



Cryogenic Treatment Equipment

In previous columns, we explored the science behind cryogenic treatment (CT) and examined the current state of the industry. In this column, we'll take a look at who uses cryogenic treatment equipment and the types of chambers available.

CT equipment is used primarily by three groups:

1. Heat treat facilities
2. DCT service providers
3. Single industry users

Heat treaters commonly perform processes such as austenitizing and quenching, carburizing, and nitriding to improve mechanical strength and durability. Metal parts are typically processed in batches using racks or preload trays. For cryogenic treatment (CT) to be effectively integrated—aimed at reducing retained austenite and minimizing residual stress from heat treatment—it must allow for rapid, preferably automated, part transfer with minimal manual handling. Most heat treaters already use nitrogen gas as a shielding agent in ovens and maintain on-site supplies in vacuum jacketed liquid nitrogen (LN₂) dewars. As a result, the cost of implementing deep cryogenic treatment (DCT) is relatively low for these operations. Additionally, because LN₂ expands 700x when converting from liquid to gas at -320°F, it serves a dual purpose in many heat treat facilities.

Heat treaters often use rectangular “coffin-style” modified deep freezers for cryogenic treatment, tailored to fit their operational needs. They typically prefer to perform post-cryogenic tempering in their existing heat treat ovens. This approach provides redundancy in capacity while ensuring compliance with AMS 2750—a standard that governs the control, testing, quality and processing of heat-treated metal components in the aerospace industry. However, many cryogenic treatment chambers, including their electrical systems and manufactured



Rectangular cryogenic treatment chamber. Credit: Jack Cahn

components, do not meet UL/CSA safety certifications or the AMS pyrometry equipment standards. Currently, there are no industry-wide AMS- or SME-recognized quality standards or certification requirements specifically for cryogenic treatment.

DCT service providers typically offer cryogenic treatment as a supplementary service rather than as part of a full heat treatment operation. They cater to individuals or organizations specifically seeking local cryogenic processing. Because post-DCT tempering is essential to completing the treatment cycle, and these providers often lack dedicated tempering ovens, they tend to favor DCT chambers capable of performing both cryogenic and tempering functions. This minimizes part handling and allows for unattended operation. Most service providers purchase bulk LN₂ on a per-cycle basis, making low LN₂ consumption crucial to maintaining competitive pricing. Due to limited material handling infrastructure, they also generally prefer manual loading of smaller parts.

Single-industry users are specialized manufacturers who have identified

substantial performance gains from cryogenic treatment and use it to gain a competitive advantage. This group includes knife makers, brake rotor and gear manufacturers, machine shop tooling OEMs, firearms producers, motorsport engine builders and audiophiles. They typically invest in cryogenic chambers that accommodate dense loading of their specific part geometries, such as knife blanks, brake rotors or gun barrels, while prioritizing ease of use and operational efficiency.

The two most common designs of cryogenic treatment chambers are rectangular and round.

1. Rectangular machines

A variety of rectangular chamber options are available for shallow and deep cryogenic treatment, commonly used in motorsport, tool and die, machine shop, firearm and audio applications. Readers can find suppliers listed in the cryogenic treatment category of the CSA Online Buyer's Guide. These units are not designed to temper parts and require an additional tempering oven to complete the full DCT cycle.

DMP CryoSystems manufactures both square and rectangular chambers that can heat treat up to 1,200°F and perform DCT down to -300°F. Most machines monitor internal chamber temperature using one or more type T thermocouples. High-quality systems use a PLC connected to an onboard proportional-integral-derivative (PID) or fuzzy logic controller to adjust LN₂ flow in real time, compensating for minor temperature variations with precision.

Most rectangular cryogenic machines are insulated with polyurethane blocks or foam, operated via a PLC and powered by 110/220V single-phase electricity. They are engineered to deliver convective heat exchange at a controlled rate of up to 1.5°F per minute, cooling from ambient temperature down to approximately -300°F. These machines can accommodate payloads up to 2,500 pounds and are typically loaded manually with an automotive hoist or via an overhead gantry. Because heat treaters primarily use rectangular machines to reduce retained austenite in ferrous materials—a process that occurs above -120°F—this design allows for efficient LN₂ usage while achieving the desired goal.

Deep Cryogenics International specializes in manufacturing large, industrial-scale rectangular DCT chambers designed for heavy-duty applications in mining, road construction and energy sectors. These chambers are built to handle payloads ranging from 10,000 to 30,000 pounds, with a volumetric capacity of 8 feet by 8 feet by 20 feet. Parts are loaded via forklift onto fixed rollers, offering a setup comparable to the car bottom furnaces used by industrial heat treaters. Tempering is provided by propane or electric auxiliary heaters. The chambers are insulated with six layers of polyisocyanurate, separated by vapor barriers, and operate across a thermal range of -280°F to 250°F. They comply with CSA, UL, EU and OSHA standards, feature external nitrogen gas venting for safety and are third-party inspected and certified.

2. Round machines

Round CT chambers are truly in a class of their own. Their cylindrical shape allows for even distribution of pressure and compressive forces across all surfaces—since curved surfaces act like segments of

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12,000 lb payload inside the Deep Cryogenics 36 K industrial DCT chamber. Credit: Jack Cahn



Forklift loading parts into the Deep Cryogenics 36 K industrial DCT chamber. Credit: University of Alberta

spheres—making them structurally very strong. The double-walled, vacuum-insulated units require no foam or urethane insulation. They are 10 to 25 times more effective at reducing heat transfer compared to non-vacuum insulated polyurethane machines, making them the most LN₂-efficient CT chamber design available.

Constructed from stainless steel, round chambers feature a hinged foam lid over the loading zone, which serves as the only thermal bridge. They offer in-situ tempering powered by a 220V electric heater, operate via a straightforward PLC/PID control system and come in three sizes. The upside of high-quality construction without insulation degradation is balanced by the need for material handling in the large size machine, which is simply too tall and deep to manually load without a support structure and gantry or preload cages. Applied Cryogenics Inc. is the only known manufacturer of round, vacuum-insulated chambers in the world, with sales, leasing and distribution handled by Deep Cryogenics International. Both the rectangular and round machines are mounted on wheels for easy mobility on the shop floor.

Limited awareness and adoption of cryogenic treatment remain the main barriers to equipment cost reduction and availability. Nearly all machines are handcrafted, with no economies of scale, resulting in delivery times ranging from 10 weeks to 6 months. Smaller DCT machines typically cost between \$40,000 and \$120,000, while industrial-scale units range from \$620,000 to \$740,000. Unlike heat treat ovens—which begin to degrade from heat exposure after their first use—cryogenic treatment chambers have a lifespan of 10 to 30 years, due to both their lack of moving parts and the absence of high temperatures that can damage insulation and compromise safety.

In our next column, we will explore the major challenge hindering widespread adoption of cryogenic treatment across industries: the lack of standardized testing, certification and acceptance protocols. 🧊



ACI round CT chambers (CP200 and CP1200). Credit: Jack Cahn



1,500 lb payload in the CP-1200. Credit: Jack Cahn