

Cylinder Salvage Receptacles

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Salvage Receptacles (Cylinders) also known as Emergency Response Containment Vessels (ERCV) or Cylinder Salvage Containers are designed to completely contain and isolate a leaking gas cylinder. They have become indispensable ER devices for compressed gas emergency response teams. In the US these are ASME pressure vessels with quick opening flanges, which can safely contain a high pressure leaking cylinder and allow it to be safely transported to another location for final mitigation. Over the years, the ERCV's have become a critical tool for ER team (private and public) to respond quickly and safely to compressed gas incidents involving Toxic, Corrosive, Oxidizing or Flammable gases. In some cases it represents the only convenient option.

They were originally designed and fabricated by gas suppliers or users for site use over 30 years ago. Each were custom designed by/for the user and were typically designed and fabricated to the local pressure vessel code. They were expensive, difficult to use and difficult to move on site. To legally transport the leaking gas cylinder in the US, an emergency exemption was applied for after the cylinder was contained. This process could take months for approval and in the meantime the cylinder would continue to leak into the ERCV before it could be moved from the site. This also tied up the ERCV so it would not be available for another emergency.



Typical Site ERCV

In the early 1980's two ERCV's designed by Sigr Elektrographit, GmbH, a German Company used end closures that were easier to operate in an emergency and the vessels were mounted on moveable carts. The small unit, TG-12 (13.7 liters) had a screw cap that was easily tightened using a handle and the larger TG 168 (188 liter) had a breach closure. These were designed to TUV pressure vessel specifications and met the requirements of the Hazardous Goods Regulations for Road Transport GGVS/ADR of leaking gas cylinders.



Sigri ERCV, Model TG-168

These were available for sale and a number of ERCV's were sold to gas suppliers and users in Europe. Over 20 were purchased in the United States primarily by gas suppliers. These received exemptions in the US from DOT for transportation of leaking gas cylinders (E10151 for TG-168)

The author designed two models in 1988 for the Solkatronic Chemicals Inc ER team in Morrisville, PA. Model 5501 is the smaller one with an internal volume of 30.3 liters while the larger one is 131 liters in volume.

These received US DOT exemptions for use in transporting leaking gas cylinders in 1989

E10504 for model 5502
E10323 for model 5501



Air Products ERCV, Model 5502

Since that time over 300 units, primarily model 5502, have been sold to gas companies, users, waste disposal companies and government agencies worldwide. A larger model 5503 was developed in 2003 for the larger diameter industrial grade low pressure Chlorine and Ammonia cylinders. Air Products and Chemicals acquired Solkatronic Chemicals Inc in 1998 and continues to supply and support the ERCV's business.

During this time, the Chlorine Institute also developed a low pressure ERCV in 1988 for use on 150 lb Chlorine Cylinders. This has a pressure rating of 250 psig. The exemption E9781 only authorized its use for Chlorine. Exemption E10987 however extended the use to any gas with a pressure less than 250 psig



Chlorine Institute ERCV

There are many other ERCV designs that have been fabricated worldwide, however the predominant models used for high pressure gas cylinders are

- Europe – Sigri TG 168
- North America - Air Products 5502
- Asia – Air Products 5502

Over the last 25 years the ERCV's have become the primary Emergency Response device that can be used with a leaking gas cylinder. They have become invaluable for compressed gas incidents since a properly trained and equipped team can safely and quickly isolate a leaking gas cylinder thus, mitigating the emergency.

Of the 300 ERCV's sold by Air Products, we are not aware of any incidents with their use or transport since their development in 1988. Two have been destroyed in facility fires and one was destroyed due to use with a strong oxidizer (Chlorine Trifluoride), which is a prohibited use. We are also not aware of any incidents involving the Sigri ERCVs.

Recognizing that ERCV's have been in use without major incident for over 20 years in the US, DOT on Jan. 24, 2005, published final rules titled "**Hazardous Materials; Incorporation of Exemptions into Regulations**", Federal Register Vol 70, No.14 pages 3302-3310 removing the requirement for ERCV exemptions. In addition the hydrotest period of two years was extended to five years.

Besides the gas suppliers, the Semiconductor Industry is the other primary user of ERCV's. A typical semiconductor fabrication facility (Fab) uses a wide variety of gases with various hazards, many of which have multiple hazards

- Highly Toxic (Arsine Phosphine, Diborane)
- Toxic (Boron Trichloride, Germane)
- Pyrophoric (Silane, Methyl Silane, Disilane)
- Flammable (Hydrogen, Methane)
- Oxidizer (Nitrous Oxide, Oxygen)
- Corrosive, Acid (Chlorine, Hydrogen Chloride, Hydrogen Bromide)
- Corrosive, Alkaline (Ammonia)

Having a ERCV on site allows the ER team to quickly isolate a problem cylinder and allow the supplier to then arrange for the transportation offsite. This minimizes the shutdown of a Fab which cost upwards of \$2 billion to build and millions per day to operate. Most Taiwan Fabs have established a best practice to have an ERCV at each Fab for use by the site ER team. This practice has been carried over to the new Fabs in China.

In 1990 the Uniform Fire Code in the Western US recognized the value of having an ERCV onsite and a trained ER team by allowing its use in place of having a leaker gas cabinet and scrubber for storage. This exception has since been adopted by the other Fire Codes (IFC & NFPA).

To service the worldwide Semiconductor and Specialty Gas customers, Air Products has a worldwide ER organization that can respond to a local incident. These teams have access to 76 ERCV's

- Europe – 25
- North America – 32
- Asia – 21

Other multi-national gas companies have similar capabilities.

With proper care, ERCV's can last for a long time. We have ERCV's that are almost 20 years old, which are still in use.

ERCV's over the last 25 years have demonstrated that they can safely contain and transport leaking gas cylinders.

Answers to Questions or Statements:

The leaking cylinder will be empty before the ERCV is used.

Not likely, outside of a catastrophic failure (rupture) of the cylinder it will take some time for the gas to leak out of the cylinder. In the rare event of a leak during use it would be very small, in the order of 0.1-10 cc/min

The US Fire Codes require monitoring of gas cabinets with Toxic and Highly Toxic gases using a electronic gas detector which will alarm at PEL level of the gas and shutdown the system. Since the gas sensors are typically at the cabinet exhaust the leak at the cylinder would be larger since it has been diluted a number of times by the exhaust ventilation of the gas cabinet. Typically the leak is larger at the cylinder since it has been diluted by the air ventilation of the cabinet but it is still a small leak. For most gases this would be <10 cc/min.

49CFR173.24b(1) General requirements for packagings and packages prohibits the shipment of a cylinder if it is leaking there will be no identifiable (without the use of instruments) release of hazardous materials to the environment. Soap solution is the most common leak detection method for gases and the lowest detection limit for soap solution is a leak rate of 0.1 cc/min. A full Hydrogen Chloride cylinder (60 lbs) contains 17,900,00 cc of gas. At this leak rate it would take **340 years** to empty! Needless to say it would not be practical to leave it in the gas cabinet until it empties. Even a leak 100 times larger (10 cc/min) would take 3.4 years.

Many Semiconductor companies also have a practice of using an electronic leak detector to test all cylinders before they are placed into storage. This procedure is very sensitive and will detect minute leaks (single ppm or ppb). While these leaks will not be detected using a soap solution, the Safety professionals will not allow these cylinders to be shipped back even though they meet the above DOT definition of a non leaker. These are typically contained in an ERCV and shipped back to the gas supplier.

Even a violent physical event for a cylinder may not develop a leak rate significant enough to empty the cylinder in a short time. For example if one assumes a worst case event of someone opening a cylinder valve fully on a Hydrogen Chloride cylinder containing 60 lbs of liquid, only a third (20 lbs) of the liquid would be vented within the first few minutes. The remainder (20 lbs) would be subcooled by the vaporizing liquid and would take more than a day to completely empty even if the valve remained open. This would be true even if the valve were to somehow be removed from the cylinder.

In all these cases an ER team would be faced with a leaking cylinder which will have to be removed and contained in an ERCV.

The user must be careful not to exceed the pressure rating of the ERCV.

The most common ERCV's in use (Model 5502 or TG-168) are designed to hold a high pressure 50 liter cylinder and they have a working pressure of 1100 & 1047 psig respectively. These have an internal volume of 133 liters & 168 liters respectively. A leaking 50 liter cylinder containing full 2400 psig pressure will equalize in the ERCV to a pressure less than 1000 psig since the internal volumes of the ERCV are more than 2.5 times that of the cylinder. This will be less than the working pressure of the ERCV. The highest pressure liquefied gas that would be contained in a ERCV is Hydrogen Chloride, which has a vapor pressure of 635 psig. This is well below the working pressure of the ERCVs.

Only in the case of the Chlorine Institute ERCV would pressure be an issue. Use of the ERCV under the Exemption for gases other than Chlorine would only be by trained ER teams who would be aware of the pressure limitation.

Fire Brigades will not know how to use the ERCV.

Most ERCV's are owned by gas suppliers, users or waste disposal companies. In almost all cases their teams will be the ones inserting the cylinder under the supervision of the Fire Brigade. This has been the case in the US for over 20 years.

There are some public agencies in the US that have ERCV's for use on gas cylinders or WMD.

Why can't the gas be vented at the location rather than moved?

Generally most user locations are not setup to scrub and neutralize the entire content of a gas cylinder. This would require a large scrubber completely react the contents and to absorb the heat of reaction. In addition a large liquefied gas cylinder such as Chlorine could take 1-2 days to vaporize the contents of the cylinder in order to empty it. Opening the ERCV to offload the leaking cylinder requires special protocols and a high volume exhaust system to capture the gases released when the flange is opened

These special types of facilities are typically located at a gas supplier or waste disposal company site. In some cases these are located overseas. For many countries in Asia these facilities do not even exist. It is safer and more efficient for the gas suppliers or waste disposal companies to handle the leaking cylinder at their facility.

In some cases it might make more sense to collect and repurify the gas rather than disposing of it. Only these special facilities have the experienced personnel to make this decision and the equipment to do it.

Why is approval for water carriage required?

In some cases the ERCV must be moved from Asia to North America or Europe. Since Air Cargo is prohibited, the only other mode would be water. This need was recognized by DOT when Special Permit SP14168 authorizing the transportation of ERCV's by cargo vessel was issued on Nov 2005.