CHART
Cooler By Design

Howden
A Chart Industries Company

Process solutions for the nuclear industry

Enabling efficient performance and safe operations within traditional and emerging nuclear processes

chartindustries.com/nuclear

Nuclear energy is a vital part of a carbon free future. Howden and Chart are **key technology partners** to both traditional and emerging process designs

Building on more than a century of technical innovation and outstanding customer service, we have amassed a team of leading specialists in virtually every type of air and fluid handling equipment.

Applied in over 50 years of successful installations, this experience enables our customers to operate their processes with the highest levels of efficiency and safety, whether in power and energy generation or research.

Safety

As an OEM for the nuclear industry, we understand the importance of compliance.

Our culture of safety exceeds even the most critical industry standards such as:

- 10 CFR 50 Appendix B
- 10CFR 21
- NQA 1
- ASME AG-1

Efficiency

Our cutting-edge technology is engineered to provide the highest performance relative to energy required.

This supports our customers in cost-effective long-term operations.

Reliability

Our products are known for their durability, often operating in applications requiring continuous service.

This is backed up by a global network of engineers to support a lifetime of highly reliable performance.

Chart Industries in numbers

$8bn market cap (NYSE:GTLS)

$4bn+ sales

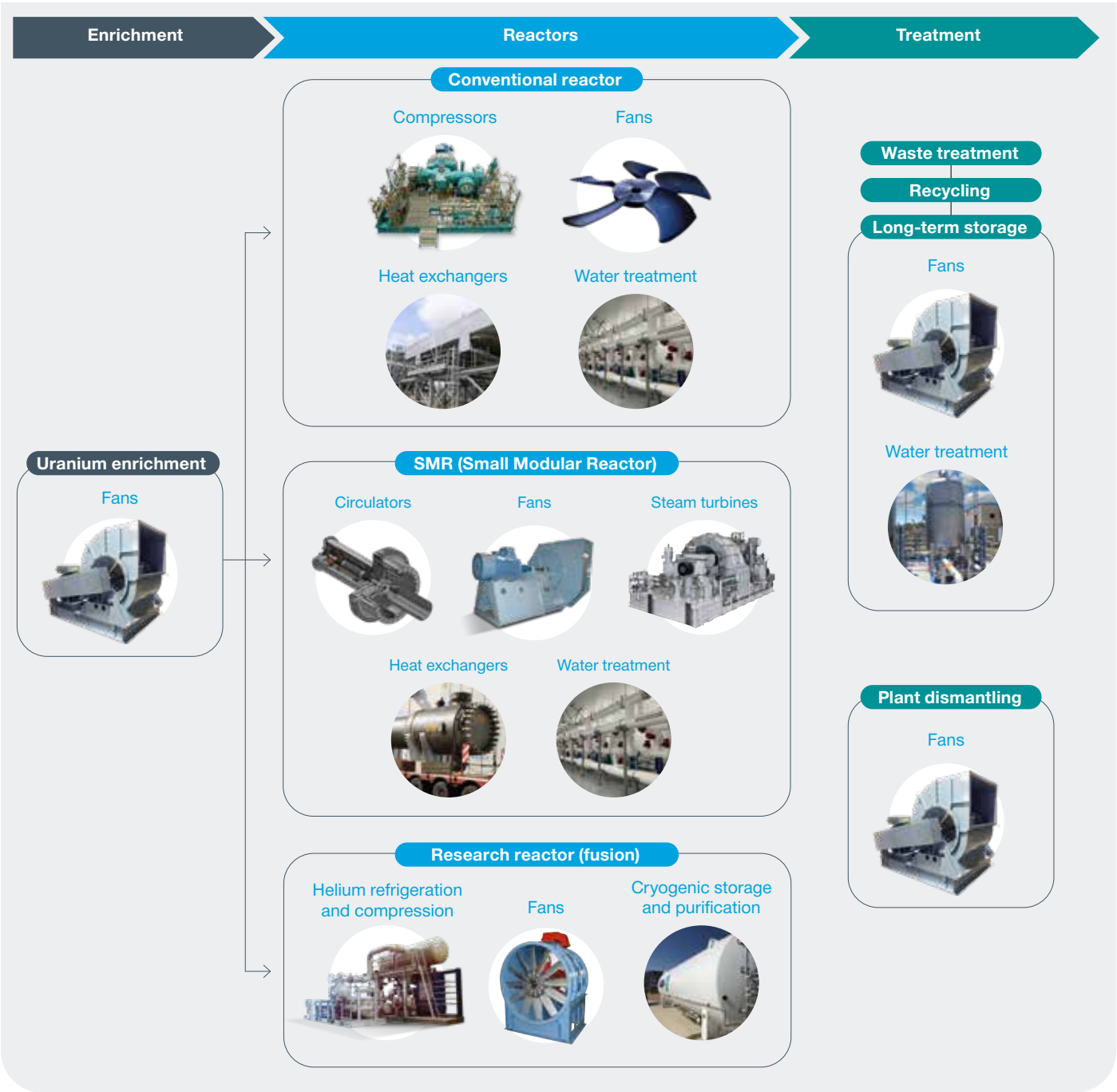
1500+ engineers

50+ service centers

64 manufacturing sites

Serving applications for air and gas across nuclear processes

Howden's equipment is used throughout various existing nuclear power technology designs and also features in developing small/ advanced modular reactor designs. Our products extend beyond production to enrichment and treatment and also into nuclear research facilities. Chart Industries, compliments the air and gas handling product range with specialist cryogenic solutions.



Proven solutions for the nuclear industry

With a range of cooling, compression and cryogenic storage solutions, Howden and Chart can support applications across traditional reactors and emerging small modular designs.

Our solutions and experience

Gas applications

Gas circulation

Gas cooled reactors require circulation of the cooling gas (typically helium or carbon dioxide) for heat transfer

Cover gas

Compression of the circulating inert cover gas for moderators

Off gas

Compression of gaseous waste from the treatment system to tank storage

Gas blowers/circulators

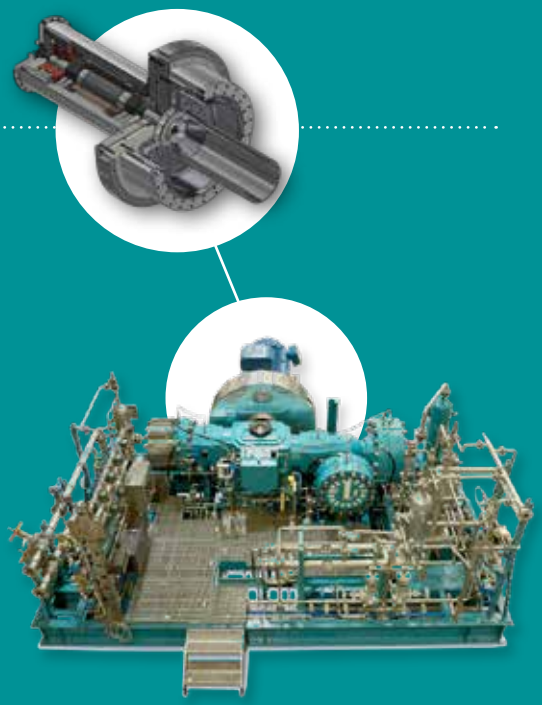
Product details

- Fully submerged in the cooling gas thereby eliminating shaft seal and high thrust bearing and reducing footprint
- Specialist seals to ensure ultra-low leakage protecting workers from potential radioactive particles in the gas
- Electro-magnetic bearings to maximize performance at high speed with low molecular weight of helium
- Advanced materials to reduce stress caused by high tip speed

Diaphragm compressors

Product details

- Zero gas leakage using high pressure sealing to maximize safety
- Three-layer diaphragm plates ensuring no oil contamination of the process gas
- Skid-mounted small footprint for easy installation with limited spaces
- Efficient handling of low-medium flows (to 1200 m^3/h or 706 cfm) and high-pressure gases (to 3000 bar or 43500 PSI)



◀ Flamanville Nuclear Power Plant, France

Drying system charge gas

Maintains nitrogen pressure within the system used to remove remaining water from the reactor cooling system

Cryogenic storage

Safe storage of critical gases for use on site

Diaphragm & screw compressors

Product details

- Oil free operation ensuring no contamination
- Compact arrangement
- Diaphragm for high pressure (to 3000 bar/43500 PSI) and low volume (1200 m^3/h/706 cfm)
- Screw for medium pressure (45 bar/653 PSI) and high volume (92,000 m^3/h/ 54,150 cfm)

Tanks, vessels and liquid cylinders

Product details

- Liquid gas storage systems for H_2, N_2, O_2, Ar, CO_2, He, and N_2O
- Perlite or Composite Super Insulation™ system for high thermal performance and extended hold times
- Modular solutions incorporating multiple tanks with vaporization and vacuum jacketed liquid transfer piping

With over 140 compressors supplied to PWR plants worldwide, our equipment is proven and trusted.

Our gas circulators supported the AGR plant fleet and are now integral to developing HGTR designs.

Howden and Chart are key partners for gas processes in power plants and nuclear research. Our cryogenic tanks and compressors are deployed in the ITER research center in France.

Air handling

HVAC/ventilation
Fresh air, exhaust air, heating, and cooling throughout all areas of the plant. Maintaining a constant negative pressure within controlled areas

Filtration
The movement of air in and out of the filtration system used to control air quality by capturing radioactive particles

Dismantling/containment
Maintaining a constant negative pressure within controlled areas during dismantling or back-up/ emergency situations to ensure radioactive materials are safely contained

Battery room exhaust
Removal of unsafe concentrations of gas to maintain reliable atmospheric conditions

Reactor cavity cooling
Safe cooling of the vessel and other structural materials during an accident

Roof extraction
Contributing to efficient, safe and comfortable working environment within nuclear facilities

A wide range of fans matching performance and sizing requirements

Centrifugal fans (direct drive, coupling drive and belt drive arrangement):

- Airflow up to 115 m^3/s (4061 ft^3/s)
- Pressure up to 25000 Pa (3.62 PSI)
- Temperature up to 350°C (662°F)

Axial fans (short casing / wall mounting, long casing):

- Airflow up to 80 m^3/s (2825 m^3/s)
- Pressure up to 1500 Pa (0.21 PSI)
- Temperature up to 150°C (302°F)

Mixed flow fans:

- Air flow up to 40 m^3/s (1412 m^3/s)
- Pressure up to 5000 Pa (0.72 PSI)

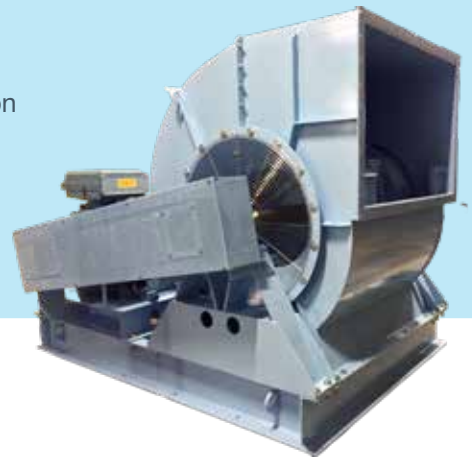
Performance to rely on:

For filtration:
Fans designed to operate in emergencies under 1.5 bar (21.7 PSI) with tightness test under 2.25 bar (32.6 PSI)

For battery room:
Special acid proof coatings and safely isolated electrical connections to ensure safe and reliable performance within controlled atmospheric conditions

For containment:
Design for leakproof operation while exposed to radiation.

- All fans tested to meet electric, vibration, aeraulic and acoustic standards as well as shock
- Safety classification with seismic design and decontaminating coating
- Zero leakage or special tightness



Over 50 years of fan supply, with more than 15,000 fans serving nuclear facilities from electrical power to fuel manufacturing, waste treatment, research and decommissioning sites.

Cooling and heat exchange applications

Reactor cavity cooling

Safe cooling of the vessel and other structural materials during an accident

Utility cooling

Cooling air for process and utility provide through systems based on cooling towers and air-cooled condensers

Heat exchange

Converting reactor heated water to steam for electrical power or thermal use

Fans

Product details

- A wide range fan technologies – centrifugal, axial, mixed flow – to match performance and sizing requirements
- Airflow up to 115 m^3/s (4061 ft^3/s)
- Pressure up to 25000 Pa (3.62 PSI)
- Temperature up to 350°C (662°F)

Cooling fans

Product details

- Howden or Hudson fans ranging from low to ultra-low noise levels to maximize output within site regulations
- Capable of handling flows of up to 3000 m^3/s (105944 ft^3/s)
- Suitable for multiple configurations: vertical and horizontal, dry and wet, induced and forced draft

Shell & tube heat exchangers

Product details

- VRV and IMB heat exchangers
- Specialist design to withstand high pressures and temperatures

Heat exchange

Removing excess heat from the power production process

Air cooled heat exchangers

Product details

- Chart is a major manufacturer of air cooled heat exchangers and owns the renowned Hudson, Air-X-Changers, Smithco and Hammco brands
- Design and configuration options to maximize efficiency relative to footprint
- Large portfolio of integrated fans providing the highest levels of efficiency and performance

Cooling & Refrigeration Systems

Helium refrigeration as part of fusion reactor cooling systems including compression of the helium coolant

Helium refrigeration plants

Product details

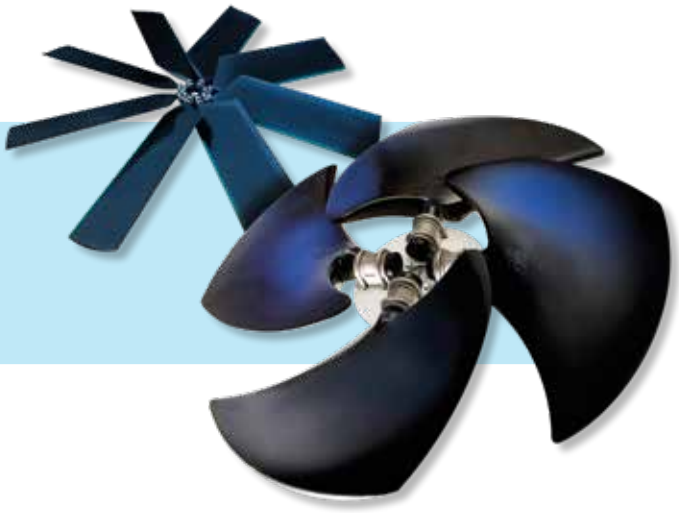
- Customizable refrigeration plant including vacuum cold box, 80K & 20K adsorbers, turboexpanders and reciprocating expander(s), valves & instruments, storage, control & analytical systems

Screw compressors

Product details

- Large range of oil-injected compressors serving a wide performance envelope
- High efficiency performance with low maintenance and long service intervals

Our fans are aiding cooling within nuclear power plants in Europe, North America and China



Our compressors play a critical role in refrigeration circuits at CERN LHC, Jefferson Lab, Brookhaven Lab and FRIB. Broader installations in thousands of refrigeration systems for heavy and light industrial cooling.

Specialty heat exchangers proven across thousands of installations requiring high temperatures, pressures, severe service and/or exotic metallurgy

Energy and power applications

Power

Electrical output through steam-based generation

Energy recovery

Increased electrical output through recovery of waste heat

Mechanical drive

Drives for major equipment such as pumps

Steam Turbines

Product details

- Reliable Kühnle, Kopp & Kausch and Peter Brotherhood turbine range of up to 40MW to fit modular nuclear systems
- Able to meet inlet pressures up to 60 bara (942 PSI) and temperatures of 525°C (977°F)

Product details

- Compact single-stage, back-pressure steam turbines from Kühnle, Kopp & Kausch
- Low maintenance and highly reliable
- Quick-start capability

Water applications

Wastewater treatment

Removal of undesired contaminates through filtration, distillation, and vaporization to a level suitable for release or use in other processes.

Product details

- Complete portfolio of treatment solutions for the removal/ treatment of multiple contaminants
- Scalable solutions targeting specific treatment conditions required for each water source and application

Over 8100 installations worldwide supporting a wide range of industrial water handling applications.

Aftermarket – serving our customers long-term needs

By working together with our customers, we custom design and build precisely the right equipment for each individual application then keep it operating at peak performance for decades, without ever compromising safety.

After installation and commissioning, we provide service, maintenance, retrofits and upgrades designed to prolong safe working conditions in the most cost-effective way.

Life cycle optimization

We can supply OEM parts, expert aftermarket services and full engineering support for all of our legacy brands.

We can also provide comprehensive parts and services for any nuclear-grade fan and arrange custom designed training packages for your own personnel.

Extending the life of your equipment

- Servicing
- Maintenance
- Retrofits
- Upgrades

Howden

Make an enquiry through our website.
www.chartindustries.com/nuclear

CHART®
Cooler By Design®

Howden
A Chart Industries Company