RFID & Safety in Industry

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Abstract

This report includes a study of RFID's use in industry over the past few years specifically relating to the safety of employees in a manufacturing and factory workspace. Case studies and methods will be discussed along with the specific techniques and technology implemented.

Introduction

The need for higher degrees and regard for the safety of workers is generally something that companies are concerned about. As standards of safety increase, companies are looking for new technological advances that can enhance the safety of employees while still allowing them to perform at work. RFID (radio frequency identification) technology has recently begun to be used by larger companies, especially in factory or manufacturing settings, to ensure the safety of their employees, especially in the case of an emergency. This involves obtaining an accurate account of which employees are in or have left, and the tracking of employees within the work area so that they can be located in the case of an emergency.

In most cases, a real-time location system (RTLS) is implemented, which provides a frequently updated view of the work place. The view responds in real-time to changes in the environment, such as movements of workers. As a result, the location of employees is known at all times. An RTLS can also be used with moving machinery,

such as forklifts or cranes, to track their movements and possibly warn employees and drivers of potential collisions.

The BP Cherry Point Model

British Petroleom's refinery in Cherry Point, Washington is the largest refinery in Washington State. Each day it produces approximately 3.5 million gallons of gasoline, 2.5 million gallons of jet fuel, and 2.2 million gallons of diesel fuel, and normally contains 2,000 staff, contractors, and visitors at a given time. [1]

On March 23, 2005, BP's refinery in Texas City experienced multiple explosions within the plant, killing 15 workers and injuring 100 others. [1]

> "The Texas City facility had outmoded venting stacks that had not been replaced by a more modern flaring system. When the plant's distillation tower was restarted on March 23 after routine maintenance, a pressure build-up caused a geyser-like release of flammable hydrocarbon liquid and vapor from an atmospheric vent stack. The eruption caused at least five explosions, killing 15 people who were in or near temporary mobile trailers near the unit." [2]

The accident was called the worst U.S. industrial accident in fifteen years and BP was fined $21.3 million by the U.S. government and paid out over $700 million in compensation. They also had to build a new office building in downtown Texas City for about 400 BP staff workers. [2]

This incident caused them to examine the company's safety culture and resulted in the development of an RFID-based employee tracking system, to be implemented within the refinery. Research on such a system had already begun, the incident merely causing its installment to become higher on the priority list. [2]

Before the incident, other methods for tracking the entrance and exit of employees from the plant were used. Bar-coded identification cards were used to track the ingress and egress of the plant, which required individual cards to be scanned. In the case of an emergency, this afforded a solution far too slow to be used as the cards had to be scanned at close range. The plant then switched to a passive RFID badge system where employees passed through a turnstile. However, this too was inadequate in the case of emergencies, as the readers were ineffective in reading the large number of tags passing by at fast speeds. [1]

With either method, a headcount procedure was instead used in the case of evacuations. But according to Bill Campin, the evacuation coordinator at BP Cherry Point, the headcount procedure could be off by 100, taking even up to the rest of the day to reconcile. [2]

This led to the implementation of a Location Aware Safety System (LASS), first to be tested at the Cherry Point refinery in June 2006. The LASS uses current RFID technology to track the location of workers within the plant so that they can be seen and found in the case of an emergency. Each employee wears an RFID badge at all times. The badges send a signal that is picked up by readers within the plant and the location is sent to a central computer that displays the real-time locations of the employee on the monitor. In the case of emergency, the readers at evacuation points are able to capture the data

from each badge as they pass through the exit gates. Employees still within the plant can be seen on the monitor, and the operator can identify the person assigned to that particular RFID badge. In this way, an accurate account of who is in or out of the factory can be had in the case of another accident. [1]

Besides keeping an accurate count of who is within or without the factory, the LASS drastically reduces the need for rescuers to spend time in a potentially hazardous oil facility. Since the location of any employee still in the factory is known, whether injured or not, the rescue team can go directly to the person in need of help and will not search in areas that do not require searching. This eliminates unnecessary sweeps of areas and reduces the time an injured or trapped employee waits until he or she is found. [3]

The RFID badges used in the LASS are made by Multispectral Solutions Inc. The badges are active, meaning they require a battery, and can function for about two years without replacement of the battery. The tag transmits a pulse with a unique ID every second, giving the reader an update on the location of the person for virtual real-time following. [1] The badge also triggers an alert if it is detected to be motionless for a set period of time. [2] More details and specifications can be seen in Table 1.

The tags used operate over Ultra Wideband (UWB) frequency (5.925 to 7.25 GHz). UWB technology simultaneously transmits over multiple frequency bands (anywhere from 3.1 GHz to 10.6 GHz), consumes less power than conventional RFID systems, and can be used in close proximity with other RFID systems or signals and not cause interference due to the different signal types and radio frequency spectrum used. UWB also performs better indoors because the bursts of pulses emitted from the UWB tags are easier to filter from signals reflected from multiple surfaces. It works better

across structures and through walls, but metallic and liquid barriers still cause some interference. According to the company, this can be nullified by the placement of the readers and by using more of them. [6]

The reader used is Multispectral Solutions' Sapphire Dart system. The readers can receive pulses hundreds of feet away and determine the location of the tag using a set of algorithms. BP used about 10 readers initially, at about $3,000 each, operating between 5.925 and 7.25 GHz. [1] [5] [7] Table 1 contains more of the specifications.

The software used within the system is a model of IBM's WebSphere, and a customer tracking interface called Atlas is used to collect the data. [1] IBM Software Group and IBM Global Business Services were also responsible for making the real-time visualization module to provide the view of the employees. [3]

Tag	T651-BDG (or similar)	Reader System	Sapphire Dart
Size	1.66 x 0.28 x 2.92 in.	Size: UWB Receivers Size: Processor/Hub	2.5 x 2.5 x 5.5 in. 14 x 9 x 3.5 in.
Weight	1.8 ounces	Weight: UWB Receivers Weight: Processor/Hub	16 ounces 58 ounces
Power	1 Watt	Power: UWB Receivers Power: Processor/Hub	20-48 VDC 100-240 VDC
Battery	CR2032	Real-Time Location Accuracy	30 cm
Battery life	2 – 7 years	Read Range	200 m (line of sight) 50 m (obstructions)
Mounting	Badge clip	Operating Frequencies	5.925-7.250 GHz
Tag Transmission Rate	Up to 200 times/sec	Tag Throughput	5,000 tags/second
Cost (each)	$40	Cost (each)	$3,000

Table 1: Tag and Reader System Specifications [4] [5]

With the system in place, all persons are required to wear the RFID enabled badge in the processing area, tank farm, and docks. The system originally covered a 600,000 square foot area broken down into eight different sections and eventually the coverage was increased to 1.5 million square feet by the third quarter of 2006. [1] Its range can be set to block out certain areas on the computer where monitoring is inappropriate, such as bathrooms. [8]

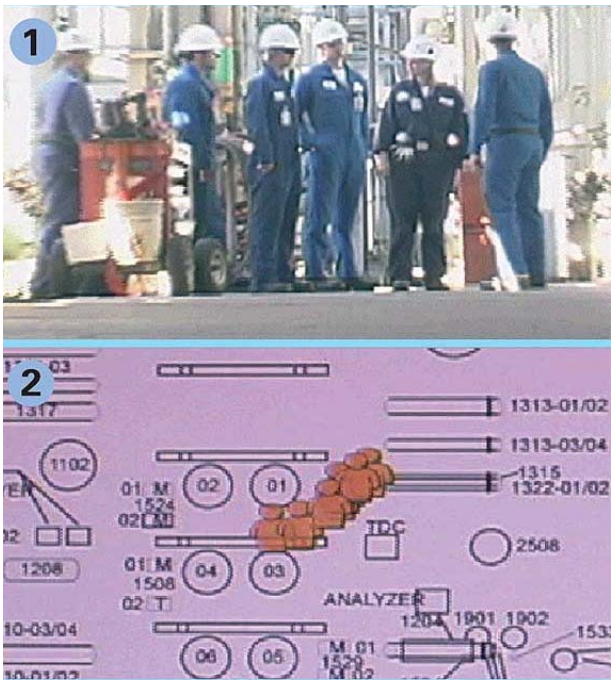

Figure 1 shows an actual snapshot of employees congregating in an area and the corresponding screen of the LASS.

Figure 1 [8]

The software can also set up, record and track employee location in specific zones. In the case of an emergency, employees can be tracked and counted in specific areas, such as safety zones, for a far quicker headcount procedure. This can be seen in Figure 2.

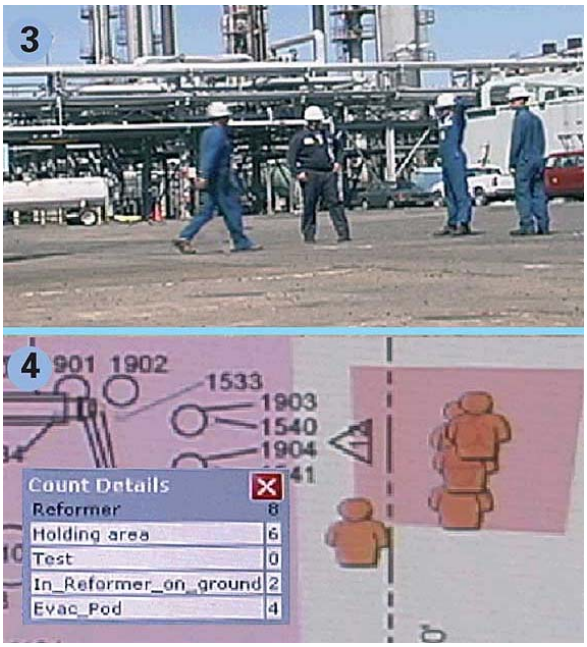

Figure 2 [8]

BP Louisiana

BP also tested another RFID system at their preservation and maintenance facility at Houma, Louisiana. The facility, 11,600 square meters in size, is used to preserve over 30,000 pieces of offshore equipment and materials that are needed for BP's operations in the Gulf of Mexico. Such operations require heavy mobile vehicles, such as forklifts and cranes. [9]

Lifting hazards, such as people being struck by moving cranes or loads, are a major source of accidents in offshore installations and drilling rigs. This being the case,

each employee that could come into the vicinity of such vehicles, as well as the vehicles themselves, are equipped with an RFID tag which sends real-time location information back to a central computer. If the computer 'observes' a potential collision between a moving vehicle and a worker, an alarm sounds which alerts the operator of the vehicle. This provides the driver a better awareness of his or her surroundings and should help prevent collisions. [9]

Several problems were encountered with this system. With fast moving loads, the need for precise real-time location information was realized. Predictions required complex algorithms and were hard to make concerning a potential collision. Also, the rapidly changing environment made it difficult to manage, as the topology of the work floor would change every time a box or crate was moved. However, the Digital Communications Technology team from BP predicted a usable system by around 2009. [8]

Sellafield Nuclear Power Plant Decommissioning

Another RFID system was put into use at the Sellafield nuclear power plant in Cumbria, England. Sellafield was mainly a plutonium production plant and was operated by BNFL (British Nuclear Fuels) until being taken over by the Nuclear Decommissioning Authority in 2005. A massive nuclear waste leak, referred to as the Thorp Plant Leak, was discovered on April 19, 2005 at the plant. In the Thorp reprocessing plant, a cracked pipe had leaked 83,000 liters of radioactive waste into a concrete sump built to contain leaks. There was a noticed discrepancy in the material entering and exiting the Thorp processing system since August 2004, but it had been ignored. As a result, around 19 tons

of uranium and 160 kilograms of plutonium in nitric acid have been pumped from the sump vessel to a holding tank. [10]

The decommissioners of the site are employing an RFID system to increase the safety of the workers decommissioning the plant. Ubisense, a supplier of UWB and RTLS technology, and BIL Solutions, a company that does monitoring, measurement, and detection technology for defense and nuclear industries, have partnered together to provide location information and detection of radiation for all the workers in the nuclear power plant. [11]

Employees working on the decommissioning of the power plant wear both RFID tags and Automess 6150 AD dosimeters, which measure levels of radiation. This provides real-time location information on both the employee's whereabouts and the amount of radiation exposure in different areas. The software, Ubisense Smart Space software platform, provides a 3D view of the facility with radiation levels shown in different colors. Managers can plan the work assignments based on the radiation data, moving workers in high radiation areas to other areas with lower radiation levels. This improves the safety of the workers, minimizing their exposure to the radiation, and keeps track of their position should an emergency occur. [11]

The tags worn by employees are Ubitags by Ubisense. They are active tags, operating between 5.8 to 7.2 GHz, with accuracy that approaches 15 cm in each direction. They cost anywhere from $50 to $100 dollars and transmit their unique 32-bit ID number 10 times a second in this application. [12] The readers used are 6 inches tall and are networked with Ethernet cabling. This type of system requires at least four readers to create cells throughout a building, and can read as far as 150 feet away. [11]

With this system in place, the safety of the employees working within the facility is improved by a considerable amount. Safe evacuation procedure and minimization of radiation exposure are important factors. Being able to see a 3D view of the full plant will also help in productivity, as managers decide where to best place workers.

Overall, the benefit of RFID and its use in RTLS in industry has been seen, at least to a small degree, in most of its applications. Without having to completely revamp a companies structure and safety procedures, RFID has provided a solution that can be fairly easily implemented, at least in the basic models, and can significantly raise the bar on the quality of safety a company's employees experience. In the future, perhaps the use of such technology will become commonplace in factories or manufacturing plants that hold safety as a high priority.

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