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Sabotage- No Excuse for 12-02-1984

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Abstract

Having been involved in process safety and risk management of nuclear/chemical facilities pre-Bhopal, I was honored (at the time naively so) to be instrumental in drafting legislation in the state of California, post-Bhopal, that soon led to regulation by Federal OSHA. In 1996, having been recruited by Union Carbide's Safety engineering group as a senior staff member, one of my many tasks was beating the US government's federal OSHA regulatory deadline of May 1997 for completing all initial Process Hazard analysis. As well I was responsible for application of carbide's pioneering methods of advanced Risk Management Planning. It is interesting to note that much of these methods have since been adopted by the US EPA. In November 2001, Dr. Raj Bisarya, former mayor and the Honorable Swaraj Puri, former chief of police of Bhopal, made an epic presentation on the aftermath of their experiences that fateful night for the very first time in USA (over fifteen years later at the invitation of US EPA Region III in Baltimore). To put this presentation in perspective, this was the same year as the 9/11 events in the United States. The comparisons were unavoidable, yet, unlike in New York, the victims in Bhopal were readily accounted for, stacked, and tagged. Then a commitment was made to these individuals to present this paper, as a former Carbider. In this paper, my effort will be to use what today would be standard process safety and risk management analysis techniques, including HAZOP, Fault Tree, and Offsite.

Consequence modeling, on the Union Carbide Bhopal Plant with, as we Americans like to say, "twenty-twenty hindsight". In doing so, I intend to demonstrate that the number of "hard" engineered safeguards may have been satisfactory in preventing the catastrophe, regardless of the claimed various versions of water

contamination as the root cause. But, without the proper technical oversight, management systems, and audits of the responsible technology owners and operators, all being "soft" administrative controls, the plant was doomed to failure. These regulations, initially regarded as burdens even in the aftermath of Bhopal, have been recently reinforced in the aftermath of the 9/11 events in the USA, and tells us to be vigilant with the soft items, but still we better have enough life boats for other real Titanics out there.

Main text:

Many papers and treatises have claimed water intrusion into the MIC storage tanks, whether by sabotage or by accident, is the root cause for the Bhopal Gas Tragedy. What is meant by root cause, is that this is not only an initiating event, but that without this event, the MIC release would not have taken place. What this paper attempts to prove, is that the water intrusion was not the initiating event. In fact, even with water intrusion, the event could have been eliminated, if not significantly mitigated, had it not been for the other independent root causes. The claim to sabotage points a finger to an individual and circumstance that appears to be beyond the control of those operating, managing, and governing the plant, a scapegoat per se; one that the public, industry, and governments may have been willing to cast out in the past, but is becoming increasingly one that must be recognized and dealt with.

The water reactions alone with methyl isocyanate could not have produced a release.

In figure 1 (figure not provided by author) are reactions with MIC and water, and their associated heats of reaction. A calculation is based on the speculation of the amount of water intrusion at 1000 liters and further assuming all of the water enters a single tank full of MIC. The estimated dimensions of the storage tank is set conservatively (the smaller the tank, the worse the potential for release) at 5 feet diameter by 10 feet long. The calculation attached on figure 2 (figure not provided by author) shows that even with all of the water reacting; the heat produced will very likely not even lift the relief valve. This is due in large part to the heat sink of the liquid MIC and water itself. But the relief valve did lift. And so what did cause the additional exothermic heat input?

It was the iron. (All for the want of the proverbial nail). Iron in aqueous solution catalyzes the reaction with MIC, and has nothing to do with water being a reactant. The MIC reacts solely with itself (trimerizes) as catalyzed by the iron, accelerated and triggered by the proper conditions generated by the milder, slower, mass transfer and stoichiometrically limited MIC/Water reactions. The reaction chemistry, heat of reaction and calculation of heat load leading to lift of the relief valve is shown in figure 3 (figure not provided by author).

This leads to another question. Where did the iron come from? The iron most likely came about due to dissolution with HCl on the walls of the vessels or piping. Where did the HCl come from? The HCl most likely came from an upset in the purification systems upstream. Entrainment or carry over of chlorine bearing constituents including HCl is a distinct possibility especially considering one of the byproducts of the reaction to form MIC is HCl. Hence the ultimate root cause is very likely the process upset leading to the presence of corrosive chlorinated compounds.

The next most likely prevention of the system from impacting the public (hence a secondary root cause) would have been the refrigeration unit. If this system was in place, the reactions may have been able to be controlled, even with trimerization. The flare and scrubber even if in operation, probably would have been overwhelmed by the flow rates of the reactions involved in the release.

Lastly and not least, is a most obvious tertiary root cause of having an inventory at all, with the safeguards dismantled. This is of particular concern due to the siting and infringement by the public that existed. Inventory of an intermediate is economically preferred for ease of maintenance and start up, but are difficult to justify with twenty-twenty hindsight of the consequences.

Attached as figure 4 (figure not provided by author) is an event tree diagram clearly showing that introduction of water is not the root cause, but only a contributing cause of the end event of a MIC release. There are several branches, that if broken could have significantly mitigated or eliminated any release.

There are some things that did work at the plant that we should take credit for. It may be hard to believe this, but it could have been worse. For example, the relief valve vented and was sized large enough to not plug with polymer and not burst the vessel. The

vessel and piping were not weakened excessively by the heat and corrosion and maintained integrity. This might have lead to even a greater volume of released gas. Lastly, the MIC did not ignite, or produce a vapour cloud explosion. The latter may actually have mitigated the incident.

Acts by individual with criminal intent against the chemical industry are only recently of the utmost concern to the chemical industry. Albeit, there was concern preBhopal. And there had been an increase in the concern since the Bhopal incident on 12/4/1984. But even with Bhopal, there has been a reluctance to consider sabotage alone as a key driving force for the way chemical plants were sited, secured and operated. In the USA as a result of Bhopal, laws were passed, basically the OSHAPSM, EPA RMP, and legislation on the state and local level that intentionally focused on conventional accidents within a plant's environment. It was not until after the attack on New York City on 9/11/01 that criminal acts against the vulnerable chemical industry, such as sabotage, came fully onto the radar screen. Yet still, even in the USA, there is a great resistance by industry to have chemical plant security legislated, as it is effectively a voluntary function executed by industry's participation and compliance with the American Institute of Chemical Engineer (AIChE) and the American Chemical Council (ACC) guidelines and recommendations. This is further subjective evidence that society at large is not yet convicted of the overwhelming threat of sabotage to the chemical industry as a whole, as well as the existence or reliance upon sabotage for the ultimate cause of the Gas Tragedy at Bhopal.