The Flixborough Disaster

On June 1\textsuperscript{st}, 1974, a disastrous explosion occurred at a chemical plant owned by Nypro. This plant was located close to the small village of Flixborough, England and produced caprolactam, a chemical used to make nylon. The sheer size of the explosion was devastating. It was said to be equivalent to a blast of 15 tons of TNT. As a result, 28 people were killed and 36 were injured out of the 72 on site at the time. It also caused widespread damage to surrounding homes and businesses. All of this destruction was a result of an ethical mistake made by an engineer. Inadequate pipework was used to bypass a leaking reactor while repairs were made. This temporary bypass could not handle the operating pressures and a leak in the reactor system occurred. A cloud of very flammable hydrocarbons formed and caused the massive explosion at the plant. This case is complex and includes relevant parties along with many engineering facts. A Kantian ethical assessment of the engineering mistake will be made later.

There are only a few relevant people to name in this disaster. Perhaps the most important party involved was Nypro UK, which was a joining of the British National Coal Board and Dutch State Mines. This company owned the plant in which the explosion occurred. A Court of Inquiry was set up by the UK government to carry out a formal investigation of the disaster. The plant and senior management were involved in the case. They were present at the meeting that determined that reactor 5 should be bypassed. The most important person involved was the plant maintenance engineer, or lack thereof. The
post of plant maintenance engineer had been vacant since the beginning of 1974. An unqualified technician was filling this position. This played such a huge role in the Flixborough disaster because a qualified maintenance engineer may have had the knowledge and experience to prevent the failure altogether. Finally, the inhabitants of Flixborough, England and the neighboring towns were involved in this case. The explosion directly affected them by damaging and even destroying most of their homes and businesses[1].

The engineering facts of the case are quite extensive because they involve chemical reactions and reactors. They are, however, essential to the ethical analysis to come. The Nypro plant was built to produce fertilizer and then changed to produce caprolactam later in its existence. Caprolactam is used in the production of nylon and includes a cyclohexane oxidation process, which utilizes a series of 6 reactors. These reactors were connected with 28-inch diameter pipes and had a 250 to 300 m$^3$/hr liquid flow through them. “On March 27th, a cyclohexane leak was observed on reactor 5 at the level of a vertical crack within the sidewall” (Aria, Catastrophic Explosion of a Cyclohexane Cloud). With the crack expanding, reactor 5 was removed for repairs and inspection. Nypro wished to resume production as quickly as possible, so they decided to bypass reactor 5 and connect 4 directly to 6. The ethical mistake occurred here. This bypass was built based on a drawing produced on the shop floor, no pressure testing was carried out, the elevation drop between the reactors was not accounted for, and 20-inch diameter piping was used instead of 28-inch. In addition, the plant maintenance engineer was not experienced enough to foresee a problem. The new 20-inch pipe that connected reactor 4 to reactor 6 was shut down on May 29th because of a cyclohexane leak[1]. On the morning of June 1st, other leaks
were found and at 4:53 pm, the explosion occurred. As noted earlier, 28 people were killed while 36 were injured at the site. It was very fortunate that the explosion did not occur during normal operating hours in which around 550 plant employees would have been present. In addition, the property damage was tremendous. “All buildings lying within a radius of 600 meters around the explosion epicenter were destroyed” (Aria, Catastrophic Explosion of a Cyclohexane Cloud). It was estimated that the explosion did over $100 million in damages. There were a couple theories as to the cause of the accident. The Court of Inquiry determined that internal temperatures and pressures of the temporary bypass pipe caused it to leak and eventually sandwich rapidly. This leaked until a 40- to 60-ton cloud of cyclohexane ignited. All of these facts lead back to the failure of the involved parties to adequately perform tests and make calculations to determine if a bypass pipe would be safe. The engineers failed on this account and jeopardized the safety of everyone working in the plant as well as the public in the surrounding areas.

The primary managerial decisions of this case ultimately led to the ethical mistake and the plant failure. The plant had a goal of producing 70,000 tons of caprolactam per year. This was hindered by a miner’s strike, which caused the British government to declare a state of emergency[1]. Industries could only use electricity 3 days in a week. Reactor agitators were deactivated and the agitator on reactor 4 had become unusable after the strike ended. The plant was now only producing 47,000 tons per year and, as a result, the plant operator was being pressured to increase production drastically. This factor contributed to the hasty decision to create the bypass pipe. Perhaps the biggest managerial error made in this case involved the vacant plant maintenance engineer position. This was discussed briefly with the relevant people of the case because it is
significant to the cause of the explosion. Nypro had a vacant maintenance engineer position since the beginning of 1974. There weren’t any engineers who were trained to fill the position, so an inexperienced technician was filling it. There is a strong feeling that a qualified engineer would have spoken strongly against the use of an insufficient bypass pipe and the failure could have been prevented[1]. These managerial and political facts certainly contributed to the Flixborough disaster.

An ethical evaluation of one of the decisions made throughout the course of this case can provide valuable insight as to the moral soundness of that specific decision. In this Flixborough disaster case, Nypro’s decision to leave the post of plant maintenance engineer vacant for so long and then to allow an unqualified technician to fill the position will be examined. This decision will be evaluated using Kantian Ethics. The Categorical Imperative (Universal Law Formulation) version of Kantian Ethics will be used. This states that you should act only according to that maxim by which you can at the same time will to be a universal law. A maxim is a personal rule of thumb that guides behavior and universal law is moral rule binding on everyone. Evaluating a decision with Kantian Ethics requires a number of steps to determine if it was morally right or wrong. First, a personal maxim must be made from the decision and this must then be turned into a general maxim. It is then visualized what the world would be like if everyone followed the general maxim. Finally, it is seen if the maxim passes Kant’s test, which consists of 3 parts. The personal maxim is, “Whenever I have an empty plant maintenance engineer position, I will fill it with an inexperienced and unqualified technician.” To convert this to a general maxim, “I” is changed to “one” in the personal maxim. Therefore, the general maxim is, “Whenever one has an empty plant maintenance engineer position, one will fill it with an inexperienced
and unqualified technician.” If everyone followed this general maxim, there is a great possibility for the world to be in disarray. It may very well have no effect on many plants, however, disasters like the one experienced at Flixborough would be much more likely to occur. This is because inexperienced plant maintenance engineers may not be able to foresee possible plant failures as a result of their insufficient qualifications. This would lead to a trend in hiring unqualified technicians for engineering positions and jeopardize the integrity of the profession. To see if the general maxim passes Kant’s test, it must pass no contradiction, no self-defeat, and no compromise of everyone’s general desire for happiness. This decision passes the first part of Kant’s test and has no contradiction. However, it fails the second part of Kant’s test because it is self-defeating. In an attempt to keep the plant safe and maintained, Nypro filled the engineering position with a technician. This ultimately led to the explosion and destruction of the plant instead of making the plant safer. Therefore, this action was self-defeating. It also fails the last part of Kant’s test. Perhaps most obviously, this decision compromised everyone’s general desire for happiness. The explosion killed and injured many people and also destroyed numerous homes and businesses in the surrounding areas. Because the decision fails at least one of the conditions of Kant’s test, it cannot be willed to be moral law and was morally wrong. Nypro should not have filled the plant maintenance engineer position with an unqualified technician. Had they not done this, the disaster may have been prevented.

There are almost always several pieces of advice that can be taken from disasters like these in order to mitigate occurrences of them in the future. For fellow engineers, it is advised to never hire workers to fill positions for which they are not qualified. This prevents accidents and errors caused by inexperience. In addition, testing and calculations
should always be performed when augmenting a dangerous chemical reactor system or any other integral piece of engineering equipment. If Nypro had done testing, they would have found that the bypass pipe would most likely fail. They could have thought of a different way to bypass reactor 5 or scrapped the idea altogether, preventing the explosion. Engineering disasters like these occur more often than they should and can easily be prevented by acting ethically.
Works Referenced


