CoreRFID Ltd

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Maintenance & Engineering
Cost savings from RFID

UNDERGROUND

Case study of the London Underground escalator maintenance project.

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Introduction

The escalators of the London Underground carry over 3 million passengers every day from the street to the platforms and back again. Most commuters and tourists don't give the travelling metal staircases a second thought; a fact that is a testament to the reliability of the system and the care taken over the maintenance of escalators.

One part of London Underground is responsible for maintenance, upgrading and replacement works across two thirds of the London Underground system, and has almost 200 escalators to support.

Escalator maintenance protects passengers and reduces the risk of travel disruption.

Maintaining escalators is a task with unique problems. Failure to carry out adequate preventative maintenance puts passenger safety at risk but taking escalators out-of-service during normal travelling hours is unpopular with passengers as well.

To address this London Underground decided to use RFID technology to support their escalator maintenance operations and worked with CoreRFID, specialists in RFID applications and technology, to develop a solution for London Underground.

CoreRFID developed the London Underground Step Tracking System.

The result, the Step Tracking System, combines readily available components in an innovative way that promotes passenger safety and convenience for London Underground and saves costs in service engineering. CoreRFID developed a pilot version of the Step Tracking System as part of a joint project with London Underground and is now involved in its operational deployment across the Bakerloo, Central, Victoria, Waterloo & City, Metropolitan, District, Circle and Hammersmith & City lines.

The Business Problem

Failures could put passengers at risk.

Millions of passengers use the escalators on the London Underground every day. The steps that make up these escalators are subject to constant wear from the feet of passengers and from the mechanical movement on the escalator track. A failure in an escalator step could cause serious injury. If an escalator step were to fail during the rush hour, lives could be put at risk and serious disruption to travellers would result.

Non-destructive testing is time consuming and it is easy to lose track of where steps are.

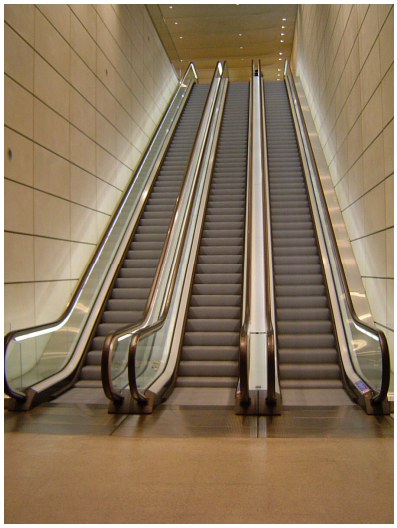

Fig 1: Escalators on London Underground have an enviable safety record as a result of stringent engineering standards.

To prevent such an event, London Underground have an inspection and maintenance regime that ensures the structural integrity of every step is checked at least once during the course of every year.

With almost 30,000 separate escalator steps needing to be checked this maintenance approach requires significant effort by London Underground's engineering staff.

The problem is complicated by the time required to carry out non-destructive tests on the structural integrity of steps. Because of the effort involved, only a small number of steps can be removed from the escalator to be tested during an over night maintenance shift. These steps are exchanged for already tested ones. The removed steps are transferred to another site for testing before returning to the pool of steps available for

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re-installation. The issue of step control is complicated by the fact that there are many types of escalator, although almost 70% of all steps belong to one of the four main types. As a result any one escalator consists of an ever changing set of steps. Keeping track of when each step was tested and replaced is a major challenge. On some occasions steps are removed from escalators simply in order to identify them

In addition, although individual steps are identified by a plate on each it has proved difficult to link the identity of a step with its engineering history and that if a step should fail a test it is almost impossible to know whether there are other steps in the network that have the same usage and service history that might also be at risk of failure. Difficulties with the readability of plates (they become obscured by dust and grease) and the problem of having to stop escalators in order to read step data means that information can only be collected during the over night maintenance shift and even then information is rarely completely accurate.

London Underground needed a system that would collect data automatically from individual steps, that could cope with the problems of dirt and grease and that would be robust enough to stand up to the constraints of one of the world's most heavily used mass-transit systems. They turned to RFID as a technology to help them.

The Pilot & The Solution

CoreRFID and London Underground worked together to come up with an effective solution design and to select and trial the most appropriate technology in a pilot application.

The eventual solution was to attach UHF RFID tags to the underside of each escalator step. Whenever a check is needed of the specific steps present on an escalator, the tags can be read by a portable reader that is slotted into a cradle near the track of the escalator mechanism on a regular basis,. As the escalator runs and each step passes the cradle, the reader detects the signals from the tag. In this way information about which steps are present in which escalator can be collected without interfering with the normal operation of the escalator.

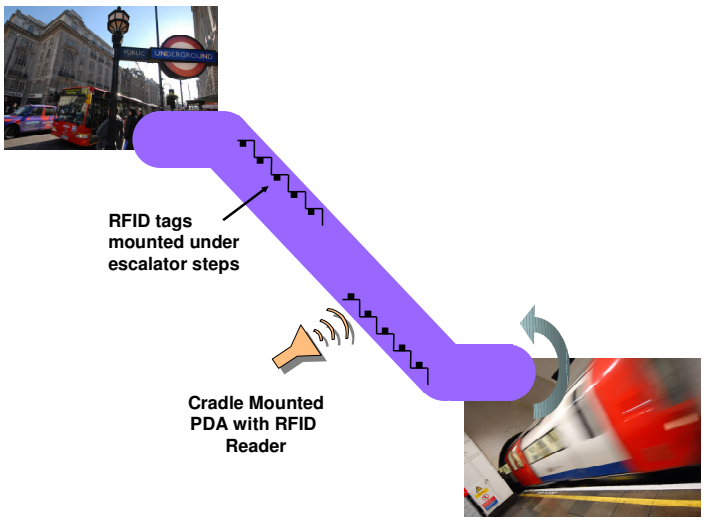

Fig 2: RFID tags allow data collection without interrupting escalator operations

The tags used were designed to be usable in the difficult environment of an operating escalator with vibration, temperature variation and magnetic fields all being a factor.

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A decision had been taken longer term to mount the tags on the steps using rivets but for an initial trial mounting the tags by using acrylic adhesive was tried. In practice the adhesive mounting for tags proved more robust than anticipated. In spite of the vibration, dirt and constant movement, not a single tag detached from its escalator step over a period of two months. Even so, riveting is being used for the eventual deployment to ensure that tags remain attached.

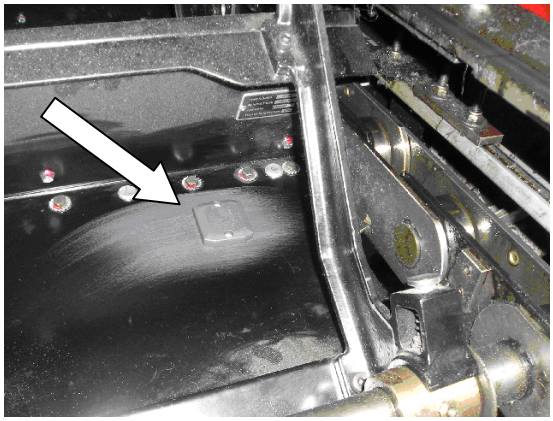

Fig 3 : RFID tags installed under steps need to be able to cope with vibration, grease and dirt as well as magnetic and electrical noise.

The initial trial was conducted on an escalator at St Paul's underground station on the Central Line. Tags were installed on the 92 steps of the escalator and data written to each tag indicating the step number, its year of manufacture and elements of its service history.

The writing process was monitored carefully during the trial. It was recognised that initial data recording would need to be done while the escalator was out of service and that, as a result, the time taken for each step had to be kept to a minimum. Writing data to RFID tags is very much slower than reading and requires the writer to be significantly closer to the tag than does reading. For the Step Tracking System, the escalator is inched forward, a small number of steps at a time, as the data is recorded on each step. London Underground expect that, in time, they will be able to achieve a time of 45 minutes for a 90 step escalator, allowing the writing process to be accommodated during a normal out-of-service shift. Data is being held on the date of the last non-destructive test (NDT). Because of this it will be possible to check that any given step has not exceeded the time allowed between NDT's, helping to avoid the risk of failure. This will help to protect passengers and reduce disruption to escalator services.

CoreRFID worked with London Underground to devise a way of packing the data to be recorded on the tag. UHF tags typically hold as little as 64bytes of data. By minimising the amount of data to be read, London Underground and CoreRFID expected to be able to ensure that high read speeds would be possible.

In practice this was found to be the case. With the reader mounted in its cradle, it was possible to retrieve data from the steps as the escalator ran at its normal speed. Trials indicated that it was possible to consistently and accurately read the data from the steps during one or at most two rotations of the escalator.

Data Collection & Use

The Step Tracking System uses a reader / writer integrated with a rugged handheld computer, suitable for use in the dusty and greasy environments found under escalators.

The reader/ writer can be operated with one hand and has a battery life of between four and fourteen hours of continuous use, allowing it to be used for an entire shift without re-charging.

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The application running on the hand-held computer has been designed to be simple to operate when used in the cramped conditions found in the escalator well. The same application is used by the manufactures of steps to encode manufacturing details on each step before new steps are delivered.

Fig 4: The hand-held computer used to collect data for the Step Tracking System.

Data stored on the tag and, as a result, available for collection includes the unique step identifier, manufacturer, date of manufacture, station, escalator number, step number on the escalator, and so forth. Reading the data provides the basic information needed to manage each individual escalator step. For the first time it will be possible to know exactly how long an individual step will have been installed on an operational escalator. It will become possible to make better decisions on when steps need to be exchanged for testing or replaced.

Data collected in the Step Tracking Systems' hand-held computer can be extracted in a simple data exchange format such as XML or as comma separated value (CSV) file. It can then be integrated with an asset database system such as Mincom's Ellipse.

The Current Status

As at the end of March 2009, only two months after the commencement of the project, tags had already been installed on four escalators.

London Underground and CoreRFID had also agreed a schedule for progressive implementation involving the installation of 1400 steps for the ten escalators at Kings Cross underground station before the end of July 2009. CoreRFID will also be training of two of London Underground's suppliers to deal with a further 2000 steps across seven underground stations and a further 2700 steps on 13 escalators by London Underground themselves.

Early installation experiences indicate that applying tags to new escalators and steps is relatively straight forward. Tags will be riveted in place as part of the manufacturing process. Adding tags to existing steps in situ has difficulties as predicted by the experiences in the trial. This is mainly related to identifying the steps in situ where, grease, dirt and poor lighting hamper the process and introduce the risk of error. However, cross checking data between what is expected and what is found is seen as being the best way to reduce the risk of error.

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Advantages of the Step Tracking System

The Step Tracking System created by London Underground and CoreRFID has a number of advantages over manual and other automated or semi-automated systems. The most important of these are:

- Automated system provides data without interrupting escalator use.
- Automatic collection of data eliminates manual errors from data collection.
- Approach means only one engineer needed to collect step data. (50% saving)
- Combined with portable ultrasonic flaw detection, can avoid the need to remove steps for testing.
- Data captured can be integrated with existing asset management systems.
- Data on step usage allows better prediction of maintenance needs.
- Improved visibility of wear gives better passenger safety.
- Hand-held computer provides low-cost and easy to use solution.
- Hand-held computer software is simple to use for operators.

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Technical Data

The Step Tracking System comprises four main components:

1. Hand-held, reader-writer computer
2. Step Tracking Systems application
3. Passive RFID tag
4. Tag data code and formats

PL3000 Hand Held Computer

The hand-held computer used in the London Underground application is the Nordic ID PL3000 handheld computer.

The Nordic ID PL3000 is a robust, high performance, high reliability hand held computer which incorporates an integrated RFID reader-writer for UHF chips (it can also have a barcode reader or 2-D barcode reader built in as well). The PL3000 runs the Windows CE operating system.

This system weighs about 500g with its battery which provides up to 14 hours operation.

The user interface is via a 3.5 inch quarter VGA touch screen and a 29 key keyboard. Each of the keys on the PL3000's keyboard can be back-lit under program control in order to direct the operator. PL3000 has been designed for one handed operation.

The PL3000 can be equipped with a range of communication options including:

- WLAN connection for wi-fi link for data upload
- Bluetooth
- GPRS
- EDGE
- 3G

Step Tracking Software

The Step Tracking application software running on the PL3000 has been developed for the Windows CE operating system. The application includes the following main modules:

- User set-up
- Step data down load (receive)
- Step data record (write)
- Escalator scan (read)
- Single step scan (read)
- Step data up-load (transmit)

Passive RFID Tag

The passive RFID tag used in the London Underground application is the Confidex Ironside G2XM UHF tag. This tag was selected because of its robustness, read reliability, and its suitability for on-metal mounting with either adhesives or pop rivets.

The Confidex Ironside conforms to EPC Gen2 protocol standards and provides a user-

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writeable area of 512 bits. It has a read range of up to 8 metres and meets the IP 63 (IEC60529) standard which defines a dust tight and water tight enclosure.

The Ironside tag has a temperature operating range of -20^0 C to + 65^0 C.

Data Formats

Because of the limited data storage area on the tag, CoreRFID developed a compact data storage format for the Step Tracking System which succeeds in packing the necessary application data into only 43 bytes.

Data held on the tag for the London Underground implementation includes:

- Step Type*
- Part Number*
- Manufacturer*
- Step ID Number*
- Year of Manufacture*
- Escalator Number+
- Step Position+
- Date of Installation+

* Items are written when the step is first delivered.

+ Items are written when the step is installed.

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About CoreRFID Ltd.

CoreRFID works with over 1100 customers across the UK, Europe, the USA and the rest of the world, providing them with the systems and support they need for their applications.

Many customers have continued to do business with CoreRFID over a number of years. Users of CoreRFID solutions are found in finance, broadcasting, construction, defence, government and telecommunications. Customers include the BBC, Capita, Nokia, BAA, Thames Water, the Channel Tunnel, Norwich Union, Galliford Morgan and Amec. CoreRFID specialises in the complete range of technologies for track, trace, audit and control applications, assisting customers in making the right choices for business critical applications. CoreRFID provides customers with:-

- RFID tags, sourced worldwide or custom manufactured
- Tag reader / scanner devices.
- Hand held computers for tag reading / scanning.
- Design and development of the software.
- Training and implementation service.

Experts In Track, Trace, Audit & Control

In a field where new development makes new applications practical, CoreRFID keeps in touch with the latest advances and makes it easy for clients to get the benefit of them.

CoreRFID has created the RFID Pilot Pack; a low cost way to try out RFID technology and assess the feasibility of potential applications. CoreRFID has strategic partnerships with providers of Ultra High Frequency components, making it possible for CoreRFID's clients to exploit this technology. CoreRFID software solutions are developed using the Microsoft .Net Framework making it easy to integrate track, trace audit and control applications with other back office systems.

Our Organisation

CoreRFID was formed in July 2007 the management team successfully completed a management buyout from Mannings UK to create a business exclusively focused on the needs of RFID technology users and with over 15 years of RFID experience. CoreRFID retains all the staff, know-how and intellectual property of the Mannings RFID business. The CoreRFID team of experienced engineers and its sales and administration centre is based in Warrington, in the North West of England.

CoreRFID is backed by Enterprise Ventures and NatWest Bank.

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