Enhanced Worker Safety in Process Industry Environments

White paper by **John Hartley**, CEO of Extronics, July 2020
The safety of workers, whilst always important, is moving higher up the list of priorities for investment. Companies operating within the process industries are continually looking to ensure their workers are safe whilst making sure they are getting the most from their investments.

Back in 2005, when the first intrinsically safe Active RFID Wi-Fi RTLS tags were made, the goal of the oil and gas industry was to use technology to improve worker safety. That aim still holds true, though adoption has been slow for various reasons, such as the maturity of available technology and concerns over costs and benefits. Health & Safety legislation is also not prescriptive, requiring companies to take reasonable steps to protect their employees but not specifying how. Using ‘best practice’ as a benchmark is a continually moving target, and when it comes to making significant investments in unproven technologies, no one wants to be first.

However, 2020 gives us a different picture. With wireless and RFID technologies widely used to protect workers in other industries (such as the emergency services and healthcare) and high-profile process industry employers like Shell and Suncor leading the way in creating the best practice of today, worker safety is coming to the forefront once more.
Workers in process industry environments face a variety of risks over and above their counterparts in other industries. ‘Hazards of the job’ are that much more serious, with a higher potential risk. Falling objects, fire, and explosion of flammable gas and dust are potential threats and whilst large-scale disasters are thankfully rare, they still occur. In 2010, eleven people lost their lives at the Deepwater Horizon oil rig in the Gulf of Mexico. In 2014, 301 workers died in the Soma mine disaster in Turkey. In 2015, four workers at a wood processing plant in Cheshire, UK, were lost in an explosion.

These types of disasters are the ones to hit the headlines, but there is a huge range of more ‘everyday’ concerns for a process industry worker. From 2008 to 2017, 1,566 workers died from injuries in the US oil and gas industry; almost the same number of US troops were killed in Afghanistan during that same time. Falls, crushing between heavy machinery or raw materials, machinery failure, and lack of oxygen are all causes for concern, as is the inherent risk posed by working at height, alone, or in confined spaces. Workers are at risk from exposure to radiation or toxic fumes, noise, and extreme temperatures. They are also subject to the same potential medical emergencies as all humans are; the risk resulting from a medical emergency, such as a heart attack, is made more serious by the physicality of their roles and their working environments.

1. https://www.epa.gov/enforcement/deepwater-horizon-bp-gulf-mexico-oil-spill
When trying to address the requirement for worker safety, we start by identifying operational challenges that need to be overcome - **what do we want our worker safety system to help us achieve?**

**Enhanced Worker Safety**

This is the obvious one - identifying where workers are, their current level of risk, and making sure that they are accounted for. This often includes providing workers with emergency call buttons with which to request aid or alert the control room to a developing situation, as well as automatic mustering of workers during emergency evacuations. Being easily able to distinguish which workers have reached refuge points and which are still in the line of fire is key information to inform actions when things go wrong.

**Lone Worker Safety**

Lone workers are, by their very nature, at a higher risk than those working in pairs or teams. They require ways to quickly call for help, but we should also consider tools to warn them of potential hazards like gas, and automatic alerts should the worker become incapacitated before they can raise the alarm, such as in a fall.
Confined Space Entry

This is a specialised area of higher risk work, about which entire white papers could (and have) been written. Traditional management methods can be labour intensive, requiring watchmen for each entry and ongoing monitoring on site. More modern solutions to manage this remotely can reduce the time and cost of such work without compromising safety.

Worker Accountability

Accurate recording of which workers (including contractors) are on site at any given time are absolutely required for compliance, invoice management, and security. It is also imperative that, should an emergency occur, every worker can be mustered and rescue teams can help those in need without wasting time searching for workers who are not actually on site.

Worker Productivity

When companies are investing in costly construction or turnaround projects, time matters. Streamlining workflows, reducing time spent searching for tools and materials, and keeping projects on track is a major concern.

So how do companies reduce these risks to their workers, whilst remaining operationally capable? Many are still using old-fashioned processes and procedures to account for people, such as signing-in books or T cards. Some have moved to an access control system that provides more oversight, such as automated headcount, but still an old-fashioned solution. Point solutions for lone workers have been available for years, such as walkie talkies with man down alerts or personal gas monitors, but these are difficult to scale cost-effectively and do not provide any other functionality to combat other operational challenges. In 2020, there are better solutions.
RTLS, or Real Time Location Systems, are a modern solution for the operational environment of today. An RTLS monitors the location and status information of personnel and assets in real time, providing the latest business intelligence to inform everything from crisis decision-making to route planning and work schedules. It can often also integrate with existing solutions, such as access control and PAGA systems, as part of a site-wide IIoT connectivity program.

There are several key technologies that may be used to create an RTLS.

**Active RFID**

An active RFID RTLS uses battery-powered tags that emit an ID signal at regular intervals. The signal is picked up by readers; depending on the radio frequency, this may be a dedicated RFID reader or a standard Wi-Fi access point. The signals are then interpreted, and the information provided in a software platform.

Active RFID tags typically transmit on a fixed frequency, though this can vary depending on their intended application.

**Wi-Fi**

Wi-Fi access points can be used to detect signals from an active RFID tag transmitting at 2.4 or 5GHz, but they can also be used to pick up on the presence of other Wi-Fi enabled devices. Using Wi-Fi as a framework can provide greater flexibility, as you may not be tied to a proprietary technology, and quicker ROI, as the wireless network can be leveraged for other applications, such as communications, as part of the Internet of Things and the move towards digitalising sites.
BLE is a wireless network technology with reduced power consumption compared to its predecessor, classic Bluetooth. BLE devices can be detected when in proximity to a BLE beacon or BLE gateway, similarly to an active RFID tag and reader.

Global Positioning System (GPS)

GPS is a satellite-based location system that provides geolocation and time information to a GPS receiver anywhere where there is an unobstructed line of sight to four or more GPS satellites. Obstacles like buildings may obstruct or reflect the GPS signals, reducing connectivity and accuracy. The GPS receiver does not need to transmit any data and it operates independently of any telephone or wireless signal, but if the GPS data is to be used in an RTLS then either cellular or Wi-Fi signal is needed for backhaul.

Ultra-Wide Band (UWB)

UWB is a radio technology that uses a low energy level to transmit high bandwidth communications for a short distance over a wide range of the radio frequency spectrum. UWB is well-suited to short-range indoor applications, such as “see-through-the-wall” radar imaging, sensor data collection, and precise location tracking.
ENVIRONMENTAL CHALLENGES

The process industry environment can be very different from non-industrial sites, with its own set of challenges. The scale of processing operations can require sites stretching over large areas, such as the INPEX Ichthys LNG onshore processing plant in Australia at 361ha⁵ or Petronas’ RAPID project in Malaysia, covering 2000ha⁶. Providing true site-wide coverage for an RTLS can become expensive.

Sites can encompass a variety of areas; indoor and outdoor, open and dense, flat and multilevel. To choose an appropriate technology, it is important to identify what areas are present and how workers are moving between them, so they can be monitored throughout their workday.

Process environments are often highly metallic, which can cause interference with location signals. Multipath and interference have historically caused issues with Wi-Fi performance in application without line of sight, but the latest 802.11 standards and MIMO functionality have functionally overcome those problems. 802.11 is the international protocol for Wi-Fi; this is what will be found in the home or offices. This gives a common platform for which devices can be designed to ensure that everything works together correctly. Over the years, the 802.11 standard has been progressing as technology improves and developments such as the multiple antenna MIMO system has greatly improved wireless capability in the industrial sector by enabling it to cope with the multipath reflections caused by these environments.

⁵ https://www.nsenergybusiness.com/projects/ichthys-lng-project/
⁶ https://www.hydrocarbons-technology.com/projects/petronas-rapid-project-malaysia/
Industrial facilities can also include hazardous areas, where there is flammable gas or dust in the atmosphere. Equipment used in such areas is subject to additional legal requirements to reduce the risk of explosion. The main standards for hazardous area equipment globally are ATEX, IECEx, and North American NEC 500/505. For ATEX and IECEx, covering the majority of the world, the IEC 60079 series of standards are typically used for the approval of equipment for Hazardous Areas. This is usually IEC 60079 Part 0 (General Requirements), Part 1 (Explosion Proof enclosures), Part 11 (Intrinsic Safety) or Part 15 (Type n). Any RTLS used on such sites would require certified equipment to provide full site coverage.

Even in industrial ‘safe areas’, which is to say that they are not defined as hazardous areas, rugged equipment is needed. Personnel are often working outside in variable weather conditions, and roles involve a higher proportion of physical labour where equipment can be dropped or damaged. Any RTLS would need to have strongly built components with high ingress protection (IP) ratings to prevent damage from the elements. They would need to be durable enough to withstand a normal work usage, small enough to not hinder workers, and flexible enough to be mounted in a practical way.

Industrial sites have a large number of workers moving around, meaning that more people are at risk. This number can also fluctuate, for example as contractors are brought in to increase production or to accomplish a turnaround. Any RTLS would need to be scalable enough to cope with growing headcount and incorporate the ability to view the site at macro and micro levels.
So, we have a variable physical environment with a range of operational challenges to overcome. It is unlikely that any one location technology ticks all of your boxes, and there is no silver bullet. Hybrid location is the only practical solution to the complexities of the use cases in the process industries. It involves using two or more location technologies as part of the same solution:

- To deliver wider coverage with reduced infrastructure
- To add greater accuracy in certain areas
- To provide additional functionality
- To reduce total cost of ownership

A hybrid location solution can involve multiple devices but can also involve a purpose-built multi-technology device. One technology alone cannot solve the diverse nature of the use cases either economically, in a cost-effective way, or practically, addressing the different physical and technical requirements.

Hybrid location is not a new idea. Indeed, the need to use multiple technologies was recognised by many RTLS vendors over a decade ago, such as those that introduced two location technologies early on. An example of that is the AeroScout and Extronics iTAG100, which uses active RFID and Wi-Fi.

However, the progression of geolocation technologies and improvements in implementation techniques over that time make hybrid location an attainable goal for the solutions of today.
The business challenges associated with an RTLS system can be divided into **three main categories:**

### Planning

Choosing your technology or technologies is a big step and requires a good understanding of your aims, site type, and budget.

What problems are you trying to solve? Which use cases are most important to your business? It is a good idea to separate what you need from what you want, to get the best value for your investment.

Do you already have a communication infrastructure? Could that be leveraged for RTLS? The classic example is an existing Wi-Fi network that could be adapted to reduce your installation time and cost.

An RTLS is a major capital investment, and you want to be sure that you can balance the cost of deployment against the value to the business.

### Adoption

It is not uncommon for workers to object to their location being monitored, feeling as though that is a ‘Big Brother’ approach and a potential invasion of privacy.

Education is a key factor here, to ensure that the facts are conveyed clearly. An RTLS can be tailored to show a greater or lesser extent of individual information, depending on the application.

For example, many customers using the Extronics RTLS will have worker data grouped for productivity analytics, as they are concerned with improving a workflow rather than following a specific worker. Of course, if an emergency call button is pressed or there is a site evacuation, individual workers are identified to allow help to reach them quickly.

In our experience, workers who have seen how the RTLS’ involvement has prevented or mitigated an accident, or who have been through a serious incident where an RTLS may have made a material difference, are in favour of such safety systems and welcome greater visibility in the workplace.

### Maintenance

How much maintenance will the system need? How easy is it to configure? What support is available?

To work successfully, an RTLS should be tailored to suit the site and the applications for which it is used. You should consider how you want to configure any future changes, such as either training in-house personnel or liaising with a vendor or system integrator.

When using an RTLS as a safety system, you should also consider reliability and redundancy. What happens if either hardware or software stops working?
Other Important Considerations

• Solution Scalability
Will your chosen solution be able to grow with your business? For example, in number of workers or visitors tracked, size of site, across multiple sites, adding additional functionality or use cases.

• High Availability Architecture
Do you require redundancy in your software systems, to keep the worker safety solution running in emergencies? Can your chosen solution deliver that?

• Accuracy Requirements
What accuracy do you actually need to fulfil your requirements? Early aspirations for RTLS were to get better than 1m accuracy in 3D. Though technically possible, the cost is prohibitive and the density of infrastructure highly impractical.

• Solution Functionality
What additional functionality do you need from your solution? For example, you could also require mustering, emergency call, fall detection, alerts, reporting, analytics etc.

• Potential Integrations With Existing Safety Systems
What safety systems are already installed on your site? In an emergency, operators should not have to waste time duplicating efforts to raise alarms or monitor evacuating workers, nor access multiple system interfaces. Identify if your chosen solution can integrate with your existing technology, such as PAGA systems or ventilation fans. Do you need to incorporate access control for security and site management? Can that be included within your chosen system or would you need to operate two systems at the same time?
Typical worker safety devices can be divided into roughly four categories:

**Worker Tracking Tags**
These are small wearable devices that transmit location signals that are picked up by a wireless infrastructure such as a Wi-Fi network or proprietary location receivers. They can often be worn in different configurations, such as on a lanyard, epaulette, belt clip, or around the wrist. Some tags include additional functionality like emergency call buttons.

**Gas Detectors**
Portable gas detectors have been around for many years, and the technology is still improving. Some modern gas detectors can also include location detection.

**Vital Life Signs or Biometric Monitors**
These are wearable devices that monitor life signs like heart rate, temperature, and breathing. They can be used to identify workers in need of medical assistance or monitoring human factors like tiredness, reducing the risk of accidents.

**Smart Safety Equipment Like Hard Hats**
Like life signs monitors, smart hard hats are embedded with sensors to detect brain activity, breathing, perspiration, and other stress indicators and provide alerts in order to prevent accidents.
There are four major geolocation techniques. Different location technologies may make use of one or more of these techniques.

**Received Signal Strength Indication (RSSI)**

RSSI is a measure of the power in a signal and can be used to identify distance from the signal origination point to the receiver. In an RTLS sense, the RSSI from several receivers is used to triangulate the position of a tag, and thus the worker wearing it.

**Time Difference of Arrival (TDOA)**

TDOA uses the signal propagation speed to determine the distance between a signal origin (such as a tag) and a receiver at a fixed location. A hyperbolic curve that satisfies the TDOA can be drawn, and TDOA from additional receivers result in additional hyperbolic curves. The point at which these curves intersect is the location of the worker.

**Angle of Arrival (AOA)**

AOA determines the direction from which a signal originated. This is either by calculating TDOA on different parts of the antenna array, or from maximum signal strength during antenna rotation.

**Proximity**

Proximity can be used when either signal range is limited, or when a signal is triggered by a limited range device. An example of this in Extronics’ RTLS is the use of exciters, which emit an LF frequency that triggers tags to add that exciter’s ID to their signal transmission. When picked up by a receiver, in such cases a Wi-Fi access point, the tag can be determined to be within the configurable range of that particular exciter. This is primarily used for muster points or chokepoints like entrance/exit points, where using two exciters in sequence can also determine direction of travel.
CONCLUSION

**Hybrid Technologies Are the Future**

There is no single RTLS technology that covers all use case scenarios on a Process Plant and provides the best return on investment.

**Accuracy Has a Cost**

UWB or BLE AOA to get best accuracy but the infrastructure costs are high – cannot be used for other data connectivity-based mobile worker applications.

**Consider Additional Applications**

Wi-Fi can be used for other applications but infrastructure density high to get acceptable RSSI accuracy increasing costs over normal Wi-Fi.

**Identify Your Site’s Characteristics**

GPS great for outdoors but not reliable for indoor locations or in the vicinity of metallic plants or buildings and has poor battery life, still requires wireless connectivity such as Wi-Fi, LORA or Cellular network to backhaul the location information.

**Ongoing Maintenance is the Sting in the Tail**

BLE offers low cost battery powered beacons but still requires wireless connectivity and ongoing maintenance of changing batteries and managing beacons – Batteries don’t last as long in safety applications as is claimed!

**Overall, RTLS offers a significant improvement in worker safety** but must be considered carefully to ensure successful deployment. Correctly identifying the type of environment and the business problems you are trying to solve are the key to a step change in protecting your workers.
Extronics has been providing RTLS solutions to hazardous industries for over fifteen years!

We specialise in developing and manufacturing ATEX, IECEx, and North American certified equipment for use in hazardous areas, and rugged industrial products for harsh environments. We serve customers around the world from industries such as oil and gas, chemical, pharmaceutical, and mining.

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