Clean-Up by the CRV

Narrator: August 20, 1980. The Chemical Control Corporation of Elizabeth, New Jersey catches fire. Fueled by 35,000 chemical containers, the fire burns for 10 hours. The flames ignite explosive products on site. The resulting detonation and fireball rocks nearby communities and commercial and industrial facilities. It also threatens a heavily populated area of up to 50-miles radius.

When the fire is finally extinguished an even more hazardous situation awaits emergency and environmental personnel. The Chemical Control site is so contaminated that it must be disassembled and cleaned piece by piece. The New Jersey Department of Environmental Protection, the DEP, begins the hazardous job of breaking down, decontaminating, and removing everything from the ruins of buildings to storm sewers. Even the soil is removed and replaced with gravel. Even before the fire, the DEP was aware of the range of hazardous materials at the Chemical Control site. In addition to a wide variety of organic and inorganic chemicals, there were also explosives, radioactive materials, and pathogenic agents.

As the post-fire cleanup progressed, workers discovered unmarked cylinders in the rubble. These fire-charred cylinders ranged in size from aerosol cans to 6-footers. Some were hand-made for specific purposes and did not conform to ASME standards. Their contents and manufacturing origins were unknown. Considering the dangerous nature of materials warehoused at Chemical Control, protocol specified that these potentially dangerous cylinders be isolated as they were discovered. Further sampling and analysis revealed such widespread contamination that the cleanup of Chemical Control involved dredging, groundwater treatment, and treatment of contaminated soils, among the many tasks.

It concluded in 1984 with the disposal of almost all of the contaminated materials. Only the unmarked cylinders remained. Because their contents were unknown, there was no acceptable way to move or dispose of them. Since these cylinders posed a potential threat to nearby commerce, shipping, and residences, some form of protection was required. As an interim measure, the cylinders were individually encased in quarter-inch thick steel overpacks specially designed by the Army Corps of Engineers. Before sealing the overpacks, the cylinders were blanketed in sand for extra cushioning. Pressure gauges mounted on the outside of the overpacks monitored internal pressure. An external port also allowed for sampling of the overpacks' atmosphere. The 182 encased cylinders, laying lengthwise, were staged in the center of the site. There they remained for 5 years.

Solving this sort of enigma is part of the United States Environmental Protection Agency's mandate under the national contingency plan. That is, to explore and develop innovative or alternative technologies for site cleanup.

During the years that the encased cylinders remained unidentified, new technology was established for handling such situations. The Cylinder Recovery Vessel, known simply as the CRV. The CRV, owned and operated by Earth

Resources Corporation was mobilized to Chemical Control in May 1989 by the EPA Region II. Up to that time this technology had not been employed in such an expansive or complex situation. The CRV is a remotely operated, observable sampling unit featuring 3 layers of containment that provide maximum safety in situations like Chemical Control. The CRV itself can withstand an explosive force of more than 2 sticks of dynamite. Using submarine technology, the trailer housing the CRV can handle up to 3 atmospheres of pressure. The CRV and trailer are attached to the vapor containment area or VCA, a completely adjustable tertiary work area. The VCAs interior atmosphere is monitored continuously and turned over hourly via treatment fans. Another safety feature is the use of non-reactive lubrication for all of its working parts to protect against accidental ignition. All 3 parts of the CRV system can be visually observed by remote-controlled video cameras.

The CRV works on the principle that distance is the best protection when sampling unknown and/or compressed gases. This unit permits sampling to be controlled and monitored from a central laboratory located up to 200 feet from the actual sampling activity.

Prior to moving into the VCA, overpacks were tested for leaks around the flange and pressure gauge. If no leaks were found, the overpacks were moved inside the VCA which was then sealed. Although the VCA is kept airtight during all sampling efforts, escape hatches inside the VCA allow for maximum worker protection. However, this cleanup effort faced a problem even before formal CRV activities could start. The protection originally offered by the overpacks, had now created a potential threat. During the 5 years that the cylinders remained exposed, their structural integrity had been compromised. Temperatures inside the overpacks had risen dramatically during the 5 intervening summer seasons. Estimates ranged from 120° to 150°. The wet sand cushioning the cylinders within the overpacks had caused rust, releasing a hydrogen by-product. Hydrogen generating under pressure mixed with oxygen to concentrations of 70 to 85% at elevated temperatures creates an explosive condition.

By the time CRV activities commenced, the gauges installed on the overpacks had failed due to exposure. There was no way for the CRV crew to determine whether explosive conditions existed. Although this was the first time that such a situation had arisen, an extra previously developed safety procedure was added to guard against a possible explosion. The overpacks were electronically grounded and purged by pumping in inert argon gas. Small samples were collected from the overpacks' port and transferred to the lab for immediate analysis. These samples were analyzed using [forier] transform infrared and mass spectroscopy. The resulting scans were checked against the on-site data library and served as a guide to the safe handling of the overpack. Sometimes it also provided some idea of what was contained inside the cylinders. If the overpack was found to contain a potentially hazardous substance, it was disposed of by 1 of the 4 means of treatment provided by the CRV. In the case of hydrogen created by the rusting of the overpacks, the gas was vented through a flare stack.

In the next step the crew removed the cylinder from its overpack and visually inspected it. If perforations were observed, the cylinder was placed in trough of water for 24 hours. This would allow the cylinder's contents to bubble out and be dispersed safely by the atmospheric turnover within the VCA. If found intact, the cylinder was conveyed to the CRV located at the far end of the vapor containment area by field stretcher. After positioning the cylinder within the unit, the safely valve and primary door were closed manually. Personnel exited the VCA into a decontamination area. The CRV's mechanized activities did not commence until personnel were evacuated to a safety zone at a minimum distance of 100 feet.

Lab staff controlled the CRV functions remotely. First, the unit was placed under vacuum. Then a hole was drilled into the cylinder. Continuous monitoring of temperature and pressure inside the CRV was performed to apprise personnel of any changes resulting from the release of cylinder contents. The cylinder was agitated to remove liquids that might be inside. All CRV activities were monitored via internal video cameras as well as the sensing equipment. Using remote control, a sample of the cylinder's contents was routed to a port on the outside of the VCA. A member of the support crew collected it in a sample [bomb], and delivered it to the laboratory where it underwent the same analysis as the sample taken previously from the overpack. A treatment determination was made by comparing the results of the analysis with the computer accessible data in the on-site library. This library contained over 5,000 EPA-registered chemical names and their accompanying scans. Depending on the molecular complexity and the purity of a cylinder's contents, analysis could take anywhere from 20 minutes to an hour. In one instance involving byproducts, the tests took a day and a half.

The CRV can treat cylinder contents through 4 different methods. A flair stack can vent and ignite combustibles such as ethane and cyanogen after generating an air model of the impact area. An activated carbon adsorption unit uses the surface adsorption capabilities of carbon to treat organic matter. A liquid […] for caustics and acids makes use of the scrubbing qualities of a flowing liquid neutralizer within a packed column. Lastly there is a molecular sieve for special compounds such as sulfur dioxide. Where ion exchange binds the contaminant to zeolike metal cation for disposal. If a cylinder's contents do not fit any of these criteria, it can be re-encapsulated for safe transport as a known material to an identified off-site treatment facility.

Upon completion of the treatment process, the CRV was purged with argon to ensure that all cylinder contents were treated and to keep the unit and its connections free of hazardous gases. Air was then introduced into the system to test for reactiveness to solids. The safely valve was released. The CRV was tilted by remote-control and the primary door opened by gravity. This movement spilled any liquids remaining in the cylinder into a container of water beneath the unit. This provided a water reactiveness test while still under the protection of the CRV. Empty cylinders were removed from the CRV and submerged in a water bath. This was another safety precaution that leached out any possibly remaining materials. After 24 hours, the cylinders were drained, cut in half, and disposed of as scrap metal.

At an average rate of a little more than 2 hours per cylinder overpack combination, the CRV treated about 5 every day. It took the CRV 8 weeks to handle the 182 overpack cylinders at this site. After 9 years, Chemical Control was finally clean due to the Cylinder Recover Vessel.