component such as a superconducting magnet support post or current leads.

Thermal Anchors For Structural Components

Support structures, such as magnet support posts and dewar necks, have cross sections which are determined primarily from structural requirements. To limit the heat conducted from the warm boundary to a cold component, these are heat-stationed as discussed in the chapter on supports. The thermal link to cold temperatures must be of high thermal conductivity to minimize the temperature rise between the link and the cold sink. Also, the thermal anchor must be able to cool the structural component uniformly at the place of application through the support. One such thermal anchor design is detailed in Nieman et al.[1] for a re-entrant support for the Superconducting Super Collider magnets as shown in Figure 2.1. This design uses a shrink fit of rings on support tubes to provide the structural and

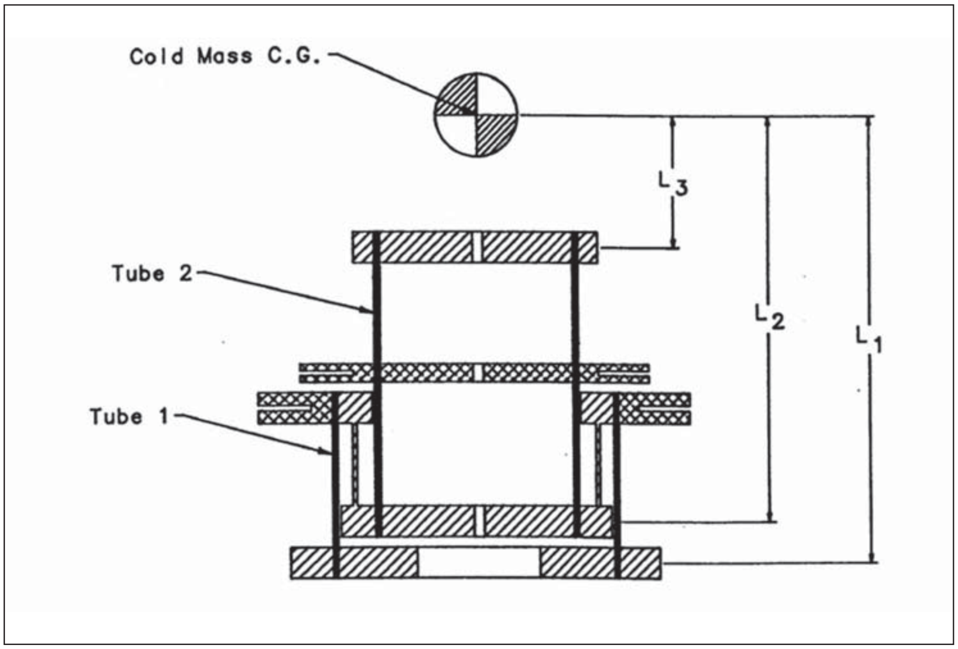


Figure 2.1 Re-entrant tube magnet support concept for the SSC from Nieman et al.[1]

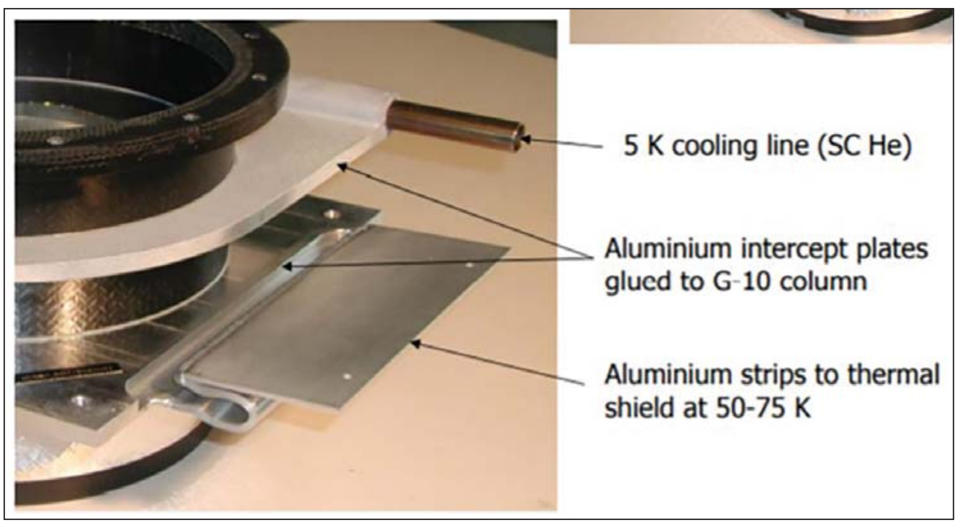


Figure 2.2 An example of the thermal anchor cooling structure for the support post.[3]

thermal load transfer capacities needed. The outer ring has the thermal anchor, which attaches to the cold heat sink. The support tube material is usually a glass reinforced composite such as G-10, G-10CR, G-11, or G-11CR. The disc and ring were made from stainless steel and aluminum. The selection of the materials and their dimensions must satisfy both the structural and thermal requirements. Nieman et al.[1] provide thermal and structural analysis approaches since design must satisfy both sets of criteria simultaneously. The design analysis determined that the heat loads to 80 K, 20 K, and 4.5 K are 2.103 W, 0.320 W, and 0.015 W

▶ *continues on page 80*

respectively, which met the required heat load budget.

The importance of thermal anchoring for thermal shields in superconducting magnet systems is discussed by Nilles and Lehman.[2] The shield temperature is very sensitive to the effective heat transfer rate between the shield piping interface and the shield. The process lines carrying the coolant are made of stainless steel, and the shield material is a high thermal conductivity material such as aluminum. Factors such as the compatibility of the materials to joining such as welding or brazing, and the differences in thermal contraction usually result in a mechanical attachment. The thermal contact conductance, which is a function of many parameters including the contact pressure, material hardness and surface conditions, becomes the controlling parameter. Reference 2 provides experimental data for two shield material combinations, Al 5083 for the shield and 304L for the piping and Al 5052 for the shield and 30L piping. The data is presented as a function of loading.

An example of the thermal management for a superconducting RF cavity is discussed in Reference 3. A support post for superconducting RF cavities is shown in Figure 2.2, showing the helium cooling line attachment to aluminum heat intercept plates.[3] These are attached to the G-10 support post using an adhesive. Aluminum strips provide a place to attach the 50 K to 75 K thermal shield. Flexible copper braids are used to provide a thermal path to cool the shields in this structure as shown in Figure 2.3.

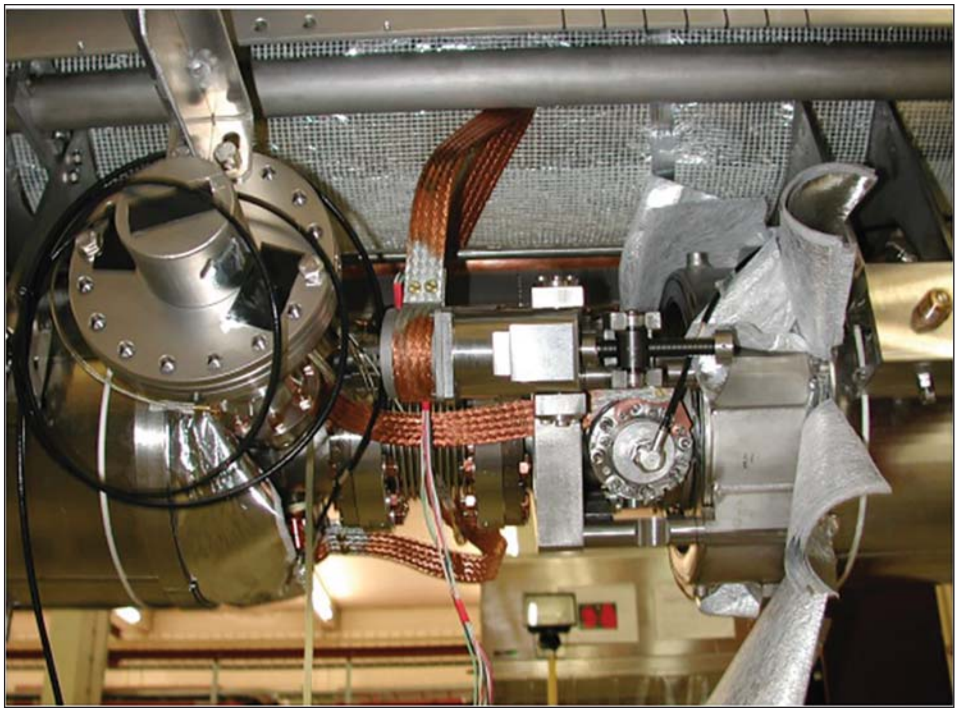


Figure 2.3 Cavity interconnection detail with the thermal anchors of copper braids among cryogen tube, shield and components.[3]

Figure 2.4 (a) Photograph of the installation of an RTD on one of the rigid ends of the inner wall of the cryostat. (b) Photograph of the installation of an RTD on the outside of the superinsulation blanket covering the inner wall of the cryostat. *Credit: Demko*

Thermal Anchors for Cryogenic Sensors And Wires

Cryogenic sensors are also thermally anchored in order to limit heat conduction flow along the sensor leads, which come from a warm connection to the low temperature sensor to increase the *temperature* measurement accuracy at low temperatures.

Instrumentation leads, such as for thermometers, are anchored in several ways. If a thermometer is placed on the outside of a pipe, the leads may be wrapped around the pipe in three or more loops to intercept the heat from the lead wires and provide an accurate temperature reading. There are also mounting fixtures for thermometers that take the form of different types of bobbins, or a carefully designed probe if inserting into a flow.

Anchors for Thermometers

For example, a stainless-steel sheath is used to surround the probe as illustrated in Figure 2.5. The leads would be wrapped around the pipe or run against the cold outer wall of the pipe for sufficient distance to limit lead conduction to the sensor.

A fixture for mounting an external thermometer to measure the temperature of helium flow in a tube in the interconnect between dipole magnets is described by Datskov et al and shown in Figure 2.6.[4] The components of the attachment consist of a thermometer (1) and thermal anchor (2). These are mounted in holes through a stainless-steel plate (3) using thermal-conducting grease (9) to enhance the thermal contact of the sensor. The fixture is clamped on the helium tube (8) with a hose clamp (5) and covered by multilayer insulation (6). During ASST Run #3 this fixture measured the tube temperature to within 0.01 K at 4.4 K from another carbon-glass thermometer mounted nearby in the magnet cold mass in the liquid helium stream. These were also installed on the 20 K and 80 K shields.

An indirect temperature measurement technique, used in the Russian accelerator the NUCLOTRON is presented by Datskov, which was developed to avoid installing thermometers in helium flow lines, eliminating many vacuum feedthroughs reducing the possibility of leaks.[2] The mounting fixture for a helium tube is shown in Figure 2.7. Twisted wires (8) from the hermetic connector at ambient room temperature sink feed into the screw-thermal anchor (9) on the copper plate (6), which is soldered onto the He tube (7). The screw-thermometer (2) measures the temperature of helium tube (7) with a 1-2% error over 4 - 300 K. The thermometer (3) is a TVO and bifilar winding (4) using a special technique for mounting in the screw (2) covered by a copper cover (1). All surfaces are polished and nickel plated.

Thermal Anchors for RF Instruments. Cryogenic anchoring of instrumentation lead wires is another crucial design detail. Batey in Reference 3 and Pagano in Reference 5 separately reported new developments in advance anchor designs in details. Figure 5.19 shows how a RF wiring cartridge will be anchored on multi cold stages.[3] Measuring wires from ambient to working cold mass cause additional heat leak. It is particularly serious when the cooling capacity is very small at ultralow temperatures and/or cooling power is difficult to supply in aerospace applications. Thermal anchoring of wires to heat sinks in cryogenic equipment is required at each intermediate stage.[3,5] Special attention is needed if coax cables are used. Thermal anchoring in large scale applications is quite different compared to ultralow temperature small apparatus. Effective and precise thermal anchoring of wires is mandatory to measure temperature to milli-kelvin accuracy and to avoid unnecessary cooling power due to additional heat conduction. Besides mechanical clamp and solder, special cryogenic epoxies are used with electrically conductive, thermally conductive/electrically insulative, low outgassing approved.

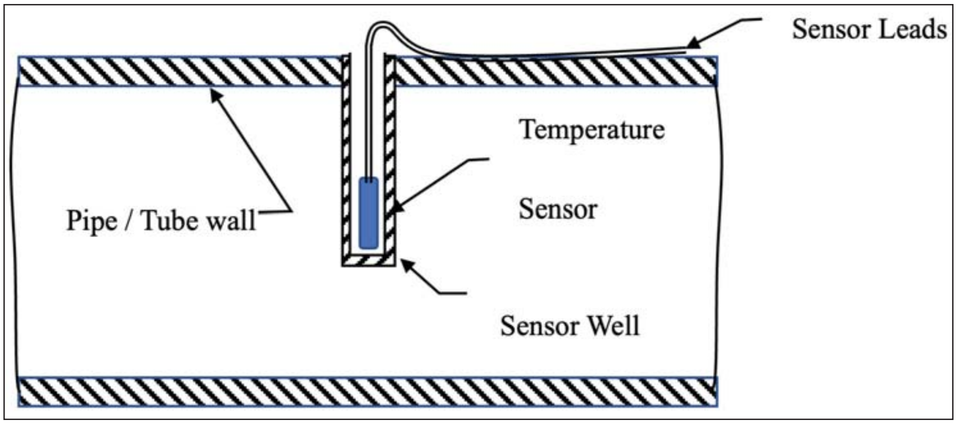


Figure 2.5 Temperature probe inserted in a well. Sensor leads are thermally anchored to the surface of the pipe / tube.
Credit: Demko and Shu

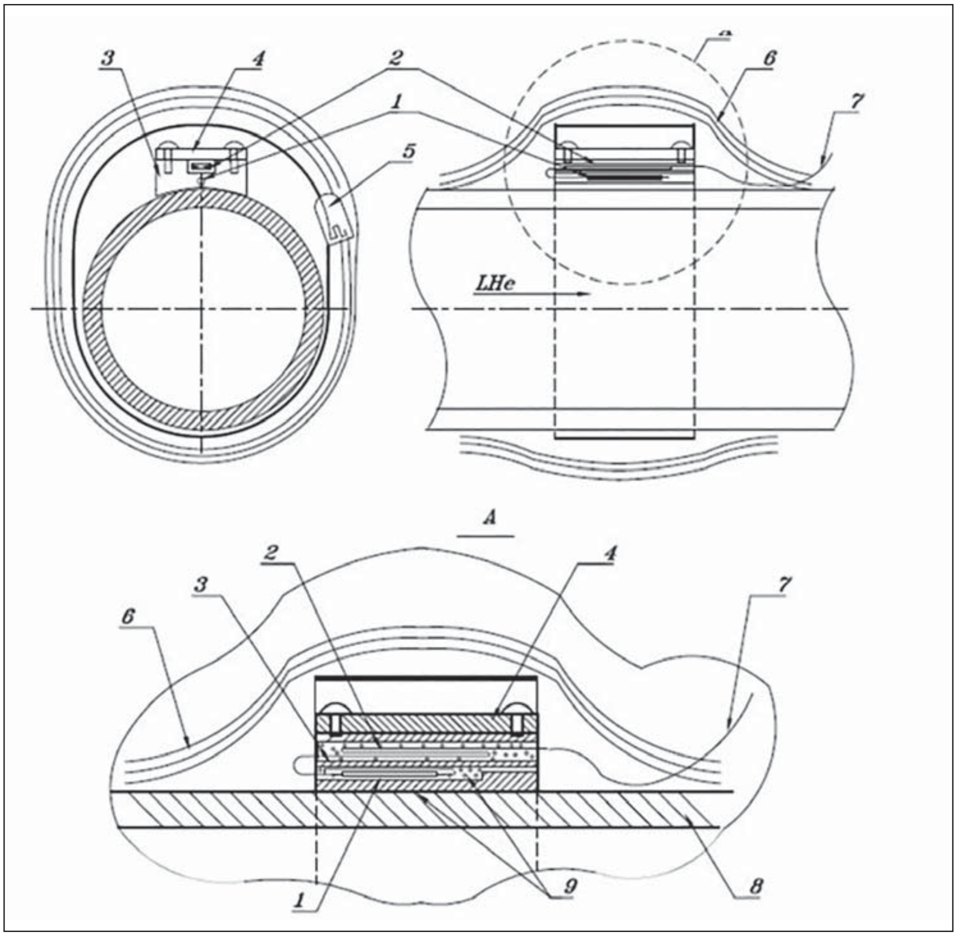


Figure 2.6 Thermometer mounting fixture on helium line.[4]

Thermal Anchors for Current Leads And Superconductor Joints

Current leads bring electric power from room temperature power supplies to devices at low temperatures such as superconducting magnets. The design and operation of current leads have been discussed in another column. The interest here is that the low temperature connections must be in thermal equilibrium with the cold connection. This requires understanding of the heat flow and heat generation at the low temperature joint. For heat-stationed leads, such as those with an intermediate temperature intercept where a high temperature superconducting (HTS) portion is connected to a conventional electrical conductor such as copper, aluminum, or brass, the thermal anchor must provide a stable, sufficiently low temperature at the warm end of the HTS material to prevent the HTS from becoming a normal conductor and burning out. But there is the additional requirement of electrical isolation from the heat sink. For typical superconducting magnets this electrical isolation is fortunately at low voltages. Recent developments in high temperature superconducting (HTS) power introduces additional complications in that the operating voltages will be greater than

10 kV. Proper size (area) for removal of the lead heat is needed.

A low thermal resistance, high electrical isolation heat intercept design was discussed by Nieman et al.[6] The heat transfer along a conventional upper stage lead is intercepted at the transition to the lower stage high temperature superconducting lead. The electrical insulating tube was made from an epoxy/fiberglass material similar to G-10. The wall thickness of 0.43 mm is based on the 8500-V breakdown requirement and fabrication considerations of machinability. The disc and ring are electrolytic-tough-pitch copper. The nominal disc/ring/tube diameter is 0.064 m. The ring is 0.070 m long and 0.0127 m thick. The thermal resistance as a function of the average tube temperature were measured to vary from 0.0068 m^2 K W^{-1} at 54 K to 0.0028 m^2 K W^{-1} at 119 K.

Summary

Thermal anchors are where the connection is made to remove heat from a cold object. This must be achieved with a minimal temperature drop to the refrigeration or coolant source. This often requires careful consideration of several factors including material compatibility, surface area and contact pressure. Some examples have been presented for typical cryogenic system applications.

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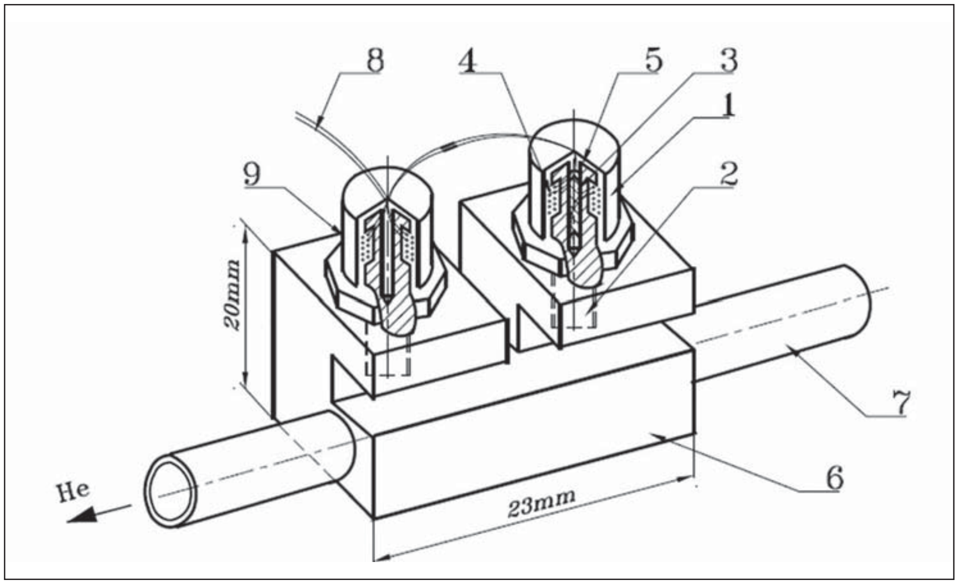

Figure 2.7 Thermometer mounting fixture on external surface of helium cooling tube.[4]

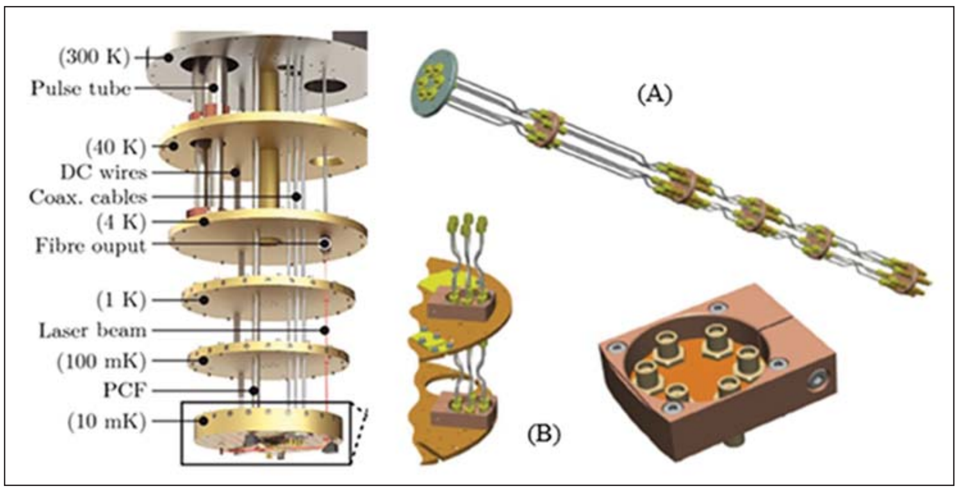

Figure 2.8 Framework of a dilution refrigerator: (A) RF wiring cartridge with hermetic feedthroughs from 300 K to 10 mK; (B) Split clamps to thermal anchor the cartridge.[5]

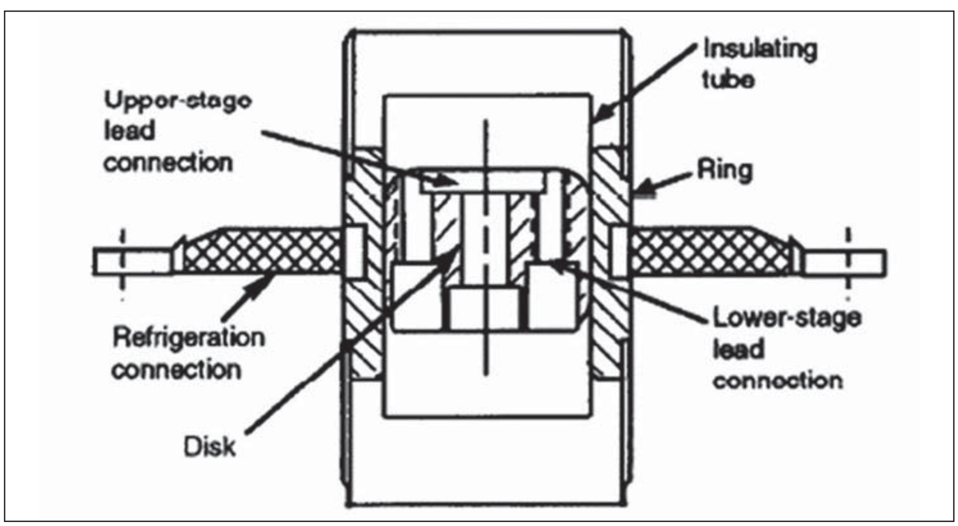

Figure 2.9 A low thermal resistance, high electrical isolation heat intercept design was by Nieman et al.[6]

by James E. Fesmire, President, Energy Evolution LLC, james@321energy.us

Cryogenics, Energy Storage and Electricity

Electricity and exergy: Paying attention to thermodynamics makes us smart but trying to avoid thermodynamics makes us dumb, broke and dead-ended. Electricity is at the heart of the cleaner use of energy and cryogenics is a key part of this energy transition. Why is that? Energy density means energy storage and cryogenics is in the middle of making it all work, particularly for the end-use applications. Electrical uses of many kinds require batteries beyond what regular batteries (Li-ion) can provide. Cryogenic batteries are infinitely scale-able and lightweight: 1) cryogenic battery of liquid air and 2) cryogenic battery of liquid hydrogen. Cryogenics makes it possible to store-up energy and later use it as needed to provide electricity and is, therefore, the lifeblood of electrification and the energy transition.

The burning of fuels, for electricity and even for heat, is becoming an anachronism for most applications. And, it needs to become an anachronism for the energy transition to succeed. The reason is thermodynamics and the second law: about two-thirds of the energy from the burning of fuels is wasted as heat.[1] Waste heat can be thought of, in simple terms, as entropy. Exergy on the other hand is the energy available to do real work. Electricity is nearly pure exergy and can provide work without the massive loss of energy to waste heat.

The world's "fossil fuel" energy consumption was about 500 exajoules (EJ) in 2023.[2] To replace this fuel with renewable energy, only about 335 EJ is required. Comparing the two categories of energy sources in the other direction, as is often done, in terms of heat value rather than exergy, is highly misleading and plainly incorrect in light of the electrification and electrotechnology developments underway. To compare energy sources based on heat value (two-thirds of which is required to be paid to the court of the 2nd Law of

Rendering of a 50MW / 300MWh liquid air energy storage plant in Manchester, UK. *Credit: Highview*

Thermodynamics), heat and work (or electricity) have the same units but do not have the same value.[3] Just think of joules and jewels, or $ and $$$, respectively. The world is going more electric, not the other way around, so let's look at some examples of cryogenic batteries.

Cryogenic battery #1 – Liquid air for long-term energy storage as part the modern electrical grid. Off-peak energy, energy uncaptured due to curtailment, or otherwise wasted energy is used to liquefy air which is kept in cryogenic storage systems for later use in spinning turbines to generate electricity. Highview Power, following successful pilot projects, is set to commission a 50 MW plant with 300 MWh of storage in Manchester UK (shown in Figure 1) in early 2026.[4] Four larger 2.5 GWh plants are planned by 2030 to set a pathway for 16 more plants by 2040. By capturing excess power and releasing it back at peak demand, the technology provides substantial reduction in gas consumption and higher stability in the critical electrical grid.

Cryogenic battery #2 – Liquid hydrogen supplying gas to hydrogen electric cells (aka "fuel cells" – a terrible and misleading name because there is no fuel burning!). Hydrogen electric cells (HEC) range from small portable devices to large plants. Electricity is made directly from the electrochemical combination of hydrogen and oxygen molecules (with nothing burning and no moving parts!). Although gaseous hydrogen is fed to the cell, it is *liquid* hydrogen that is required to provide scalable, lightweight batteries for applications more demanding than, for example, a small vehicle like a Toyota Mirai. Ballard recently launched production of its 9th generation HEC for mobility, the FCMove shown in Figure 2, which provides up to 75 kW in a simplified, modular package for city bus applications.[5] Construction of the Gyeongju Gangdong Hydrogen Fuel Cell Power Generation plant began in South Korea this year and is planned to generate 108 MW by 2028.[6]

Nonrenewable energy or so-called "fossil fuels" such as petroleum, natural gas, or coal make electricity as follows: Burn Fuel > Make Steam > Spin Wheel > Generate Electricity or just Generate Electricity. And nuclear power is the same process where the fuel is enriched uranium. For renewable energy, the process is as follows: Spin Wheel > Generate Electricity or just Generate

Electricity where it is then put into the grid (and some batteries). Hydrogen can be produced from excess renewable energy and load balancing and then liquefied to provide cryogenic batteries at all scales. Hydrogen is used to make electricity as follows: Hydrogen > Electricity. It doesn't get more direct than that. Liquid hydrogen provides the necessary energy for mobility equipment that requires more than about 50 kg of hydrogen. Liquid hydrogen also ensures that the hydrogen is absolutely pure to not degrade the life of the HEC. LH_2 is scalable, for example, to 860 terajoules of electrical energy equivalence in a single 100,000 m3 (26 million gallon) tank.

Cryogenics may or may not be at the beginning or the end of the energy chain, but it serves a crucial role for many steps along the way. Cryogenics, energy storage and electricity all go together for a better and cleaner energy future.

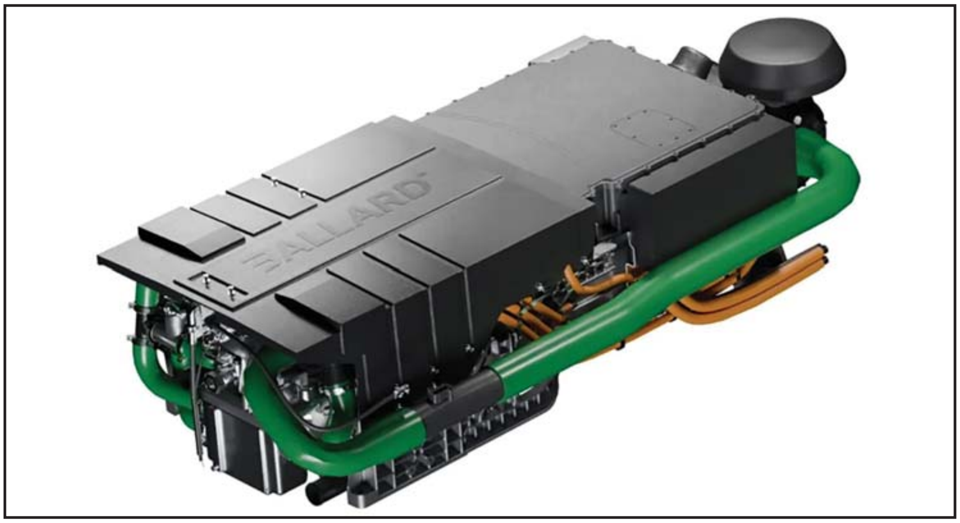

Figure 2. Hydrogen electric cell for city buses. *Credit: Ballard*

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Cryo Bios

by Dr. John Weisend II, European Spallation Source ERIC, CSA Chairman, john.weisend@ess.eu, and
Anne DiPaola, ***Cold Facts*** Editor

Russell Burton Scott

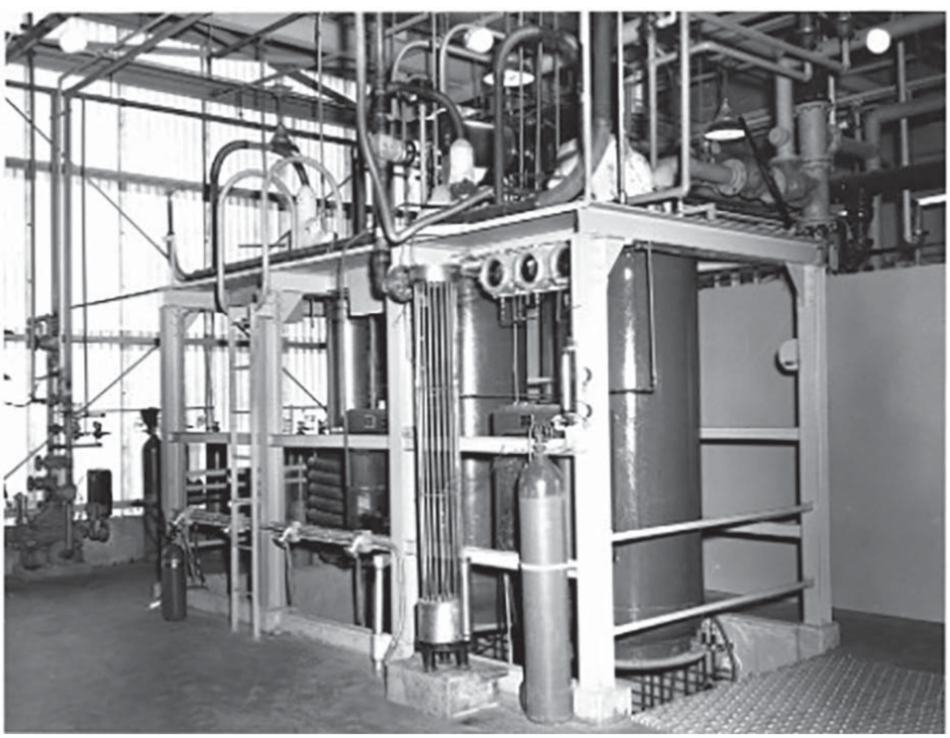
Russell Scott was a prolific cryogenic researcher and manager who made important contributions to large scale liquid hydrogen production, thermometry and cryogenic engineering and led the National Bureau of Standards (NBS) cryogenics laboratory for many years. He helped found the Cryogenic Engineering Conference and wrote one of the first textbooks in cryogenic engineering.

Scott was born in Ludlow, Kentucky in 1902 and attended the University of Cincinnati and University of Kentucky where he earned his Bachelor's (1926) and Master's (1928) in Physics. Shortly after graduation he took a position in the Low Temperature Section of the National Bureau of Standards, then located in Washington D.C. There he worked on a variety of fundamental topics in cryogenics, including early work on the thermodynamic properties of liquid hydrogen and on ortho-para conversion in hydrogen. During the Second World War he researched properties of uranium compounds as part of the Manhattan Project. In 1948 Scott was promoted to Leader of the Low Temperature Section of NBS.

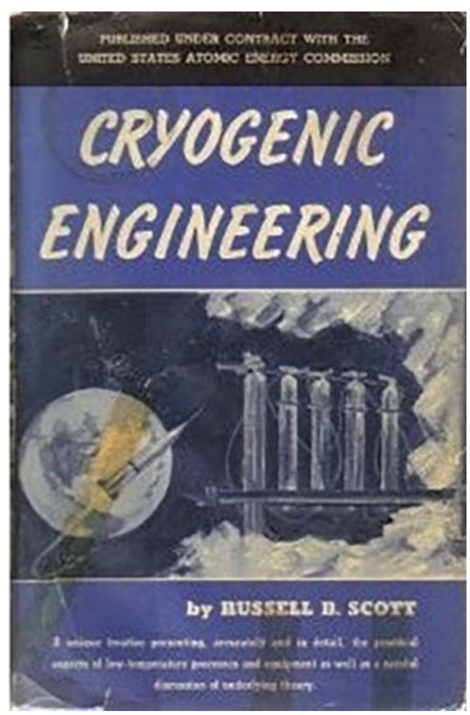
In the early 1950s the United States expanded its program to build a fusion (hydrogen) bomb. The choice of fuel for these early weapons was deuterium, an isotope of hydrogen in liquid form. It was clear that success required a strong understanding of liquid hydrogen: its production, storage and transport, along with the associated techniques of cryogenic engineering. The Atomic Energy Commission (AEC), responsible for the hydrogen bomb project, chose the NBS to carry out this research and development. The NBS in turn established a new Cryogenic Engineering Laboratory (CEL) in Boulder, Colorado and appointed Russell Scott to lead this facility.

Early work in this area included the design and construction of three hydrogen liquefiers (Image 1) and liquid hydrogen (deuterium) transport dewars. One of the liquefiers was sent to the South Pacific for the first hydrogen bomb test. Not long after the first successful hydrogen bomb test in November 1952, the bomb design changed to using solid lithium deuteride as a fuel. This meant that cryogenic fluids were no longer required and as a result the AEC removed all its funding from the Cryogenic Engineering Laboratory.

In response to this, members of the laboratory organized a conference on



NBS-CEL hydrogen liquefier #2 inside its metal dewar, along with the associated refrigeration drier and adsorption purifier. Liquefier #1 is identical. *Credit: NIST Digital Archives*



Cover of R.B. Scott's Cryogenic Engineering (1959)
Credit: R. Radebaugh

cryogenic engineering to showcase the CEL's expertise in cryogenic engineering and to help attract funding. The Cryogenic Engineering Conference was held in Boulder in 1954. This was the first in an ongoing series of conferences now held every two years in odd years https://www.cec-icmc.org/2025/ which are one of the two major regular conferences in cryogenic engineering. The first two conferences were held in Boulder. In 1960 the Cryogenic Engineering Conference established an award for the best paper presented at the conference and named it the Russell B. Scott Award. This coveted award is still given out every two years (https://www.cec-icmc.org/2025/cec-russell-b-scott-memorial-award/).

The CEL was able to gain additional government funding and it and its successors have had a long history of innovations and contributions to cryogenics in areas such as properties of cryogenic fluids, solid properties, superconductivity, space propulsion, liquid hydrogen thermometry and small cryocoolers. The Boulder laboratory remains an important center for cryogenic research.

In 1959 Scott published the book *Cryogenic Engineering* (Figure 2). This book, based largely on the experiences at CEL, represented the first time that all the existing principles and practices of cryogenic engineering were gathered together. For many people this was their first textbook in the field and remains well worth reading. He was also the co-editor of the book *Technology and Uses of Liquid Hydrogen* published in 1964.

Scott was promoted in 1963 to manager of all the NBS Boulder Laboratories, including the Radio Propagation Laboratory. He kept this position until 1965 when he returned to the Cryogenics Lab as a consultant. Among Scott's many honors were being awarded the Dept. of Commerce's Gold Medal for Service twice and a third Gold Medal by the Department of Commerce for exceptional leadership and authorship in the field of cryogenic engineering. He was a Fellow of both the American Physical Society and the American Association for the Advancement of Science.

Who's New in the **Cold Facts Buyer's Guide?**

The Cold Facts Buyer's Guide is the place to find suppliers in every area of cryogenics and superconductivity. These are our new Corporate Sustaining Members and suppliers added to the Buyer's Guide since the last issue of the magazine. Find it online at ***csabg.org***.

NanoFEA, LLC

NanoFEA is a manufacturer of state-of-the-art getter technologies and materials for use in many applications including cryogenic applications and NEG replacement.

*TriSeas International, Inc.

TriSeas Energy is a cryogenic machinery service provider with service facilities worldwide. Partnering with a wide array of cryogenic experts, the company services all brands of cryogenic pumps, cryogenic turboexpanders, and cryogenic safety valves.

*CSA CSM

Cryotreatment

by Jack Cahn, Chief Technologist, DCI, jack@deepcryogenics.com

Cryogenic Treatment Standards, Testing and Certification

In previous columns, we explored the science of cryogenic treatment (CT), examined the current state of the industry and surveyed types of CT chambers. Now we turn to the primary barrier preventing widespread adoption of cryogenic treatment: the absence of standards for manufacturing, processing, testing and certification.

On the hot side of thermal treatment, heat treaters have successfully commercialized their services through established quality systems that demonstrate:

1. Equipment is built to recognize safety and quality standards.

2. Processing follows defined industry procedures to achieve predictable results.

3. Testing verifies application of each thermal process and documents such proof.

4. Certification confirms compliance with documented data-based standards.

Collage of UL, CE, CSA and ETCSA images. *Credit: Jack Cahn/ETCSA*

Cyclones. *Credit: Jack Cahn/DCI*

Equipment

"Classification rules and standards ensure the safety, reliability and quality of processes and products. Rules and standards also provide a foundation for creating products that conform to certain specifications and are compatible with products provided by different suppliers seeking the same quality, performance and interchangeability" (Class guideline, DNVGL-CG-0197, edition November 2017).

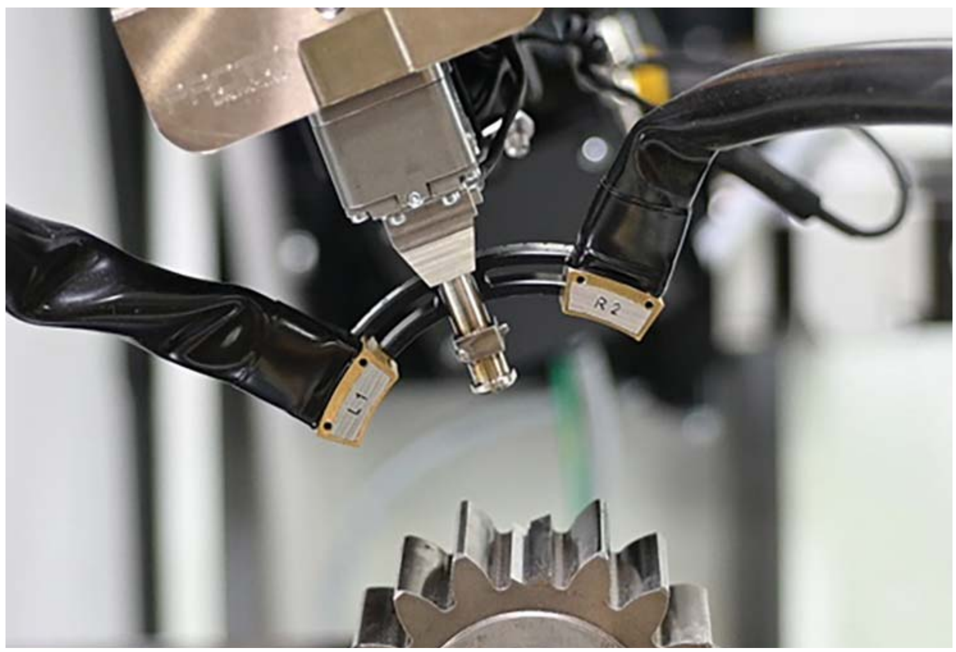
Commonly, thermal treatment equipment used by heat treaters meets UL and CSA electrical requirements, ASTM B51 boiler and pressure vessel specifications and AMS 2750 pyrometry standards. Engineering design and new furnace approval is crafted using a validation master plan and third-party qualifications. Country-of-origin stamps (Made in USA, Product of Canada, CE stamp) authenticate content. OSHA standards help reduce risk, ensure safe operation, provide legal compliance and mitigate hazards.

On the cold side, CT chambers can be manufactured to easily meet these same standards. The limitation is not technical, it is economic. Until demand grows, chamber production remains confined to small-scale handcrafted builders. As adoption rises and consumers require engineering and quality approvals, existing furnace manufacturers (box, pit, I/Q) will likely take over, bringing the same platform of engineered safety, compliance and quality practices to CT chamber design.

Processing

Unlike heat treatment, which has evolved over 8,000 years, cryogenic treatment is relatively new (under 70 years). As a

Proto Mxrd. *Credit: Proto Mfg.*



XRD of gear tooth. *Credit: Proto Mfg.*

result, no universally accepted CT processing standard exists. Key challenges include:

- Process dependency: CT effectiveness varies with alloy composition, prior heat treatment and failure mode

- Custom applications: Because no single CT recipe applies to all alloys, heat treaters often rely on specialized tribal knowledge developed within their facility

Most CT recipes are fairly similar (ramp down, low temp dwell, ramp up, temper) but the trigger mechanism and temperature to achieve toughness, added wear life, corrosion resistance or increased conductivity vary significantly among carbon and tool steel alloys, iron castings, carbide, aluminum and titanium. Although artificial intelligence, computer modeling and PID controllers will accelerate testing to correlate a CT process against predicted results, it will take extensive R&D while developing an AMS or ASTM CT standard to create go-to processing recipes that form a CT chapter within the ASM Heat Treater's Guide (military spec Mil-H-6875).

Testing

Few heat treaters possess in-house tools to verify CT applications or quantify improvements. Most heat treaters do not use quantitative methods (such as statistical testing, proxy coupon or model-based verification) to validate CT applications. Currently, customers rely on the service provider's word and a receipt or certificate as anecdotal proof of treatment. Since automotive, aerospace, power, oil and gas and mining all require test validation (such as NADCAP, ISO, API and MILSTD) and certification for part acceptance, the introduction of testing and validation coupled to end-item certification is essential for CT adoption.

Unlike heat treatment, which relies on the commonly accepted ASTM E18 Rockwell hardness test to measure increased hardness, E18 neither correlates positively nor negatively when parts have been cryogenically treated. Ideally, heat treaters need a reliable and accurate nondestructive test that measures changes resulting from CT in all classes of metallic materials that is ready for field use, available at reasonable cost and simple to operate. Could this test detect mechanical property improvements resulting from related surface treatments like shot peening, welding, hardfacing or cladding? Could it also measure nonvisual defects and be reliable as a failure analysis forensics tool?

This grand slam capability actually exists in X-ray diffraction (XRD) technology. Manufacturers like Proto, Stresstech and Rigaku produce portable XRD units that precisely measure residual stress, making them ideal for validating CT results.

XRD is a highly accurate means of characterizing residual stress in both surface and subsurface locations, making it a match to CT's through-core process in reducing vacancies, aligning interatomic spacing, precipitating micro-carbides and reducing both fatigue crack initiation and propagation. XRD can detect flaws and inclusions in cast and forged items, shifts in crystallographic planes, measure reduction in retained austenite and recognize phase change. It can also detect improvements in compressive stress caused by complementary processes like shot peening.

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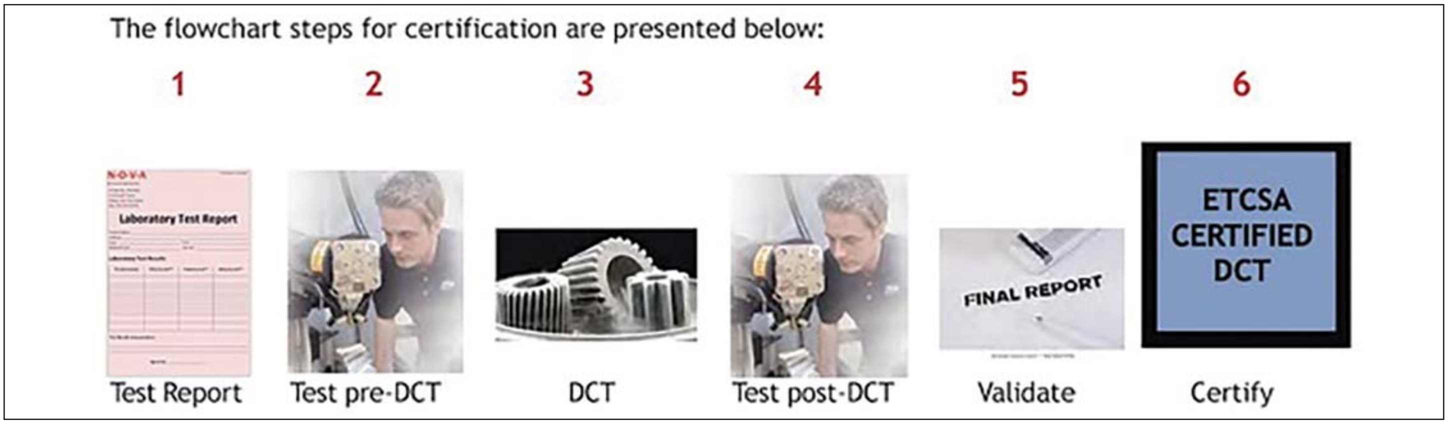


Flowchart. *Credit: Jack Cahn/DCI*

XRD testing can therefore validate CT effectiveness, confirm process application, reduce risk by detecting flaws and chart improvements to enhance part longevity.

Certification

The last step is certification: providing proof to a third-party customer, not present during cold thermal treatment, that an item has met the standards of test and validation. Luckily for heat treaters, there is no reason to reinvent the wheel.

In 1971, the Society of American Engineers published and approved a manufacturing, quality, test and safety standard for the automotive industry. Called SAE J784A, it details and advances residual stress measurement by XRD. In 2012, ASTM published E2860-12 Standard Test Method for Residual Stress Using XRD. Both standards are used extensively in aerospace, energy, medical and industrial products to ensure manufacturing quality, measure thermal treatment improvement and reduce risk.

By integrating recognized test and certification methods, the heat treat community can finally bridge the gap, bringing CT under the same framework that established conventional heat treatment as a trusted industrial process.

In our next column we will explore new and emerging opportunities for cryogenic treatment, particularly in markets yet to be tapped by the heat-treating industry .

Calling Women in Cryogenics and Superconductivity

Join us for our annual feature in ***Cold Facts*** as we honor the remarkable contributions of women in cryogenics and superconductivity. Seeking fresh perspectives and untold stories, we invite women who are yet to be included to share their insights.

Are you a trailblazer or know someone breaking barriers in these fields? Contact our editor, Anne DiPaola (editor@cryogenicsociety.org), to receive an applicant questionnaire. Return your responses and a headshot by January 16 to be featured in our March 2026 issue.

Help us widen the scope! Spread the word and encourage deserving women in cryogenics and superconductivity to step forward. Together, let's spotlight the innovation and impact of these remarkable individuals.

Your story matters. Join us in celebrating the brilliance of women shaping the future in cryogenics and superconductivity for generations to come!

Product Showcase

This Product Showcase is open to all companies and related manufacturers offering new or improved products for cryogenic applications. We invite companies to send short releases (150 words or fewer) with high-resolution JPEGs of their products to editor@cryogenicsociety.org.

DELTA Modular Liquid Hydrogen - Series 4

Duron Cryogenics

Duron cryogenics high-pressure, modular pump assemblies—the 4DM3-88H and 4DM3-100H—utilize specialized designs and materials for liquid hydrogen service. A key feature is the full-floating –3 titanium suction valve plate, which reduces moving mass and improves valve dynamics. The 88 mm and 100 mm fluid ends do not use plate springs, as testing of various spring configurations showed that springs performed only marginally well within narrow operating conditions. In contrast, the full-floating valve plate design delivered increased performance across a wide speed range. All dynamic soft materials are sourced specifically for LH_2 service. The 4DM3-88H achieves 6000 PSI at 2.1 PPS with a volumetric efficiency of 0.88 at 900 RPM, while the 4DM3-100H operates at 4000 PSI and 2.73 PPS with the same volumetric efficiency and speed. Duron cryogenics products are designed, engineered, sourced, and manufactured in the United States of America. **pdduron@roadrunner.com**

Cryogenic HV3 Shipping System

Cryoport

Cryoport has launched its Cryoport Express® Cryogenic HV3 Shipping System, designed specifically for high-volume transport of ultra-low-temperature payloads in life-sciences cold chains. The HV3 system features a rectilinear enclosure designed for current and future airline regulations, an integrated mobility design with wheels and handles, and state-of-the-art monitoring and risk mitigation features to ensure secure transit of biologics or research materials. This system enables organizations to scale their cold-chain logistics with full compliance and visibility into payload condition through the supply chain. **www.cryoport.com**

Vacuum-Insulated Transfer Lines

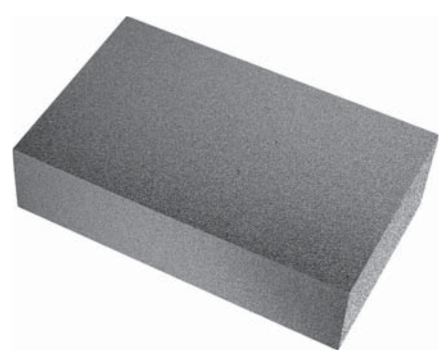
Nexans

Nexans has expanded its portfolio of vacuum-insulated cryogenic transfer systems, offering high-flow, multilayer vacuum-insulated piping solutions for liquefied nitrogen (-196°C), liquefied hydrogen (-253°C) and helium (-269°C) between storage tanks and point-of-use. These vacuum-insulated cryogenic lines reduce thermal losses and facilitate long-length transfer for hydrogen infrastructures, superconducting cable systems and other high-flow cryogenic fluid applications. By combining high vacuum insulation with multilayer reflectors the solution delivers improved thermal efficiency and supports next-gen cryogenic architectures. **www.nexans.com**

FOAMGLAS® ONE™

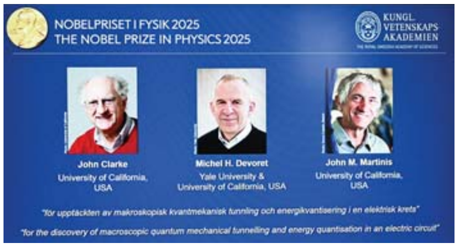
Owens Corning

Owens Corning has introduced its advanced cellular glass insulation products for cryogenic systems in industrial gas, LNG, and research applications. Their FOAMGLAS® ONE™ insulation provides robust thermal control and enables system designers to maintain ultralow temperatures (often below -150°C) with reduced heat ingress and improved operational stability. The insulation is suited for vacuum-jacketed piping, tanks and cryogenic containment where long-term performance and safety are critical. With this offering, Owens Corning supports high-performance cryogenic installations in energy, aerospace and scientific markets. **www.owenscorning.com**



People & Companies in Cryogenics

John Clarke of **UC Berkeley**, **Michel H. Devoret** of **Yale University** and **John M. Martinis** of **UC Santa Barbara** were jointly awarded the 2025 Nobel Prize in Physics for their groundbreaking discovery of macroscopic quantum mechanical tunneling and energy quantization in electric circuits. Through experiments in the mid-1980s,



Recipients of the 2025 Nobel Prize in Physics. Credit: Royal Swedish Academy of Science

they demonstrated that superconducting circuits known as Josephson junctions could display quantum behaviors—such as tunneling and discrete energy levels—at a visible, macroscopic scale. Their work proved that quantum mechanics governs not only atomic particles but also engineered systems containing billions of electrons, bridging the classical and quantum worlds. This discovery laid the experimental foundation for quantum sensing and today's superconducting qubits that power modern quantum computers.

....

Kim Povlsen has officially stepped into his new role as Chief Executive Officer of **Bluefors** to lead their global team of 700 employees in delivering industry-leading cooling systems for quantum technology. He joins Bluefors from Universal Robots A/S, where he served as President and CEO. As global investment and research into quantum technology accelerates, the demand for scalable, reliable cryogenic infrastructure is greater than ever. Under Kim's leadership, Bluefors will increase the pace of innovation, continue to drive the industrialization of quantum cooling, and deepen collaboration with partners worldwide.

....

SemiQon and **VTT** have received top honors from the European Association of Research and Technology Organizations (EARTO) in the Impact Expected category for their breakthrough in cryogenic CMOS chip technology. The collaboration has achieved full CMOS functionality at cryogenic temperatures, a critical milestone for scaling quantum computers and enabling advanced space applications. By making traditional semiconductor technology operate efficiently at low temperatures, the project bridges the gap between conventional electronics and quantum systems. SemiQon and VTT's innovation will accelerate the development of practical quantum processors and inspire further integration between European research and industry in the quantum sector.

....

Researchers at the **U.S. Department of Energy's Ames Laboratory** have identified a new "quantum echo" effect in superconducting materials using precise terahertz-pulse excitation. The phenomenon shows that quantum information can be encoded, stored and retrieved directly within the superconducting state, revealing previously unseen dynamics of electron pairing. This discovery opens new possibilities for quantum memory devices and for understanding how coherence can be maintained in practical systems. By exploring the connection between material structure and quantum behavior, the Ames team has provided valuable insight into how superconductors can be engineered for information storage and processing in next-generation quantum technologies.

....

ICAS, the Italian consortium specializing in superconducting cables, has been awarded the Fusion Technology Transfer Award by **Fusion for Energy** (F4E) in recognition of its successful transition of superconducting Cable-In-Conduit

One of the ITER Toroidal Field coils during winding at ASG Superconductors, using the conductors by ICAS. Credit: ASG

Conductor technology—originally developed for fusion magnets—into broader industrial markets. The award highlights ICAS's investment in advanced production lines and quality sub-processes such as precision wire cabling and stainless steel tube welding, which enabled it to supply over 100 km of conductor to major fusion projects. With this recognition ICAS affirms its position at the intersection of superconductivity and industrial application and will leverage its achievement to further drive scale and reliability in high-field magnet systems.

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Meetings & Events

24th International Cryocooler Conference
June 15-18, 2026
Syracuse, NY
https://cryocooler.org

ICEC 30/ICMC 2026
June 22-26, 2026
Daejeon, Korea
https://icec30-icmc2026.org/

Cryogenic Engineering and Safety Annual
5-Day Course
August 3-7, 2026
Golden, CO
https://cryocourses.com/

Applied Superconductivity Conference (ASC)
September 6-11, 2026
Pittsburgh, PA
www.appliedsuperconductivity.org/asc2026

Korea Cryogenics has officially appointed **Choi Jun-young** as Chief Executive Officer, overseeing the parent company and its subsidiaries in Pyeongtaek, Songsan and Osan. Choi brings more than 30 years of experience in logistics and leadership roles at global firms including DB Schenker, Agility and most recently LF Logistics Korea and Maersk Contract Logistics Korea. At his inauguration he emphasized the company's evolution from a vaccine-cold-storage pioneer to a renewable-energy-driven ultralow temperature logistics leader. Under his leadership Korea Cryogenics will build on its LNG-cold-energy warehouse and hydrogen fuel cell infrastructure to become the absolute leader in the domestic cold-chain market.

....

Valcor Engineering Corporation has opened a new in-house Vibration Laboratory to expand its environmental testing capacity. Known for its cryogenic solenoid valves and precision fluid controls, Valcor's new lab provides 3-axis vibration testing, active flow-through capability, and thermal conditioning of units under test. The facility allows the company to accelerate component qualification for aerospace, nuclear and scientific applications, many of which involve cryogenic conditions, while reducing reliance on outside test facilities and shortening production lead times.

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