Executive Summary

The use of chrysotile asbestos is key to the manufacture of chlorine and caustic soda in the United States. The chlor-alkali industry recognizes the inherent useful properties of this mineral, and from its entry into a port in the United States to its ultimate disposal, the management of chrysotile asbestos in the chlor-alkali industry is highly regulated and managed in a closely controlled process.

Chrysotile asbestos arrives in the United States in sealed containers, is stored in controlled areas, processed with dedicated equipment, and disposed of in accordance with Federal, State and local requirements. While a variety of regulations generally cover hazard communication, release reporting, waste management, etc. of chrysotile asbestos, the Federal government has issued two specific rules that govern the safety of workers and the protection of the environment. These are the Occupational Safety and Health Ad ministration's (OSHA) Standard for Toxic and Hazardous Substances, Asbestos (29 CFR § 1910.1001) and the Environmental Protection Agency's (EPA) National Emission Standard for Hazardous Air Pollutants (NESHAP), National Emission Standard for Asbestos (40 C FR § 61.140). Additionally, the industry follows the procedures set forth by Chlorine Institute Pamphlet 137, "Guidelines: Asbestos Handling for the Chlor-Alkali Industry."

Worker safety is paramount in the management of chrysotile asbestos and nowhere i n the chlor-alkali process does a person come into direct contact with dry material while not wearing appropriate personal protective equipment (PPE) . We estimate that about 100 workers industry-wide across the United States process chrysotile asbestos on a day-to-day basis. Specific training, PPE use and work practices govern how they conduct their work activities. Even though they wear PPE, the workplace is monitored for chrysotile asbestos and employees are afforded specific medical monitoring and surveillance. These activities, coupled with equipment maintenance and management of the workplace environment, form an overall comprehensive chrysotile asbestos management program that is specifically aimed at eliminating any potential exposure to chrysotile asbestos by personnel and the environment.

The following text provides specific information on the management of chrysotile asbestos by the chlor-alkali industry in the United States.

Supply Chain

Chrysotile asbestos is shipped to the United States in 40 kilogram bags. Typically, twenty (20) bags are placed on a pallet at the point of shipment. The pallet is covered completely in a heavyweight wrap; it is very durable and similar in thickness to a drum liner. The pallets are then placed in a shipping container. The shipping container is sealed and protected from accidental or purposeful opening with a heavy duty bolt-type car seal. The car seal can only be removed using a substantial cutting tool like a bolt cutter or similar device.

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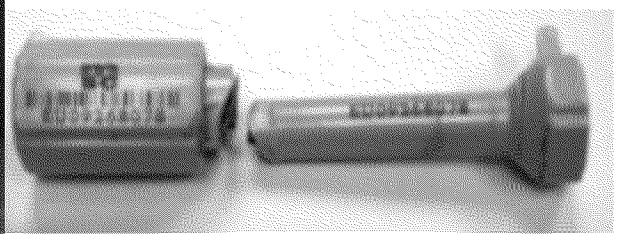
At the port of entry, the shipping container is removed from the ship and placed on the d ock. It is not opened and material is not transloaded to a different trailer or conveyance. The shipping container is marked per Department of Transportation requirements and is transported to a chlor -alkali facility where the pallets and bags will be removed. This process ensures that workers and the ambient environment are protected from an accidental release of material.

Shipping Container



"Bolt-Type" Car Seal

Chlor-alkali facilities will not accept a shipment unless a current Safety Data Sheet is available from the supplier, and moreover, will not accept a damaged shipping container.

Material Delivery

Upon delivery to a chlor -alkali facility, the chrysotile asbestos shipping container is inspected before unloading. As with the entire handling experience, strict adherence to process, procedures and housekeeping is followed for container inspection. Once the container has been opened, pallets and bags are ins pected. If broken bags or loose chrysotile asbestos is evident , the area is controlled to prevent accidental exposure, the bags are repaired, and the area is barricaded and treated as an area requiring immediate cleanup.

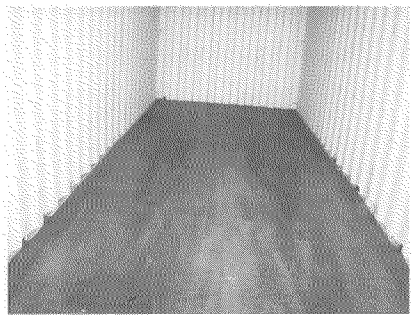
The plastic wrapped pallets are labeled, and as required by OSHA's Hazard Communication and Asbestos Standards contains the following language:

DANGER
CONTAINS ASBESTOS FIBERS
MAY CAUSE CANCER
CAUSES DAMAGE TO LUNGS
DO NOT BREATHE DUST
AVOID CREATING DUST

In the event that a container is damaged, port or warehouse personnel must repair the container and manage their remediation activities in conformance with OSHA's Asbestos rules.

Container Upon Opening

Container Partially Unloaded



Empty Clean Container

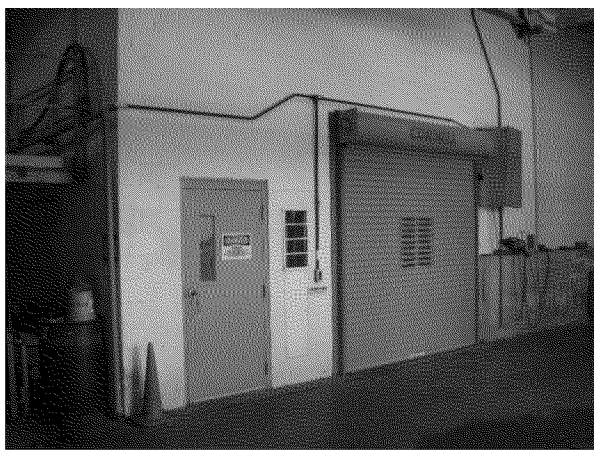
Personnel involved in the cleanup wear specific PPE, including respirators and protective clothing and footwear. Once the shipping container has been emptied, it is inspected and cleaned as necessary.

Any loose chrysotile asbestos is cleaned up using a High-Efficiency Particulate Air (HEPA) filter-equipped vacuum cleaner or is wetted with water and clean ed up before unloading proceeds. Broken bags are placed in an appropriately labeled, heavy-duty plastic bag or they are securely repaired. Individuals not involved in the cleanup are prohibited from entering the area until cleanup is completed.

When moving chrysotile asbestos to its storage location, care is taken to ensure that bags are not punctured. The unloading personnel are trained per regulatory requirements pri or to any unloading activity. Personnel moving chrysotile asbestos containers wear specific PPE, including respirators and protective clothing.

Storage

Chrysotile asbestos is stored in an isolated, enclosed area with restricted access (e.g., a locked bu ilding). The area is also provided with signage for awareness of entry only by authorized personnel.



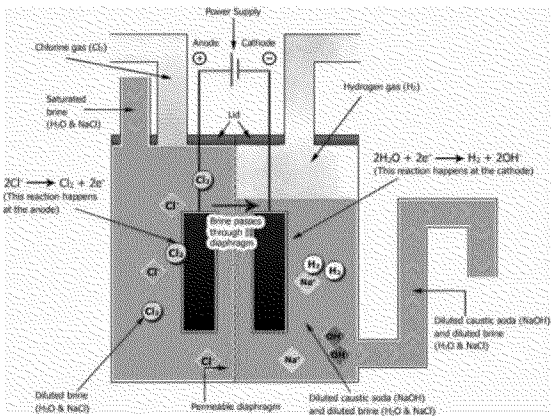
Secure Storage Room - Exterior

The storage area is secure, properly maintained and inspected on a regular basis. The standard for cleanliness is high - *any* area or surface that exhibits signs of chrysotile asbestos is cleaned with a HEPA

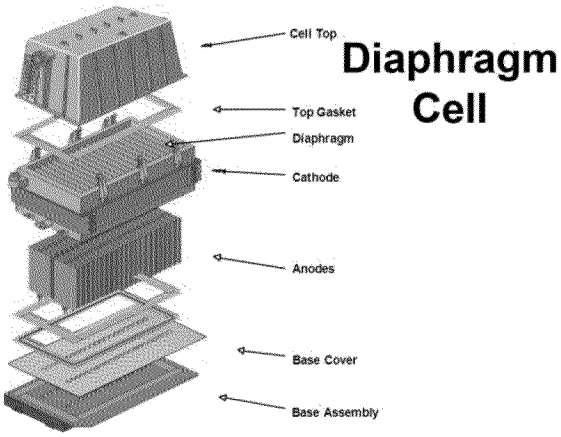
filter-equipped vacuum cleaner or by wetting the fibers and cleaning up the spill. Personnel involved in the cleanup are required to wear specific PPE as stated earlier (respirators, protective clothing, etc.).

Chrysotile Asbestos Processing

The diaphragm cell chlor-alkali process involves separation of the sodium and chlorine molecules of salt via electricity to produce sodium hydroxide (caustic soda), hydrogen, and chlorine. Specifically, brine (an aqueous solution of salt) is passed through an electric current and sodium hydroxide, hydrogen and chlorine are formed. Key to the diaphragm cell process is the electrolytic cell. It is in this cell that the electrolytic reaction occurs. The cell contains two compartments separated by a permeable diaphragm, which is made mostly of chrysotile asbestos. The diaphragm prevents the reaction of the caustic soda with the chlorine and allows for the separation of both materials for further processing. The use of chrysotile asbestos in the chlor-alkali industry is solely related to its use as a diaphragm in an electrolytic cell and it has been used safely for many decades.



Electrolytic Cell Diagram

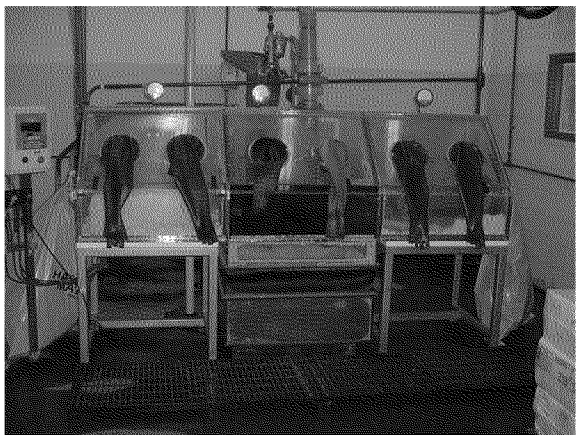


Electrolytic Cell Construction

The preparation of diaphragms is key to the electrolytic cell process, and how this is accomplished is tightly controlled. The process involves the following steps:

- Raw Material Management - Chrysotile asbestos is only removed from the secure storage area when it is needed for the diaphragm preparation process. The required bags of asbestos are moved to a designated area with limited access. The bags selected to be opened are placed in a glove box or hood prior to being opened.

Storage in Secure Area



Glove Box

The use of respiratory protection is required to protect the employee in the event of an unforeseen circumstance since the chrysotile asbestos is in a dry state when handled. During these activities, the employees are also required to wear protective clothing.

Empty bags are deposited in a closed and labeled waste container through a port in the glove box. When only partial contents of a bag are required, the partially filled bag is stored within the glove box. If partially filled bags must be moved outside the glove box, they are resealed and HEPA filter equipment-vacuumed before they are moved. Waste containers are likewise sealed and vacuumed prior to removal.

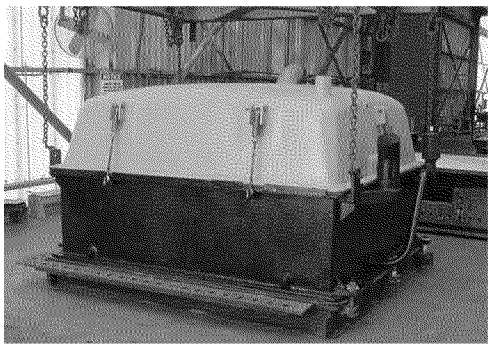
Chrysotile asbestos from the glove box is transferred to a mixing tank via a closed system that is maintained under vacuum. The chrysotile asbestos to be used to create a diaphragm is mixed with a liquid solution of weak caustic soda and salt . The slurry is created in the mixing tank and this process is typically referred to as creating a chrysotile asbestos slurry. At this time, chrysotile asbestos is no longer in the dry form and accordingly is no longer likely to become airborne. Halar® or Teflon™ fibers (e.g., modifier) are added to the chrysotile asbestos slurry in appreciable quantities. This material then co -deposits in the diaphragm and, upon heating in an oven, the Halar® or Teflon ™ fibers sinter and fuse to the chrysotile asbestos rendering the diaphragm non - friable. The slurry is then transferred to a depositing tank for diaphragm preparation. Any visible wet chrysotile asbestos in or around the mixing or depositing tanks is removed before it is allowed to dry.

- Diaphragm Preparation - The creation of a diaphragm requires that the chrysotile asbestos slurry be applied to a specifically designed metallic screen or perforated plate . Vacuum is applied so as to allow for uniform application of the slurry across the screen. Once this is complete the slurry - containing mesh is drained and free water removed (chrysotile asbestos is still wet). After this, the screen is placed in an oven to fuse the chrysotile asbestos deposit. During this process, the chrysotile asbestos and modifier s lurry hardens and becomes fused on the screen to form a diaphragm. After it has cooled, it is ready for installation in the electrolytic cell.

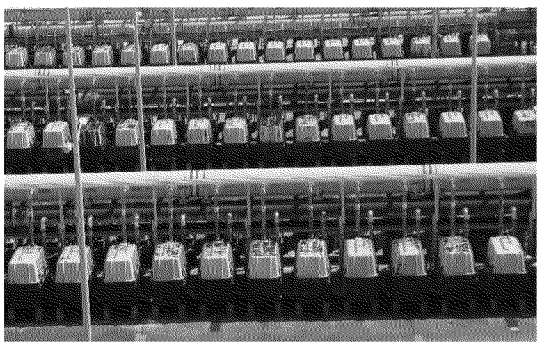
Close Up - Final Electrolytic Cell Diaphragm

The fused diaphragm is hard and the chrysotile asbestos contained in it remains in a non -friable state. The amount of chrysotile asbestos used for each diaphragm is in the range of 50 -250 lbs. depending on the cell size. A typical chlor-alkali production plant will use about 5 -25 tons per year of chrysotile asbestos depending on cell size and technology.

Diaphragm Installation - Once the diaphragms have been created, the deposited screens are inspected, physically joined with another part of the electrolytic cell and sealed. The cell can then be placed in service.



Single Electrolytic Cell



Electrolytic Cell "Circuit"

The process described above occurs in a designated area in the facility and access is restricted. PPE is worn throughout this process by anyone who works in the designated area.

Personnel are required to decontaminate their PPE and equipment to prevent exposure to skin and hair and inhibit the transfer of chrysotile asbestos fibers from designated areas to other areas of the facility. Facilities have procedures in place to prevent c ontamination of footwear upon building entry and exit. Additional procedures have been established for entry and work in designated areas that contain wet chrysotile asbestos to prevent contamination of skin, clothing, and footwear. These work procedures include decontamination of work clothes and footwear, use of disposable coverings, and controlling access of personnel and visitors wearing personal footwear. Outer clothing and footwear is decontaminated or discarded whenever the employee exits a designated area. Individuals working in such areas are not allowed to keep contaminated work clothing and personal clothing in the same storage area.

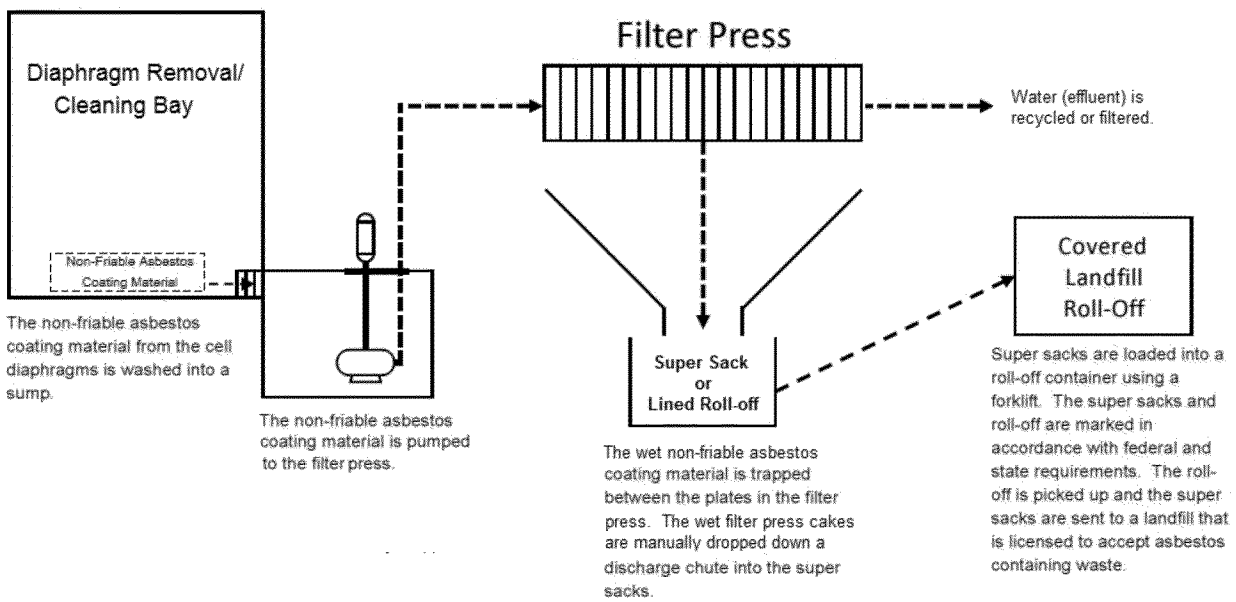
Care is taken to ensure that all surfaces are maintained free of chrysotile asbestos-containing material, debris and accompanying dust. The movement of chrysotile asbestos by mechanical (brush, broom) and pneumatic (compressed air) means is prohibited. Personnel are trained to recognize that dry chrysotile asbestos must not be disturbed and that HEPA filter-equipped vacuums must be used to collect or clean up dry chrysotile asbestos. Wet management methods are allowed if HEPA filer-equipped vacuum or local HEPA exhaust ventilation is not available.

Management of Diaphragms

Diaphragms may last a year or more before they become inefficient and need to be removed from service. While most of the electrolytic cell parts, including the screen on which the diaphragm is situated, are reusable, the chrysotile asbestos diaphragm itself is not.

In order to reuse the parts of the cell it must be disassembled and the chrysotile asbestos diaphragm must be removed . The diaphragm, which is still hard and fused to the screen, is removed with a hydroblasting apparatus. The cleaning bay is an enclosed area and constructed to minimize potential emissions and allow for effective cleanup. Fluid from the hydroblasting operation is contained.

After each use of the cleaning bay, the work surfaces are flushed and cleaned with water. A filtration system is used to remove chrysotile asbestos from the hydroblasting water prior to discharging the water to the facility's wastewater collection and treatment system. The filtered waste material is stored in properly sealed containment areas prior to disposal.



Management of Chrysotile Asbestos Wastes

Chrysotile asbestos wastes (chrysotile asbestos separated from the hydroblasting water , containers and bags, chrysotile asbestos contaminated clothing, etc.) are placed in a labeled, plastic lined impervious

container. An approved landfill is used for disposal of chrysotile asbestos wastes in compliance with Federal NESHAP (40 CFR § 61.154) and applicable State regulations for chrysotile asbestos disposal.

Chlor-Alkali Process Controls and Protections

The safety and health of workers is the top priority. In order to safely handle and work with chrysotile asbestos, engineering controls, PPE, training and medical surveillance are used to meet strict OSHA and EPA requirements.

- Engineering Controls - According to OSHA, engineering controls implement physical change to the workplace, which eliminates/reduces the hazard of the job/task. When the use of a substance cannot be eliminated or substituted, the use of engineering controls is considered to be the most effective means of controlling workplace hazards. For this reason, the chlor-alkali industry has adopted three significant systems of engineering controls: wet methods, ventilation, and glove boxes (or a similar enclosed system).

  Activities that have the potential to generate friable/dry chrysotile asbestos (e.g. diaphragm preparation and cell renewal) are performed using wet methods. When chrysotile asbestos is no longer in the dry form (i.e. wetted), it is no longer likely to become airborne.

  Exhaust ventilation or dust collection is used to maintain exposures at or below permissible levels. A typical dry room and the glove box are both under vacuum and routed to a baghouse containing a HEPA filter. The filters in the baghouse meet or exceed OSHA requirements. When vented after the filter, visible emissions monitoring inspections are performed as required by EPA's Asbestos NESHAP.

  A glove box is a sealed compartment similar to those which are used in laboratories and allows personnel to use secure gloves to open the bags without actually touching or being in direct contact with the material. The glove box operates under a vacuum to ensure all fibers are contained and vented to a high efficiency filter.

- Personal Protective Equipment (PPE) - The engineering controls used by the chlor-alkali industry are sufficient to control chrysotile asbestos emissions. However, employees handling chrysotile asbestos are required to wear PPE as an additional precaution to ensure no exposure. PPE includes respiratory protection, disposable gloves and suits, and appropriate footwear (e.g. rubber boots). Each facility requires the use of protective clothing and decontamination procedures to prevent skin and hair contamination and to prevent the transfer of asbestos fibers from designated areas to other areas of the facility. Based on the results of PPE Hazard Assessments, each plant determines required PPE by task based on OSHA requirements and corporate procedures.

- Employee Training - Workers who may be exposed to chrysotile asbestos receive training on appropriate procedures for moving and handling chrysotile asbestos, required PPE, decontamination procedures, and other applicable topics. Training is given initially prior to or at the time of initial assignment to work in designated areas and periodically thereafter, but at least once every three years.

- Medical Surveillance - The OSHA Asbestos Standard requires that the employer establish a medical surveillance program for those employees who are or may be exposed to airborne concentrations of fibers of asbestos at or above the time weighted average (TWA) and/or excursion limit. Therefore, all employees who have the potential to work in a designated area are offered medical examinations at the time of placement into the designated area, annually and upon termination of employment.

The medical examination will include height, weight, blood pressure, heart rate, and a physician's written opinion. A health history is completed with each exam with a special emphasis on respiratory, cardiac, and digestive systems as required by OSHA (29 CFR § 1910.1001). A respiratory disease questionnaire is also completed for each exam. Laboratory testing, including a chest roentgenogram (x-ray) and pulmonary function test (PFT), also known as spirometry or lung function test, is required as part of the medical exam.

- Personnel Monitoring - Personnel monitoring (eight-hour TWA shift monitoring and specific task monitoring) is conducted to provide quantitative exposure data, verify functionality of engineering controls, determine medical surveillance, define designate d areas, and demonstrate compliance with all Federal and State laws and regulations. The monitoring frequency is based on past results, job observations, and planned inspections, and meets all OSHA requirements.

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