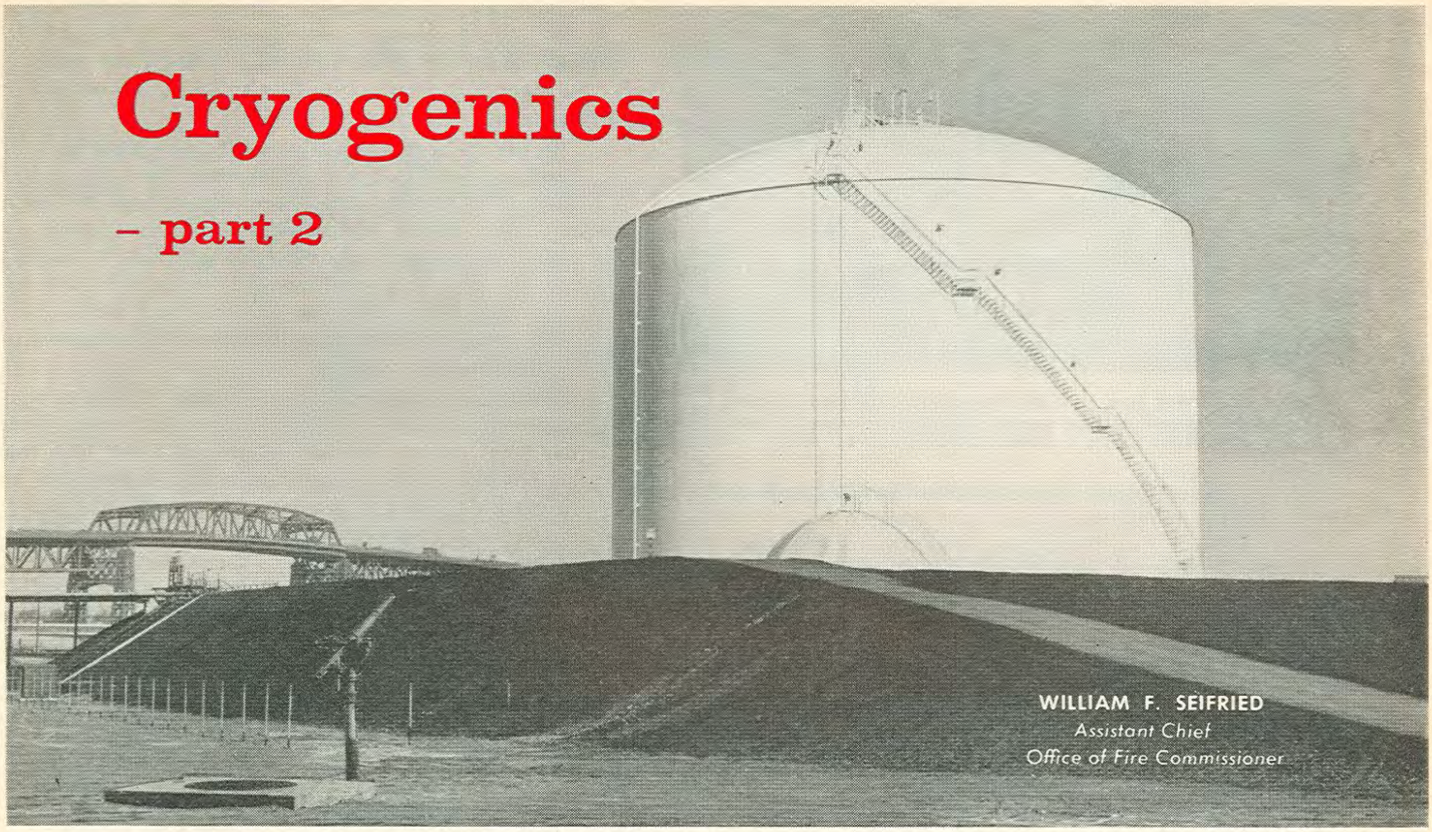
Cryogenics

– part 2


WILLIAM F. SEIFRIED
Assistant Chief
Office of Fire Commissioner

Shown above is a new storage installation at the Brooklyn Union Gas Co. containing liquefied natural gas. Note one of 8 fixed monitors which ring the tank and are used to set up a salt water curtain in the event of fire.

Liquefied Natural Gas

LNG FIRE FIGHTING CONSIDERATIONS

A. As previously indicated under the fire hazard evaluation and fire protection programming section of this article, the possible emergency situations that could occur in the operation of a LNG plant were identified. The five (5) conceived possibilities can be divided into two (2) relative categories of emergency situations with related Department scope of Operations.

1. Massive failure with maximum demand on Department resources:
   a. Failure of the LNG storage container shell or bottom resulting in the escape of gas in the liquid phase.
   b. Failure of the LNG storage container roof resulting in the escape of gas in the gas phase.

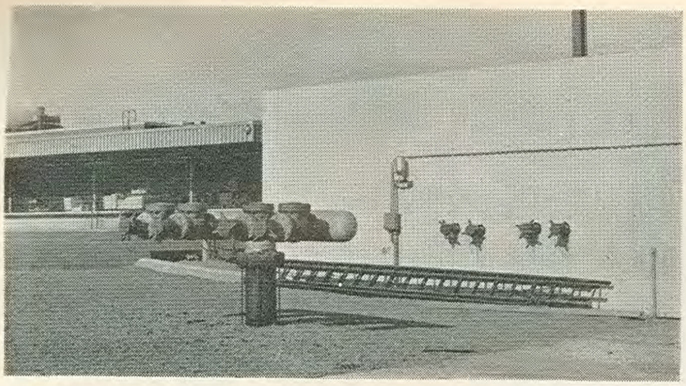
The requirement of an earth berm (sloping earth fill) around the LNG storage tank at the Texas Eastern LNG plant in Staten Island practically eliminates the possibility of the escape of liquid natural gas from a storage container shell or bottom failure. The possibility of the escape of gas from failure of the LNG storage container roof exists at both plants.

In the event of a major disaster involving the contents of the LNG storage container tank shell, bottom or roof, with a resultant fire, the overall fire fighting strategy would be to permit the contents of the tank to burn out while protecting exposures. This strategy highlights the importance of the radiation studies and the exposure protection requirements for the two (2) plants.

It is estimated that a fire in the Texas Eastern LNG storage tank would burn itself out in 45 hours. A fire in the Brooklyn Union LNG storage tank would burn itself out in 36 hours and if the contents of this tank were to be spilled into the protective dikes, any resultant fire would burn itself out in ten (10) hours.

In the event of a major disaster involving the contents of the LNG storage container and no resultant fire, the overall fire emergency strategy would be to have units in a position to protect all exposures, cause the elimination of all sources of ignition and to have the contents of the tank pumped to the regasification unit for entry into the distribution system.

At the Brooklyn Union gas plant, combined evaporation (due to tank container shell, bottom or roof failure) and the regasification process would empty the contents of the LNG storage tank in three (3) days. Combined evaporation and regasification at the Texas Eastern plant would empty the contents of the LNG tank in approximately 7.3 days.



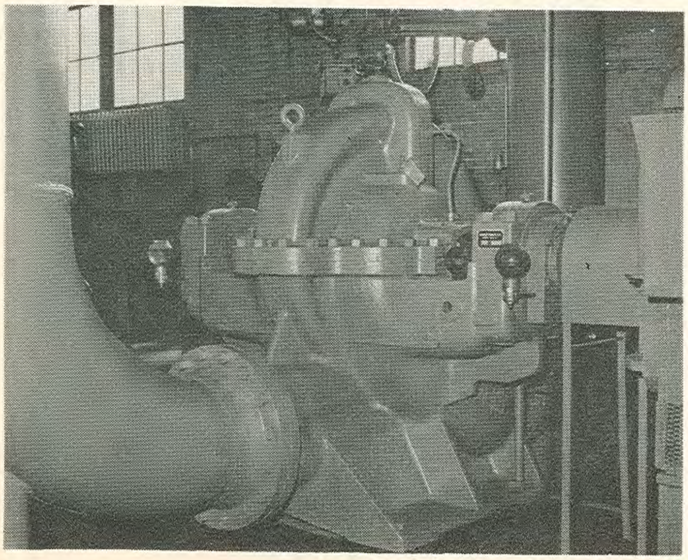
Heat shield wall used to protect men and equipment as they "hook-up" to special superpumper manifold in event of fire.

2. Localized failures with above normal demands on Department resources.
   a. Failure of the liquid piping or piping system component resulting in the escape of gas in the liquid phase.
   b. Failure of the gas piping or piping system component resulting in the escape of gas in the gas phase.
   c. Normal operation of system components, such as, relief valves or bursting discs, resulting in the escape of gas or liquid.

In evaluating the hazard of these three (3) potential emergency situations, the situation wherein the liquid system or piping system fails, resulting in the escape of gas in the liquid phase, is the most serious. This situation is most specifically related to that section of process piping between the LNG storage tank and the vaporizer, as this section of process piping, if ruptured, would permit the greatest amount of LNG to be spilled because of the large diameter of piping involved. (Automatic shut-off valves have been required between the storage tank and the vaporizer).

In the event of a rupture in the process piping with a gas or liquid leak resulting in fire, the overall fire fighting strategy would be to assure that the blocking valves which sub-divide the process system are closed (reducing the amount of fuel available to the fire), to utilize water to protect exposures within the plant or adjacent property while the limited amount of fuel burns out.

Shown below is a salt water pump which operates automatically from ultra-violet ray protective devices on top of the tank. These devices are extremely sensitive and efficient.



In the event of a rupture in the process piping with a gas or liquid leak and no resulting fire, the overall emergency strategy would be to assure that the blocking valves which sub-divide the process system are closed, to eliminate all sources of ignition, to position units so that they can immediately protect any exposure resulting from an ensuing fire, and to use water sprays to reduce the possibility of explosions involving the LNG vapors.

In the use of water spray to reduce the severity of possible explosions of LNG vapors, it is recognized that LNG vapors are not soluble in water and that the possibility of an explosion would depend on the air-gas ratio and the presence of a source of ignition. However, the presence of the water spray would dilute the oxygen content in the vapor air mixture, and that the use of water sprays could be used to direct the path of travel of vapors away from sources of ignition.

B. It is recognized that effective fire fighting or fire emergency operations can only be implemented after a specific emergency situation has been evaluated. Obviously, the combination of variables within an emergency situation work against the development of detailed, valid "pre-packaged" solutions. However, after the Officer in command of fire operations has made his initial survey to determine the nature of the LNG emergency, his decisions should be influenced by the overall strategic concepts outlined above and to some degree by certain considerations which are generally applicable to the situation. It is with that reference in mind, that, the following general considerations are offered:

1. There is no probability of a fire or explosion in an LNG storage tank as long as the tank and roof structure maintains its integrity. The constant vaporization within the tank eliminates the possibility of oxygen being present to create a mixture within the flammable range. (To assure that this condition is maintained during any change in volume of storage of LNG within the tank, vacuum or breather vents are required to allow only methane or nitrogen to enter the tank).

2. LNG in liquid form will not burn. Only its vapor will burn when mixed with definite proportions of air.

3. LNG is a liquid hydrocarbon and it has no qualities that make it more susceptible to fire than any other liquid hydrocarbon. The fact that it is lighter than air (above -150°F) when it reverts to its gaseous state minimizes the danger of its vapors pocketing or collecting in low places.

4. The Bureau of Mines has established that the maximum LNG linear burning rate under fully exposed conditions is 0.5 inches per minute and that after five minutes of burning, the vaporization and burning rate becomes constant. (This presents a means to the Officer in charge of operations to estimate duration of fire and the time when maximum fire intensity at a given location has been reached).

5. The specific location of a fire within these plants can be ascertained by a check of the indicators at the panel boards in the control rooms.

RADIATION STUDY CHARTS – TEXAS EASTERN LNG PLANT

I. EQUILIBRIUM TEMPERATURE OF OBJECTS NEAR FLAME

Distance From Flame Center Line, Feet	Summer Conditions Wind	Vel	MPH	Winter Conditions Wind	Vel	MPH
	0	30	60	0	30	60
405	372°	400	510	420°	448	558
540	315	320	446	348	353	473
675	270	268	367	290	288	387
810	240	232	289	252	244	301
1080	194	170	168	193	169	167
1350	167	Lower Than		Lower Than		
1620	148	For 0 MPH		Summer Temperatures		

In coming to the above conclusions, computations were based on the suppositions that the base of the flame would be 69′ above grade level and that the fire would continue for 45 hours. Other factors which were considered in the thermal radiation study were: The thermal output of LNG flames, absorptivity of receptors, radiation loss of receptors, convection loss of receptors, view factors, effect of wind on flame, temperature and humidities, the effect of wind on the radiation and convection losses of the receptor.

II. DISTANCE OF EXPOSURES FROM FLAME CENTER-LINE, FEET

Object	Minimum Distance, Feet
Property Line	540
Con Edison Plant	625
Railroad Spur	635
Pralls River	790
Nearest Petroleum Storage Tank	1400
Jersey Power Plant	2600

The coordinated use of Table II with Table I enabled the Department to determine the maximum temperatures on exposures when the content of the LNG tank was allowed to burn out and on the premise that no exposure protection in the form of water curtains was established. (A similar study of the exposure problem at the Greenpoint LNG plant was performed.)

6. In controlling an emergency or fighting a fire in LNG, the shut-off or block valves which isolate the storage tank from the process system or which subdivide the process system should be checked to assure that they are closed. These valves provide a means for limiting the amount of liquid or gas that could be discharged in the vicinity of containers or other important structures in the event of pipe or vessel failure.
7. When confronted with a gas fire, it is usually best to stop the flow of gas rather than extinguish the fire. It may be dangerous to extinguish the flame and allow the gas to continue to flow, as an explosive mixture may be formed with air which, if ignited, may cause greater damage than if the original fire had been allowed to burn. In many situations, consideration should be given to allow the flame to continue, keeping the surroundings cool with water spray to prevent damage to other portions of the plant and to prevent ignition of other combustibles.
8. Tests have proven that dry chemical extinguishing agent is the only practical approach to extinguishing LNG fires. The use of such dry chemicals (sodium bicarbonate or potassium bicarbonate) may be desirable to extinguish fire where necessary to permit immediate access to blocking valves to shut off the supply of gas.
9. Water may be utilized through hose lines preferably equipped with combination (spray and straight stream) nozzles to permit wider adaptability in fire control. It should be emphasized that water is used for the sole purpose of cooling equipment, foundations and piping, or making manually operated blocking valves involved in fire situations accessible to operating forces. It should not be relied upon for extinguishing LNG fires.
10. Solid hose streams can be used for washing LNG spills away from containers, equipment, piping, blocking valves and danger points which represent a source of ignition to vapors from a LNG spill.

When the Board of Standards and Appeals approved these installations, it fixed the responsibility for the fire protection with the New York City Fire Department. The Department has carried out its mission by assuring that the mechanical design of the plants are in accordance with generally accepted good engineering practices and that the selection of materials for use in cold service was based on well established cryogenic technology. In the Department's effort to ensure fire safe cryogenic plant operations, in addition to safe plant operation, emphasis was placed on providing adequate protection for surrounding property and operating personnel and equipment. ►