

# Effective Personnel Tracking in Hazardous Environments

## Abstract

The production, transmission, processing, refining, and distribution of hydrocarbons involve substantial risk. Accidents, and the subsequent environmental damages, affect not just the people responsible for the disaster, but also the ones in the vicinity. In spite of implementing best policies and procedures, there have been instances of negligence that have caused equipment failures leading to environmental disasters and human casualties. Therefore, effective tracking and monitoring of personnel inside tall massive metallic structures in an inflammable environment is essential for the well-being of workers and for smoother emergency rescue operations in the wake of a disaster.

With more than 700 operational oil refineries across the globe, which process more than 70 million barrels of oil per day, the probability of a major incident is alarmingly high.

## Challenges in Ensuring Personnel Safety in Hazardous Hydrocarbon Processing Environments

Refineries are extremely hazardous, high risk facilities since they involve the processing of hydrocarbons at high temperatures and pressure. Due to the increased possibility of accidents in such environments, constant tracking and monitoring of personnel and their precise locations, is imperative. This will ensure on-time emergency evacuation in case of accidents.

However, deploying such tracking mechanisms in such harsh environments characterized by high metallic columns, chemical storage tanks, pipes, pumps, boilers, evaporators, decanters, and purifiers, poses many challenges. The atmosphere may be sultry and noisy. There could be patches of dark or poorly lit areas where the line of sight is restricted to a few meters. The personnel are also required to don safety apparel, which act as a hindrance to visual tracking devices.

The moist air surrounding offshore platforms absorbs radio waves from trackers, and the metallic structures prevent the radio waves from being transmitted effectively. The wide spectrum of sound waves generated from machines, motors, and flowing fluids in pipes and columns could interfere with ultrasound applications. Vibrations from the movement of viscous fluids, motors, pumps, and heavy equipment create disturbances. Magnetic waves generated from huge electrical cables and appliances generate pools of localized eddy currents within the metallic structures which interfere with RFIDs and other contemporary beacon-based alarms..

## Harnessing the Best of Technologies for Tracking Personnel in Metal Environments

Techniques for tracking personnel in challenging and hazardous working conditions include RFID-based tracking, Ultrasound ID (USID) badges or tags, digital video tracking, and GPS-based tracking. There are a few promising technologies that have the potential to simplify the process of personnel tracking such as infrasound beacons, laser light bursts beacons, and barcodes.

The key to an effective personnel tracking system: use a combination of RFID, ultrasonic waves, videography, and barcodes.

Each technology has its own set of merits and demerits, and no single technique for personnel tracking can comprehensively address the challenges posed by hydrocarbon processing units. Therefore, a combination of techniques, along with immaculate design to address each and every area, is recommended. In addition, integration with a central monitoring room will help trace personnel and raise alarms for faster response during emergencies.

A combination of RFID, ultrasound, videography, and barcodes is ideal for overcoming the complexity of metallic barriers, eddy currents, electromagnetic fields, broad range of sound frequency, and poor lighting conditions. Using RFID at the core of the solution would be ideal since it is low cost and durable, and works well even in harsh weather conditions.

However, it is also important to address its downside with respect to detection of tags in a metallic environment. Using passive receivers that receive signals only from active tags makes RFID much more efficient in a metallic environment. To increase the efficacy of passive RFID readers, they can be mounted on radio signal absorbing pads, which help negate the effect of residual radio waves or magnetic fields from electrical equipment. Further, using small parabolic mirrors behind passive readers, along with directional and omni-directional antennas positioned under the roof in covered areas, or on the surface of tall structures, enhances signal reception from active tags embedded in the safety caps. Based on the concept of triangulation, back-end applications can narrow down the location of personnel.

In spite of using the most efficient RFID combinations, undetected pockets can exist between intricate, massive, metallic structural stretch. In such circumstances, it is prudent to have a backup: ultrasonic detection devices. Ultrasound waves are mechanical, and therefore get reflected back to nearby sensors, which not only helps to detect, but also pinpoint the exact location of personnel even in extremely remote and congested areas.

Optical surveillance can supplement RFID and ultrasound tracking devices, since most facilities are already under constant video surveillance. Moreover, video cameras are unaffected by electromagnetic, radio, and mechanical sound waves. High resolution commercial cameras with optical zoom feature make it easier to capture the stress and discomfort of

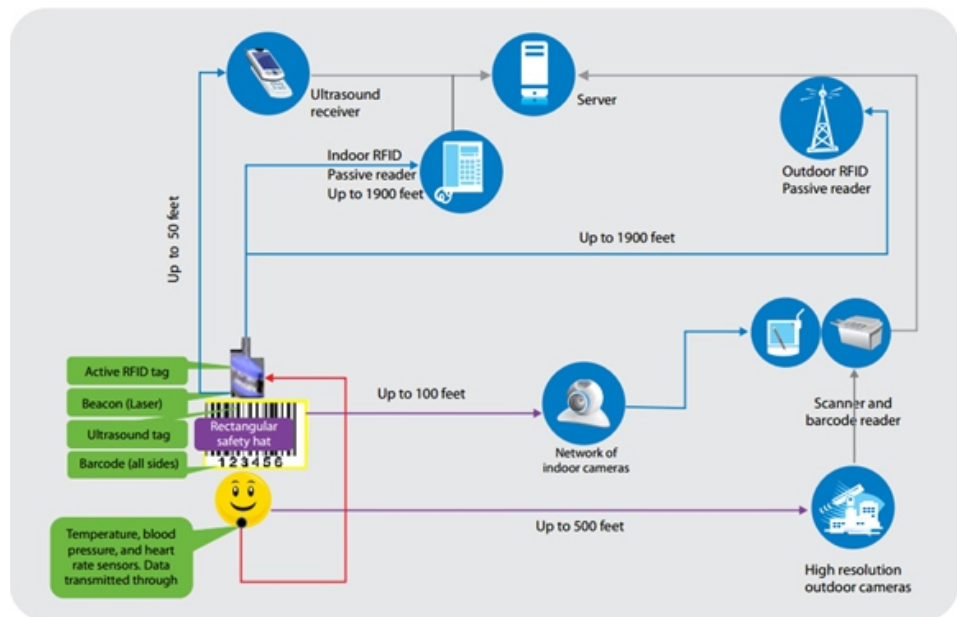
personnel which is not possible with RFID and ultrasound devices. They can also capture barcodes printed on the safety caps or the uniform of a worker for accurate identification.

The entire facility can be split into zones based on the probability of hazards and risks. Creating special routes facilitates the tracking of personnel entering and exiting these zones. Enhancing the existing video feeds with powerful cameras placed at these strategic locations helps in capturing any visual irregularities that depict distress. In case of emergencies, the streaming video proves useful for scanning the area and devising an effective evacuation strategy. Alarms can be raised after the lapse of a predefined timeframe. The personnel tracking application can be linked to a compliance system to generate reports and publish warnings in case of violations.

## Designing the Ideal Track-and-Trace Approach

A safety cap with embedded long-range RFID and ultrasound tags, 4"X6" barcodes imprinted on the sides and the top, with a visual and audio beacon mounted on it, seems the most appropriate solution. The total weight of this head gear should be within 70 grams. Blood pressure and temperature sensors can be attached to the worker's body, and the RFID tags can transmit data from these sensors to the central application. Passive readers mounted on a magnetic barrier must be placed at the end of passages and corners, both at high and low points, so that radio waves from tags can reach them. Underlying algorithms that calculate the common coverage across readers are needed to determine personnel location.

In addition, ultrasonic readers mounted indoors and in congested areas help pinpoint the exact location. Hand-held passive readers can also be used to locate a worker in the unfortunate event of a disaster. Infrared cameras or high resolution video cameras can be placed at all entry and exit points, along the passages, and at the work stations, as well as between walk-throughs, to capture a holistic view. These images can then be scanned in real time. Barcodes help in identifying personnel and storing Information, and beacons get activated if a certain worker is immobile for a considerable period of time.



*Ideal system design for a personnel tracking solution that makes use of RFID passive readers, ultrasonic receivers, and cameras, to effectively capture signals.*

## Conclusion

The increasing number of accidents in the oil and gas industry point to the growing need for more effective tracking of personnel to ensure their safety and prevent potential disasters. A combination of long range RFID active tags, ultrasound tags, and passive readers can effectively detect and track personnel while monitoring their vital parameters.

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