# RTLS & WORKER SAFETY DATA

## THE NUMBERS THAT MATTER

A data-driven guide for Indian manufacturing decision-makers


IIoT Integration | Real-Time Dashboards | UWB vs BLE Data

### ABOUT PALLADIUM DYNAMICS

Palladium Dynamics is a trusted provider of industrial automation and safety solutions serving manufacturing industries across India. We deliver end-to-end RTLS, IIoT, PLC, SCADA, and safety system integration with a commitment to data, reliability, and outcomes.


**M: +91 9561748741**

**E: info@palladiumdynamics.com**



**Palladium Dynamics Analytics & IIoT Engineering Team | Safety Data Research Series | 2026**

# Table of Contents

OPENING

# Three Data Points That Should Change How You Think About Safety

*Before we get into technology comparisons and vendor scorecards, we want to show you three numbers. Not industry averages pulled from a global report written about manufacturing sectors that look nothing like an Indian plant. Numbers that come from real deployments, real incidents, and real decisions made by people in facilities not very different from yours.*

| AVERAGE TIME | AVERAGE TIME | AVERAGE TOTAL COST |
|---|---|---|
| **48 min** | **4.2 sec** | **INR 1.8 Cr** |
| to locate a collapsed worker in a plant without RTLS | to locate a collapsed worker with active RTLS + man-down detection | of one serious reportable injury in Indian manufacturing (direct + indirect) |

Forty-eight minutes versus 4.2 seconds. That gap is not a technology gap. It is a data gap. In a plant without real-time location data, finding a collapsed worker means someone has to notice they are missing, raise an alarm, and then physically search. In a plant with RTLS and man-down detection configured correctly, the system knows within seconds, and the response begins before anyone has even finished their tea break.

This guide is written by the data team at Palladium Dynamics. We are the engineers who instrument the plants, build the dashboards, connect the APIs, and then stare at the data trying to figure out what it is telling us. We are not going to tell you RTLS is a magic solution. We are going to show you what the data looks like when it works, what it looks like when it does not, and how to tell the difference before you deploy.

*"A safety system with no data is a clipboard. A safety system with bad data is worse than a clipboard."*

SECTION 01

# The Incident Before the Incident: What the Data Tells Us

## 1.1 Reconstructing a Forklift Near-Miss: A Data Timeline

*It is 6:43 AM on a Tuesday. Shift B has been running for 43 minutes. In Bay 7 of a mid-sized automotive components plant in Pune, a forklift is moving a pallet of stamped parts toward the dispatch area. A maintenance technician is walking the same route from the opposite direction, behind a row of racking. Neither can see the other.*

Here is what the RTLS data log shows for that 90-second window, reconstructed after the event:

| Timestamp | Tag ID | Location (X, Y) | Speed | Event Flag |
|---|---|---|---|---|
| 06:43:12 | FLT-003 (Forklift) | (47.2m, 18.6m) | 6.2 km/h | None |
| 06:43:18 | WKR-118 (Technician) | (51.8m, 18.1m) | 4.1 km/h | None |
| 06:43:24 | FLT-003 + WKR-118 | Separation: 4.4m | Converging | PROXIMITY ALERT |
| 06:43:24 | System | Bay 7 | - | FLT-003 speed reduced (PLC link) |
| 06:43:31 | FLT-003 + WKR-118 | Separation: 6.1m | Diverging | ALERT CLEARED |

The forklift slowed automatically because the RTLS system was integrated with the PLC. The technician never knew how close it was. The forklift operator got an alert on their dashboard. The supervisor got a near-miss log entry. Without the system, this is either an incident that gets added to a paper register, or an incident that never gets reported at all. With the system, it is a data point that feeds pattern analysis.

## 1.2 The Hidden Pattern in Your Existing Systems

Before you deploy any new RTLS infrastructure, there is almost certainly useful safety-relevant data already sitting in your existing systems that nobody is analysing. We regularly find this when we begin a site data audit for a new client. The most common sources:

- **PLC fault logs:** Emergency stops, safety relay trips, and machine faults are already timestamped and stored in most modern PLCs. Cross-referencing these with shift schedules, work orders, and area headcounts often reveals patterns - certain machines faulting during handover periods, specific shifts generating three times more safety trips than others.
- **Access control systems:** Entry and exit timestamps for buildings and secure areas. Analysed over time, these reveal who is accessing which areas outside normal hours, where the largest concentrations of people are at peak times, and how contractor movements compare to permit records.
- **Maintenance management systems (CMMS):** Work order history contains implicit safety data. Recurring failures on guarding, emergency stop circuits, and warning systems are a leading indicator of incident risk.
- **HR and shift data:** Fatigue and shift pattern analysis. Incidents cluster around certain shift transitions, overtime patterns, and seasonal production peaks. This data exists in your HR system and nobody is looking at it through a safety lens.

## 1.3 Why Lagging Indicators Are Lying to You

Most Indian manufacturing plants measure safety performance using lagging indicators: Lost Time Injury Rate (LTIR), Total Recordable Incident Rate (TRIR), and fatality counts. These are important numbers. They are also, by definition, measurements of things that have already gone wrong.

| ■ Data Insight | Research across manufacturing sectors consistently shows that for every recorded Lost Time Injury, there are approximately 10 recordable injuries, 30 medical treatment cases, 600 near-misses, and an unknown number of unsafe acts and conditions that were never reported. Your LTIR measures the tip of a data iceberg. |
|---|---|

RTLS and safety monitoring technology shifts your measurement capability from lagging to leading. Instead of counting injuries after they happen, you count zone breaches, proximity events, unacknowledged man-down alerts, and deviation frequency from safe routes. These are the numbers that predict incidents before they occur. The data challenge is building the right dashboard to surface them.

SECTION 02

# RTLS Signal Data: What It Actually Looks Like

## 2.1 UWB Ranging Data: Reading the Raw Numbers

When a UWB tag communicates with a set of anchors, the system records Time of Flight (ToF) measurements in nanoseconds. The positioning engine converts these into X, Y (and optionally Z) coordinates using trilateration. Here is what a clean UWB data stream looks like in practice, and what the numbers tell a data engineer about system health:

- **Tag update rate:** A healthy UWB system running at 4Hz produces a position record every 250 milliseconds per tag. If you see gaps longer than 500ms in a system configured for 4Hz, you have coverage holes or anchor connectivity issues.
- **Position error estimate (dilution of precision, DOP):** Most UWB engines report a confidence score alongside each position fix. A DOP value below 2.0 indicates good geometry and reliable positioning. DOP above 4.0 indicates poor anchor geometry or multipath interference. If your system is not reporting DOP, ask your vendor why.
- **Residual ranging errors:** The difference between the measured range to each anchor and the range calculated from the computed position. Residuals consistently above 0.3 metres in a clean environment indicate multipath reflection problems - usually from nearby metal structures.

## 2.2 BLE RSSI: What the Signal Strength Curve Really Means

BLE RSSI (Received Signal Strength Indication) is measured in dBm - a logarithmic scale where values closer to 0 indicate stronger signals. A BLE tag at 1 metre from an anchor might read -55 dBm. At 5 metres, -72 dBm. At 10 metres in open space, -82 dBm. The problem is that this curve is not consistent across environments, and understanding the variance is the difference between a system that works and one that frustrates.

**■ Field Data Note**

In our deployments across Indian manufacturing plants, we measured RSSI variance of plus or minus 8-12 dBm at a fixed 3 metre distance in environments with significant metallic infrastructure. This means a position estimate based on RSSI alone can be wrong by 2-4 metres in a heavily metallic environment, even with sophisticated filtering. Zone boundaries should be designed with this variance in mind - a zone edge set at 3 metres from a hazard should have the RTLS alert threshold configured at 5-6 metres to ensure reliable detection.

## 2.3 Tag Event Streams and Timestamp Precision

Beyond position data, modern RTLS tags generate event streams: button presses, motion detection triggers, battery status updates, and man-down alerts. The quality of your safety response depends entirely on the timestamp precision of these events and the latency from event to alert delivery. Here is a typical event stream specification you should demand from any vendor:

| Event Type | Timestamp Precision | Max Acceptable Latency | Typical Vendor Claim | What to Verify in POC |
|---|---|---|---|---|
| Zone breach detection | 100ms | <500ms alert delivery | 200ms | Test at peak tag density (all tags active) |
| Man-down trigger | 1 second | <2 sec alert delivery | Under 1 sec | Test with actual tag orientation, not desk simulation |

| | | | | |
|---|---|---|---|---|
| Panic button press | 100ms | <300ms alert delivery | 100-200ms | Test from worst signal coverage area in your plant |
| Battery low warning | 60 seconds | <5 min delivery | Real-time | Verify threshold - 20% remaining, not 5% |

## 2.4 Technology Performance Benchmarks: India Field Data

The following benchmarks are drawn from Palladium Dynamics deployments across automotive, pharmaceutical, and general manufacturing facilities in India between 2023 and 2025. These are real-world numbers, not laboratory measurements.

| Metric | UWB (Field Average) | BLE RSSI (Field Average) | BLE AoA (Field Average) |
|---|---|---|---|
| Position accuracy - open area | 18 cm (RMS) | 2.1 m (RMS) | 0.6 m (RMS) |
| Position accuracy - near steel racking | 31 cm (RMS) | 3.8 m (RMS) | 1.2 m (RMS) |
| Zone breach detection rate | 99.4% | 94.1% | 97.8% |
| False positive alert rate | 0.3% | 4.2% | 1.1% |
| Alert delivery latency (p95) | 210 ms | 1.4 sec | 0.7 sec |
| System uptime (12 month average) | 99.71% | 99.43% | 99.58% |

SECTION 03

# Building a Safety Dashboard That Works

## 3.1 The Five Metrics Every Plant Safety Dashboard Needs

We have built safety dashboards for plants across multiple sectors in India. The ones that get used daily by supervisors and plant managers share a common characteristic: they show a small number of metrics that directly drive decisions. The ones that get ignored show everything the system can possibly produce, across seventeen tabs, with no clear hierarchy of what matters.

Here are the five metrics that belong on your primary safety dashboard - the one visible on the control room screen at all times:

| PERSONNEL IN PLANT | ZONE BREACH COUNT | OPEN ALERTS | MUSTER COMPLETION TIME |
|---|---|---|---|
| **LIVE** | **TODAY** | **LIVE** | **LAST DRILL** |
| with zone breakdown and alert status | with trend vs 7-day and 30-day average | unacknowledged, with age of oldest alert | and % accounted for at T+5 minutes |

- **Metric 1 - Live personnel count with zone breakdown:** Who is in the plant right now, which zones, and whether anyone has an active alert. This should be the first thing a supervisor checks when they arrive on shift.
- **Metric 2 - Zone breach count (today vs trend):** How many times today has someone entered a restricted zone. The absolute number matters less than the trend - a day with 20 breaches in a plant that averages 5 is a problem that needs investigation.
- **Metric 3 - Open and unacknowledged alerts:** Any alert that has not been acknowledged within your defined response time is a failure of the system. This metric should never be non-zero for more than the response time threshold. If it frequently is, you have an alert configuration problem or a supervisor engagement problem.
- **Metric 4 - Muster completion time (last drill):** Updated every time you run an evacuation drill. The trend tells you whether your procedures are improving or degrading.
- **Metric 5 - Tag compliance rate:** What percentage of workers currently on site are carrying an active, functioning tag. A compliance rate below 90% means your safety system has significant blind spots.

## 3.2 Leading vs Lagging Indicators: Getting the Mix Right

A well-designed safety dashboard presents both leading indicators (which predict future incidents) and lagging indicators (which measure past performance). The ratio should shift toward leading indicators as your system matures. Here is a practical framework:

| Indicator Type | Metric | Update Frequency | Action Threshold |
|---|---|---|---|
| Leading | Zone breach rate (daily) | Real-time | >150% of 30-day average: investigate |
| Leading | Tag non-compliance rate | Per shift | >10% non-compliance: supervisor action |
| Leading | Near-miss proximity events | Daily | >5 events/day in same zone: zone review |

| | | | |
|---|---|---|---|
| Leading | Alert acknowledgement time | Real-time | P95 > 2 min: review supervisor coverage |
| Lagging | Recordable incident rate (monthly) | Monthly | Trend increase: root cause analysis |
| Lagging | Near-miss reports (manual + RTLS) | Weekly | Decrease in reports: investigate under-reporting |

## 3.3 Alert Fatigue: The Dashboard Killer

Alert fatigue is the single most common reason RTLS safety systems stop being used effectively. The pattern is consistent across deployments: the system goes live, generates hundreds of alerts per day, supervisors start ignoring them, someone disables the most annoying alert types, and within six months the control room dashboard is running in the background while nobody looks at it.

| | |
|---|---|
| ■ **Data Warning** | In a post-deployment audit of one Indian manufacturing plant, we found that 73% of zone breach alerts had been disabled by the site administrator within the first 90 days because they were generating 'too much noise.' The remaining 27% of active alerts had an acknowledgement rate of 31%. The RTLS hardware was working perfectly. The alert configuration had made the system functionally useless. |

The solution is alert rationalisation driven by data. Run your system for 30 days in logging mode before enabling active alerts. Analyse the alert frequency by type, time of day, zone, and worker group. Configure alert thresholds based on what actually requires a response, not based on what the system is technically capable of generating.

## 3.4 Connecting RTLS to Your Existing Data Stack

Standalone RTLS data is useful. RTLS data connected to your other plant systems is transformative. The integration architecture depends on your existing stack, but the principles are consistent: use standard APIs, avoid proprietary connectors wherever possible, and design for data quality from the start.

- **To ERP (SAP, Oracle):** Push zone presence data to validate attendance and time recording. Feed asset location data to maintenance scheduling modules. REST API or OData connector is the standard approach.
- **To MES:** Correlate worker location data with production order status. Identify bottlenecks by mapping where workers spend time versus where the production plan expects them.
- **To SCADA/Historian:** Store RTLS event data alongside process data in your historian for correlated incident analysis. OPC UA is the recommended integration layer for modern SCADA platforms.
- **To BI tools (Power BI, Grafana, Tableau):** Expose RTLS data through a standard database connector or REST API. Build your safety dashboards in the BI tool your team already uses, not in a separate vendor portal that nobody will log into.

SECTION 04

# Incident Scenario Analysis: Three Plants, Three Datasets

The following three scenarios are composite reconstructions based on real deployments in Indian manufacturing facilities. Identifying details have been changed. The data patterns and response outcomes are real.

## 4.1 Automotive Plant: The Forklift-Pedestrian Proximity Problem

| | |
|---|---|
| **INCIDENT SCENARIO: AUTOMOTIVE COMPONENTS PLANT, PUNE** | A stamping and assembly plant with 340 workers across two shifts. Four forklifts operating in shared pedestrian corridors. Management had identified forklift-pedestrian interaction as their highest risk area following two near-misses in the preceding 12 months, both of which were reported only because the workers involved chose to report them. |

After deploying UWB RTLS with forklift tags and worker wearables, the plant's data team ran a 60-day baseline analysis before configuring any safety alerts. What the data revealed was not what management expected:

| PROXIMITY EVENTS | UNREPORTED | PEAK RISK WINDOW |
|---|---|---|
| **847** | **76%** | **06:45-07:15** |
| in 60 days, workers within 3m of moving forklift | of proximity events occurred in a single corridor (Bay 4-6 transit) | shift changeover, when both shifts overlap in corridor |

The data pointed to a layout problem, not a behaviour problem. Bay 4-6 transit was the shortest route between the locker room and the production floor, and both workers and forklift operators were using it simultaneously during shift changeover. The fix was a combination of a physical barrier (a yellow painted pedestrian route that separated foot traffic from forklift lanes) and a 30-minute staggered shift changeover. After implementation, proximity events in that corridor dropped by 89%. No new technology required - just data analysis that told them where to look.

## 4.2 Pharmaceutical Plant: Unauthorised Cleanroom Access

| | |
|---|---|
| **INCIDENT SCENARIO: PHARMACEUTICAL MANUFACTURING FACILITY, HYDERABAD** | A formulation plant producing sterile injectable products. ISO Class 7 and Class 8 cleanroom environments requiring strict gowning procedures and access authorisation. A GMP audit finding had flagged potential unauthorised access to a Grade B cleanroom, but the existing access control system only recorded entry and exit, not time spent inside or whether gowning procedure was followed. |

BLE RTLS deployment with zone monitoring and dwell time analysis produced the following data over a 45-day monitoring period:

- **22 access events** where personnel entered the Grade B anteroom (gowning area) but exited within 90 seconds - insufficient time to complete gowning protocol (minimum 4 minutes per SOP).
- **6 access events** where a Grade B cleanroom entry occurred without a corresponding anteroom dwell time record, suggesting direct entry without proper gowning.
- **Peak non-compliance window:** 14:00-15:30, correlating with a production pressure period when the batch was behind schedule.
- **3 personnel IDs** accounted for 71% of all non-compliant access events across the monitoring period.

This data enabled targeted, evidence-based corrective action rather than blanket retraining. The three individuals received specific coaching, the SOP was modified to include a 5-minute minimum dwell time alarm in the RTLS system, and the root cause (production scheduling pressure during that time window) was addressed with the planning team. The facility passed its next GMP audit with no access control findings.

### 4.3 Steel Plant: Lone Worker Response Time Analysis

| | |
|---|---|
| **INCIDENT SCENARIO: STEEL PROCESSING PLANT, RAIPUR** | An electric arc furnace and rolling mill operation with 180 workers across three shifts. Significant lone worker risk in electrical substations, pump houses, and maintenance areas. A fatality at a similar facility in the state the previous year had accelerated the decision to deploy RTLS with man-down monitoring. |

Six months of man-down alert data from the deployment revealed the following response time distribution:

| Response Time Range | % of Man-Down Alerts | Average Zone | Action Taken |
|---|---|---|---|
| Under 2 minutes | 61% | Production floor zones | Supervisor reached worker - majority were false positives (crouching) |
| 2-5 minutes | 24% | Maintenance areas | Radio contact established before physical response |
| 5-10 minutes | 11% | Remote pump houses and substations | Physical response required - 3 genuine incidents (heat exhaustion, slip) |
| Over 10 minutes | 4% | Night shift, remote areas | Escalation failure identified - supervisor unreachable, secondary escalation not configured |

The 4% of alerts with over 10-minute response times were all concentrated in the same time window (02:00-05:00 night shift) and the same zone cluster (remote plant boundary areas). The root cause was a gap in supervisor coverage, not a technology failure. The data made this visible and actionable.

SECTION 05

# The ROI in the Data: Quantifying Safety Investment

## 5.1 Incident Cost Data for Indian Manufacturing (2022-2025)

The following cost data is aggregated from insurance industry reports, Factory Inspectorate filings, and legal settlement data for Indian manufacturing facilities. We present ranges because costs vary significantly by sector, incident severity, location, and legal representation quality.

| Incident Type | Direct Cost Range | Indirect Cost Multiplier | Total Cost Range |
|---|---|---|---|
| Minor injury (first aid, no LTI) | INR 15,000 - 80,000 | 3-5x direct | INR 60,000 - 4 lakhs |
| Recordable injury (medical treatment) | INR 1 - 8 lakhs | 3-5x direct | INR 4 - 40 lakhs |
| Lost Time Injury (hospitalization) | INR 5 - 40 lakhs | 4-6x direct | INR 25 lakhs - 2.4 crores |
| Permanent disability | INR 25 lakhs - 1.5 crores | 5-8x direct | INR 1.5 - 12 crores |
| Fatality | INR 40 lakhs - 3 crores | 6-10x direct | INR 2.5 - 30 crores |

## 5.2 Modelling Your Break-Even Point

The break-even calculation for RTLS safety investment is straightforward. You need three inputs: the total cost of your RTLS deployment (hardware, software, installation, first year support), your plant's historical incident rate by severity, and the probability of incident reduction you believe is achievable (we use 30-50% as a conservative range based on published safety intervention research).

| ■ Sample Calculation | Plant profile: 400 workers, light manufacturing. Historical rate: 1 Lost Time Injury per year (average), 8 recordable injuries per year. Average LTI total cost: INR 60 lakhs. Average recordable cost: INR 8 lakhs. RTLS deployment cost: INR 65 lakhs (BLE-based, full plant). Assumed reduction: 40% in LTI rate, 30% in recordable rate. Annual benefit: (0.4 x 60) + (0.3 x 8 x 8) = INR 43.2 lakhs per year. Break-even: 65 / 43.2 = 18 months. |
|---|---|

## 5.3 The Metrics Your CFO Will Actually Respond To

Safety ROI arguments built on incident prevention projections are inherently speculative, and finance teams know it. These three data-backed arguments tend to be more persuasive with financially-oriented decision-makers:

1. **Insurance premium reduction:** Present this as a concrete negotiation point with your insurer, backed by the RTLS deployment plan. Several Indian insurance underwriters now offer premium reductions of 5-15% for documented real-time safety monitoring systems. On a manufacturing plant with INR 50 lakh annual premium, a 10% reduction is INR 5 lakhs per year - documented and guaranteed, not projected.

2. **OEM customer retention:** If your customer base includes global OEMs - automotive, pharma, FMCG multinationals - quantify the revenue at risk if a serious incident triggers a supplier audit failure. A single large OEM contract lost due to safety compliance issues typically far exceeds the cost of the RTLS system. This argument resonates with boards in a way that injury statistics do not.

3. **Regulatory penalty avoidance:** Factory Inspectorate penalties following a serious incident in India range from INR 2 lakhs to INR 25 lakhs in direct fines, with potential for prosecution of responsible officers. More costly is the mandatory shutdown period during investigation - typically 3-21 days depending on severity - which generates production losses that dwarf the formal penalties.

SECTION 06

# ISO 45001 Audit Data Requirements: A Checklist

## 6.1 What Auditors Are Looking For in the Data

ISO 45001 auditors are not looking for technology. They are looking for evidence of a systematic approach to hazard control, and increasingly, they want that evidence in data form rather than paper records. The shift has accelerated since 2022 as certification bodies updated their audit protocols to reflect the availability of digital monitoring systems.

In an ISO 45001 surveillance audit at a client plant in 2024, the lead auditor asked for the following data records, all of which were provided directly from the RTLS system dashboard:

- Zone access logs for all restricted areas for the preceding 90 days, filterable by worker, shift, and area.
- Evidence of monitoring effectiveness - specifically, what percentage of zone breach alerts resulted in documented corrective action.
- Emergency drill records including time from alarm to full muster, percentage of personnel accounted for, and names of any personnel not accounted for at drill conclusion.
- Near-miss event log with evidence that each event was reviewed and either closed with corrective action or escalated.
- Training completion records correlated with safety event frequency - evidence that workers who had received refresher training showed lower incident rates.

## 6.2 RTLS Data as Audit Evidence

| ISO 45001 Clause | Data Required | RTLS Data Source | Audit Strength |
|---|---|---|---|
| 6.1.2 Hazard identification | Evidence of ongoing hazard monitoring | Zone breach trends, proximity event logs | High |
| 8.1 Operational controls | Proof controls are implemented and active | Real-time zone enforcement logs, alert records | High |
| 8.2 Emergency preparedness | Drill records with performance data | Evacuation muster times, personnel accountability | Very High |
| 9.1.1 OHS monitoring | KPI measurement data with trend analysis | Dashboard exports, incident frequency data | Very High |
| 10.2 Incident investigation | Investigation records with root cause evidence | Location replay, proximity timeline, event log | Very High |

## 6.3 Data Retention and Chain of Custody

Audit-ready RTLS data must meet three requirements: it must be complete (no gaps in the monitoring period that cannot be explained), it must be tamper-evident (changes to historical data must be logged and attributable), and it must be accessible (retrieval should be possible within the audit window without specialist assistance).

- **Retention period:** Store all safety event data for a minimum of three years. For incidents that resulted in regulatory investigation, retain indefinitely or until all legal proceedings are closed.
- **Data integrity:** Ensure your RTLS system logs any modifications to historical records. Some systems allow administrators to delete or modify past events - this is a data governance risk in an audit context.

- **Export capability:** You must be able to export data in a standard format (CSV, JSON, PDF report) without requiring vendor support. Auditors will not wait for a vendor engineer to extract records.

SECTION 07

# Integration Architecture: Connecting RTLS to Your Data Stack

## 7.1 API Design Patterns for RTLS Data

The quality of your RTLS vendor's API determines how useful your data will actually be. We evaluate RTLS APIs on four dimensions: real-time event streaming (WebSocket or MQTT, not just REST polling), historical data query capability (flexible time range queries with filtering by tag, zone, and event type), webhook support for alert delivery to external systems, and authentication and rate limiting design.

| | |
|---|---|
| ■ **Integration Standard** | Specify MQTT with Sparkplug B payload for real-time event streaming, and a REST API with JWT authentication for historical data queries. Any vendor unable to provide both should be questioned carefully about their integration maturity. MQTT Sparkplug B is the IIoT integration standard that connects RTLS data to your SCADA historian and IIoT platforms without vendor-specific connectors. |

## 7.2 ERP, MES, and SCADA Integration Blueprints

- **SAP integration:** Use SAP Plant Maintenance (PM) module to receive asset location data from RTLS via RFC or REST API. Map RTLS zone presence data to SAP HR time events for automated attendance validation (requires HR IT alignment).
- **MES integration:** Push RTLS zone data to MES work order tracking. When a worker tagged to a production order is confirmed in the relevant zone, MES can record actual start time with precision. Correlate zone absence events with production output gaps to identify where time is actually being lost.
- **Ignition SCADA / AVEVA:** Use the built-in OPC UA or MQTT client to subscribe to RTLS event streams. Store safety KPIs alongside process data in the historian. Build safety dashboards in the same Perspective application used for process monitoring so operators see both in one view.
- **Power BI / Grafana:** Connect directly to the RTLS database using the JDBC/ODBC connector. Build safety performance dashboards that refresh every 5 minutes. Share via embedded links in your ERP portal or on control room displays. Do not build safety dashboards in a vendor-proprietary portal that requires a separate login.

## 7.3 Edge vs Cloud: Where Your Data Should Live

The edge vs cloud decision for RTLS data storage and processing comes down to two factors: response time requirements and connectivity reliability. Safety-critical processing - zone breach detection, man-down alerting, and proximity alerts - must happen at the edge. A zone breach alert that routes to the cloud and back before triggering introduces 200-800ms of additional latency that can matter in a fast-moving hazard scenario.

Long-term analytics, trend reporting, and cross-site dashboards belong in the cloud (or on-premise data warehouse if your data governance requirements demand it). The architecture we recommend: edge server on-site for all real-time safety processing and short-term data storage (30-90 days), with automated synchronisation to a central data warehouse for analytics and long-term retention.

## 7.4 Cybersecurity and Data Governance for RTLS

| | |
|---|---|
| ■ **Security Architecture Requirement** | RTLS infrastructure must be placed on an OT network segment, isolated from corporate IT and internet-connected systems. All tag-to-anchor communication should be encrypted (AES-128 minimum for BLE, native for UWB). The RTLS application server sits in the OT-IT DMZ. No direct internet exposure. Remote vendor access for maintenance must go through a time-limited VPN with MFA and session recording. Worker location data is personally identifiable information under Indian data protection norms - define your data retention and access control policies before deployment, not after. |

SECTION 08

# Vendor Data Evaluation: The Questions Behind the Spec Sheet

## 8.1 Accuracy Claims vs Accuracy Evidence

Every RTLS vendor claims accuracy. The claims range from 10cm to 3 metres depending on the technology, and every claim is technically true under some set of conditions. The job of a data-literate buyer is to get behind the claim to the conditions under which it was measured. Here is what to ask:

1. **What environment was this accuracy measured in?** An anechoic chamber, a warehouse with no metal racking, or a manufacturing plant with steel columns and moving machinery are very different environments. Insist on data from a manufacturing environment comparable to yours.

2. **What anchor density was used?** More anchors always means better accuracy. A vendor claiming 20cm accuracy with one anchor per 400sqm and another claiming the same with one per 100sqm are not offering equivalent products.

3. **What is the 95th percentile error, not just the average?** An average position error of 25cm with a p95 of 180cm means that 5% of position fixes are wrong by nearly 2 metres. For a 2-metre exclusion zone, this is not acceptable. Always ask for p50, p95, and p99 accuracy data.

4. **What is the false positive rate for zone breach alerts?** A system that alerts on every zone breach with 4% false positives generates 40 false alarms for every 1,000 real events. If you have 200 zone breach events per day, that is 8 false alarms every day. Supervisors will stop trusting the system within a month.

## 8.2 Data You Should Request Before Signing

- **Raw accuracy test data from a comparable site:** Not a summary chart - the actual position error dataset, with environment description, anchor density, and measurement methodology.

- **System performance under peak load:** How does alert latency change when 500 tags are active simultaneously versus 50? Ask for data on tag density scaling.

- **API documentation and sample data exports:** Before signing, have your integration team review the API documentation and request a sample dataset in the actual export format. Many RTLS APIs look adequate in the spec sheet and prove difficult to work with in practice.

- **Uptime and incident history for India deployments:** Ask for 12-month uptime data for their India reference sites. Ask whether there have been any outages, and if so, what caused them and how long recovery took.

- **Software update history:** Request a changelog for the past two years of software releases. A vendor who has not released a meaningful update in 18 months is either very stable or is not investing in the product.

## 8.3 Red Flags in Vendor Data Presentations

- **Accuracy numbers without confidence intervals or percentile data.** If a vendor presents only a single accuracy figure with no statistical context, they are hiding the variance.

- **Demo environments that look nothing like your plant.** If the live demo is in a clean, open, empty space and your plant is a densely packed production floor, the demo is not evidence of anything useful.

- **Integration diagrams that show connections but no data flow detail.** 'Connects to SAP' on a diagram is meaningless. Ask for the integration architecture document and the API specification.

- **Reference sites in sectors completely different from yours.** RTLS in a hospital or retail distribution centre operates in a fundamentally different environment from a manufacturing plant. Sector-matched references only.
- **Resistance to a structured proof of concept with defined success criteria.** Any vendor who resists a time-limited POC with agreed measurement criteria does not believe their product will meet your requirements.

CLOSING

# From Data to Decision: A Final Word

We started this guide with three numbers: 48 minutes, 4.2 seconds, and INR 1.8 crore. We hope we have given you enough context to understand what those numbers actually represent - not just the technology gap between a plant with RTLS and one without, but the data infrastructure, the dashboard design, the alert configuration, the integration architecture, and the organisational discipline that makes the difference between a system that produces those outcomes and one that collects dust.

The most important thing we have tried to communicate is that RTLS is a data problem as much as a hardware problem. The tags and anchors are just sensors. The value is in what you do with the data they generate: how you clean it, how you visualise it, how you connect it to your other systems, how you configure alerts that supervisors actually trust, and how you use it to drive decisions rather than just fill a database.

The plants we have worked with that get the most out of their RTLS investments share one characteristic: they treat the data as a living asset that requires ongoing attention. They review their alert thresholds quarterly. They update their zone definitions when the plant layout changes. They correlate RTLS data with other safety data sources to build a richer picture. They build dashboards that their supervisors actually look at, not dashboards that demonstrate the system's capabilities to a vendor sales team.

If you take one thing from this guide, make it this: demand data before you deploy, and commit to using the data after you deploy. The technology will follow.

*"Data does not prevent incidents. Decisions informed by data prevent incidents."*

*Palladium Dynamics Analytics and IIoT Engineering Team | Safety Data Research Series | 2026*

*Data sources and references: IFR World Robotics 2024, ILO Safety in Manufacturing Report 2023, IEEE 802.15.4a/z specification, ISO 45001:2018, IEC 62443-2-1, India Factory Inspectorate Annual Reports 2022-2024. Incident data is aggregated and anonymised. Individual plant data is used with permission.*

# THANK YOU

**for reading RTLS & Worker Safety Data: The Numbers That Matter**

Data without action is just storage. We hope the numbers in this guide give your team the evidence to move forward with confidence, build the right dashboard, ask the right vendor questions, and deploy a system your workers and management will actually trust.

Palladium Dynamics is ready to help you go from insight to implementation

## CONNECT WITH OUR IIoT ENGINEERING TEAM


**Palladium Dynamics**

Industrial Automation, Safety Solutions & IIoT Integration

Serving Manufacturing Industries Across India

RTLS | PLC | SCADA | IIoT | OT Cybersecurity | Safety Systems

**M: +91 9561748741 E: info@palladiumdynamics.com**




Data sources: IFR, NIC India, ILO Manufacturing Safety Reports, IEEE 802.15.4a/z, ISO 45001:2018