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Missing safety measures led to the jet fire and seven deaths at a steel plant in Turin. Dynamics and lessons learned

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ABSTRACT

The Authors of this paper are the technical experts that were entrusted by the Public Prosecutor to conduct the technical inquiry into the accident that occurred in the ThyssenKrupp plant in Torino on December 6, 2007. The paper contains the results of the inquiry under the above mentioned point of view. The dynamics of the accident, the main causes and the consequences have been defined.

This was an unusual accident from which important lessons can be learned. On December 6, a modest fire developed in the entry section of a pickling and annealing line in the TK plant in Turin. The eight workers on duty seized the firefighting equipment and started to try to extinguish the fire. The workers had portable fire extinguishers and a fire hydrant, so they had to get close to the fire to fight it. Suddenly, a violent jet fire, caused by the rupture of a hydraulic circuit, occurred. The flame instantaneously struck the eight workers while they were still fighting the fire. Seven workers suffered very serious burns, one died instantaneously while the other six had over the following month. One of the workers, who was partly protected by an operating machine, suffered only minor burns and survived. The paper contains some important lessons that have been learned from the present case, which demonstrate that the fire risk at pickling and annealing lines has generally been underestimated by the steel industry. The fire risk due to hydraulic actuators is also evident and new fire fighting strategies are suggested.

1. Introduction

Stainless Steel coils are produced throughout the world in a multitude of industrial sites. The process is conceptually simple, whereas the mechanics of the machines are rather sophisticated. The process phases, which are well known, are melting, casting, hot rolling, cold rolling, pickling and annealing. The accident occurred at a pickling and annealing line, two operations that are usually conducted in the same plant. Pickling and annealing lines are conceptually very simple: steel coils have to be unrolled, then a thermal treatment is conducted in a furnace and chemical and electrochemical pickling is performed in a series of basins. After these treatments, the coil is re-rolled. The main technical challenges of the process derive from the need to run both the thermal and the electrochemical processes continuously, even when the coils have finished. In order to comply with continuous process constrains, the subsequent coils have to be welded, and this introduces a discontinuous process. As a consequence some complications arise in the architecture of the lines. These lines should be provided with devices able to temporarily store the length of coil that must be supplied to the furnace and to the pickling section while the unrolling is suspended during welding. Further complications arise from the weight of the coils, reaching several Tons, depending upon the length and width, from the need to guarantee the correct traction of the coil, and from the need to move it over several hundred meters of process line while providing adequate position control.

The coil is handled via hydraulic systems which use mineral oil. This oil is not usually flammable (see its properties in Table 1), but it is of course combustible. Hydraulic circuits are fed with high pressure oil. In this case, the pressure ranged from between 70 and 140 bar. Under these conditions, highly flammable spray/mists can originate from small leaks. As a consequence, a diffused fire risk should be recognized in P&A lines. Other sources of fire hazards are the flammable/combustible materials that accompany the coils which come from the lamination process. A paper ribbon is placed between the steel coils at the end of the lamination to prevent surface damage. The paper absorbs the lamination oil residue present on the coils and sometimes sticks onto it due to high temperatures and oil ageing. In this way, paper can spread along the

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