CLIENT GUIDE TO **TAGGING UNDERGROUND ASSETS**

THE SURVEY ASSOCIATION

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The Survey Association's Client Guides are primarily aimed at other professionals such as engineers, architects, planners and clients in general. They are not intended to go 'in depth' into practical issues but to act as a basic guide on a particular topic and in particular, on procedures and regulations which may govern how a particular aspect of the survey is carried out.

Introduction – why TSA felt there is a need for a client guide on asset tagging

Installing and maintaining the UK's 4-5 million kilometres of buried assets requires extensive input from utility companies, contractors and highway authorities. Back in 1997, it is estimated that UK contractors are digging 4 million maintenance holes per annum. With the amount of buried assets dramatically increasing, particularly with the rollout of high value fibre-optic networks and new polyethylene water and gas mains the number of holes dug will also increase. In 2004, Transport for London estimated that one million excavations a year are made in the capital alone.

The cost of the smallest and cheapest excavation is £500 excluding disruption costs to business and traffic delays. In 2010, London First estimated the cost of road works disruptions to London's economy at £750 million per annum, and the annual figure nationally could be as high as £5 billion.

With the cost of disruption estimated at £3,160 per roadwork/day, reducing disruption has to be a national strategic priority. All stakeholders now accept that excavations should only be carried out where necessary, and then with minimum disruption and maximum sustainability.

Figure 1
Tags installed on a new water main

To minimise disruption and cost, avoid injury to the public, the workforce, accidental damage to plant and to facilitate repair and maintenance using new keyhole techniques, underground assets need to be quickly and accurately locatable and identifiable from the surface.

Historically, location of underground assets has been based on record information held by utility companies on two-dimensional media, requiring verification by on-site trial investigations. Information, where it exists (and much of it does not), is often inaccurate, incomplete or out of date. Surface landmarks may have changed or disappeared and network modifications may never have been recorded.

Whether deploying trenched or trenchless techniques, there is a real need to understand the nature of the underground environment when planning and excavating for new installations or maintaining existing infrastructure. What pipes or cables are there? Where precisely are they, and at precisely what depth?

Various non-destructive surveying techniques are currently used to detect, identify and locate underground assets from above ground. However, no widely used method can detect every type of buried asset at any depth or positively identify an asset from the surface. One solution is to install marker tape with a core of metal wire above non-ferrous assets to aid their re-location. However, this is not always done and, when it is, the tape is easily broken, moved or removed. Where it is detected, it only acts as a warning and cannot identify the hazard.

Another solution that can now be used to mark **new and exposed existing** assets is Tagging.

Figure 2 & 3
Examples of typical tags

What is asset tagging?

Tags are electromagnetic markers located with or physically attached to underground assets allowing them to be accurately re-located at a later date. These assets might be newly installed or existing assets which have been exposed through excavation. Tagging solutions not only provide three dimensional position data but usually also allow other data, whether textural, photographic or otherwise to be recorded, often completely automatically, from the street. Some tags include electronics, which may enable data to be stored on them directly. By contrast other tagging solutions store all the data elsewhere using the tag itself as a basic marker. All tagging solutions allow recording, sometimes automatically, of basic attributes such as information on the installation date, the owner and the type of utility.

This guide explains the types of tags available, their uses, advantages and limitations. It is written specifically for tagging underground assets, in particular buried services.

Above ground assets and services can be tagged using an array of devices. Where it is practical to do so, above ground services that are an important reference to the infrastructure of new-lay buried services and/or exposed services can also be tagged with the devices described in this Guide. This will ensure consistency of the tagging device used and the subsequent detection using the same locator and personal digital assistant (PDA). The tagging device would not ordinarily be used for wide spread tagging of above ground services.

What type of tagging systems are available and how do they work?

A Typical Tagging system

Systems are typically a combination of three elements:

1. **Tags** (or markers) affixed directly to or close to underground assets
2. **A hand-held locator and PDA** for use in the field
3. **Integrated Database** that holds the data relating to the tagged asset

NB *Systems vary from one supplier to another and remain under continuous development. They may not follow this exact description.*

The Tags

The tags should be specified to be robust enough to withstand back-filling. Consideration should be given to the expected design life which could vary depending on the type of tag used, from two years to over 100 years.

All passive tags are energized by a radio frequency signal, emitted from and reflected back to a surface locator. The reflected signal is combined with asset specific data, in whatever format required (textual, photographic etc), to create a unique record, allowing each tag to be individually identified on a 3D Database. This also means tagging systems are able to assist field operatives when re-location is required.

There are two main categories of tags:

RF (Radio Frequency) tags have a limited number of frequencies so not all have unique codes; in which case Global Navigation Satellite System (GNSS) coordinates are needed to discern one RF tag from another.

When using RF tags with GNSS the tag separation needs to be greater than accuracy of the GNSS. Where tag separation has to be close then high accuracy GNSS has to be used.

RFID (Radio Frequency Identification) tags typically enable unique identification of tags in the ground although the method of achieving this varies in important ways. RFID tags carry a unique code stored in electronic circuits allowing unique identification and therefore access to a database holding further information on the asset including photographs and mapping showing other assets or known obstructions in the immediate area.

Tags may be 'Passive' or 'Active'.

Figure 4 (Left)

A typical locator and PDA unit. The unit enables pinpoint re-location of Tags attached to specific features on buried assets

Figure 5 & 6 (Right)

Tags are attached at all points of interest (joints, ferules, valves and so on). Data is automatically uploaded to the Database using the PDA.

Passive Tags

'Passive' indicates that the tag itself has no integral power source but responds to an activation signal emitted from a hand held locator. Its primary function is to act as a marker but some passive systems have a limited amount of 'on board' information as discussed above. All passive markers have associated information held in an external database.

Figure 7 & 8
More examples of locators

Active Tags

Active tags perform in a similar way but require a power source to operate. This is provided by either a battery or a nearby external power supply. These tags should not be used for buried services as batteries need replacing on a regular basis – typically around 2 years and reliable external power supplies are not always readily available. If the tags are located within manholes allowing ease of access then active tags can be considered although it should be noted that RF signals will not travel through metal covers.

Tags are designed to operate to different depths and can in fact theoretically operate to any depth. More typically they are designed to operate either as shallow tags (down to about 0.5m) or down to about 2m. Deep tags are physically larger than shallow tags.

The Locator

Depending on the system selected, the locator may consist of a send/receive Energiser Unit (often called either a locator or a detector) and a PDA Unit.

Once information is registered and stored on the Database it can be interrogated and received back in the field on the PDA unit which, when used in conjunction with the energiser unit, guides the operator to any desired nearby Tag location. All Database information can be viewed in the PDA screen.

The Database

The interactive 3D database classifies and stores all tag data transmitted from the locator, including location, utility type, specific asset type, job information, photos or any additional data. Some systems have no limit as to how much data can be stored against each Tag entry, other systems do put a limit. This information is relayed on demand via the PDA to the field operatives whenever and wherever required.

Some systems have all the 'intelligence' above the ground, others carry some basic data on the tag itself complemented by the data held in the database. All systems use databases that are accessible at all times and easily updated to take advantage of developing technology.

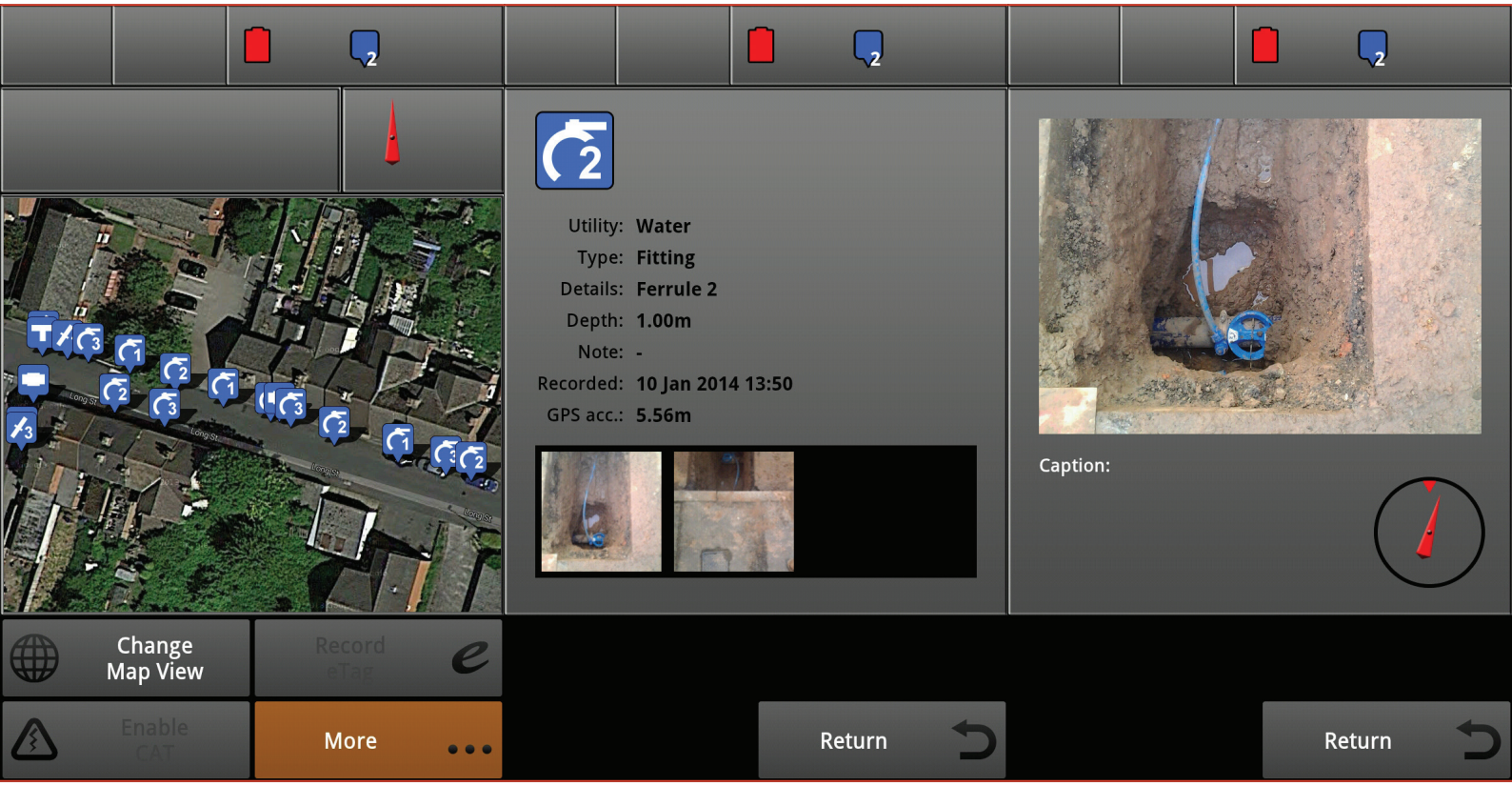

Figure 9
A typical PDA display

Field operatives may select from a number of background map alternatives to receive, actionable information to do their work with minimum disruption.

The Database links seamlessly with pre-existing and third party databases to complement and improve existing datasets.

The database is security protected at every level with authorisation access in the control of the utility.

How are asset tags deployed?

Asset owners may require tagging of assets during new-lay operations or after exposure for repair and maintenance. By installing the tag at these times the cost of tagging is kept to a minimum.

In new-lay situations tags may be placed at key locations such as joints, fittings or changes of direction. Alternatively the number of tags may be reduced by increasing the scope / extent of the 'intelligence' covered by each tag. Where excavation has taken place after the initial installation tags should be placed to record what is found; be it the targeted asset or an unknown buried object (UBO). The recording of this information is important to those who may subsequently be excavating in the area.

The density of tagging and specifically which assets should be tagged remains always at the discretion of the utility owner, contractor or even the work gang on site.

Tags can be deployed by any trained operator. Once trained, the operator positions the marker in the trench adjacent to the asset if providing information about the general area or attaches the tag to the asset itself if marking a salient point. The operator then uses the locator and PDA to capture the relevant data and create the record.

The asset types to be captured are determined by the user, and the software can be adapted according to their requirement.

How are tags subsequently detected, interrogated and, where appropriate, updated?

Tagging systems link a specific underground asset to a point on the surface (immediately above that asset) to a location in a Database.

When energised, tags resonate and reflect radio signals back to the surface at predetermined frequencies. They are energized by a radio frequency signal, emitted from and reflected back to a surface locator. The reflected signal is combined with asset specific data to create a unique record, allowing each tag to be individually identified and, when integrated with GNSS coordinates, instantly identifiable on a 3D Database. Every tag is individually identifiable and therefore its relation to that specific asset at that specific location.

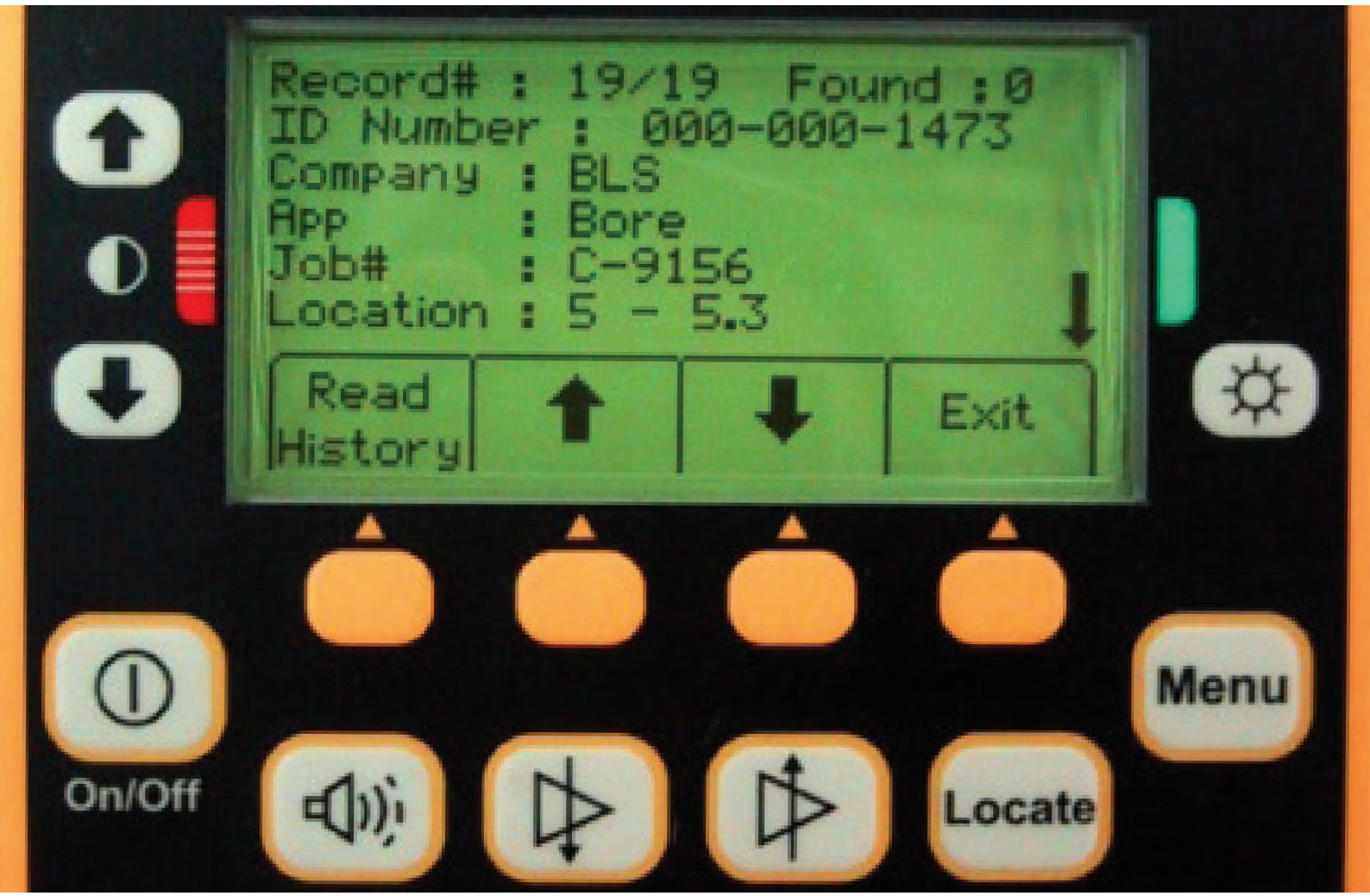

Figure 10
An example of a PDA screen

Once a marker has been deployed, and a record created, if the client has a need to re-visit the location the process is straightforward. Marker locations can be checked on the web portal prior to visiting the site. Once on site the operator locates the marker using the locator. Once located, the marker is read and the record associated with the marker is automatically displayed direct from the asset database.

All tag information corresponding to the exact or surrounding GNSS position of the locator is automatically displayed to the field operator on the PDA screen. The operator may choose any tag or combination of tags on the screen in any order and be guided to those exact tag locations.

Any alterations to the configuration of the underground assets as a result of the intervention should be recorded and uploaded to the database so that the latest information is being held for others to subsequently use.

Figure 11
A tag and locator in use on a gas pipe line

What security of data can be given against malicious corruption or commercial insolvency

Consideration should be given to understand the access and data security offered by the systems under evaluation and what would happen to the data should the database supplier become insolvent. While totally secure, the systems are entirely flexible. Individual items of data, data-types, data streams, data-sets, etc. can be coupled or de-coupled from the database and accessed by certain levels, groups, operatives and individuals but denied to all others.

Operators must be identified and then log-in to the system in order to connect a locator to the database. Operators seeking entry to the database must have the necessary security clearance to do so. Access to the database is controlled and policed in real time.

Every tag located with every detector leaves an audit trail. Every location that a detector is used leaves an audit trail.

Customers are protected from commercial insolvency. Tag, detector and database information, specifications, manufacturing process, and so on are lodged in legal escrow to be made available to customers in the event of insolvency or discontinuation. Some systems allow data to be encrypted during transmission to/from the database, and access to the software is password protected on both the PDA and the database.

Why use tagging?

The use of asset tagging can allow improvements in the way utilities manage their assets, reducing repair and maintenance (R&M) costs, streamlining job performance and quality assurance, improving health and safety and reducing environmental impacts.

Asset management

- Progressive automated build-up of an underground asset register
- Automatic update of database as tags are installed, building into a full asset history
- Audit trail for all interventions and re-instatement record
- Complements and adds value to existing datasets by adding spatial representation and management

Job Management and Quality Assurance

- Better workmanship through traceable ownership of work done in the field
- Quick location, re-location and identification from surface, and damage avoidance
- Automatic data input that replaces as-laid drawings
- Better job planning: less disruption and measurable environmental benefits
- Shorter permit times and lower lane charges with fewer overruns
- Less disruption to the local economy and improved PR messaging

Improved Health and Safety

- Less likelihood of collateral damage to owned or third party assets
- Less likelihood of accidental damage to owned or third party assets with reduced risk of injury or fatality
- Enables targeted interventions and associated keyhole techniques with corresponding reductions in scope and timing which reduces the likelihood of accidents
- Less guesswork, positive identification with linked data records

Cost Reductions

- All listed benefits directly deliver cost reductions
- Cost of tagging is offset by savings elsewhere
- Costs of R&M dramatically reduced
- Reduced insurance premiums and reduced incidence of penalties and fines
- Less dry digs, more accurate digs, faster re-location of previously marked assets

Limitations

As this is a relatively new technology tags have historically not been installed on either new build or at points of intervention. Tags are now being considered and installed by a number of organisations and hopefully one day will be widely used. However, because of this history many buried assets are not tagged meaning that there are large gaps in the records of this technology. This means that asset tagging needs to be considered as just one of many techniques to understand the network of utilities beneath our feet.

NB *This guide describes systems available at the time of going to press, clients should ensure their search and evaluation considers developments that may have come to the market since publication.*

The Survey Association

Formed in 1979 as The UK Land and Hydrographic Association, TSA is now established as the representative organisation for UK private surveying firms. The Association's aims are:

> To provide a vehicle for members to act effectively together on agreed courses of action

> To promote the interests of the profession to all those who determine the economic and social conditions in which the industry operates

> To identify and represent the views of the industry.

Using a TSA member

By using a TSA member you can be assured that your project will get off to the best possible start. Whatever the size of project, you can be certain that TSA member companies are expert in the provision and management of spatially related data on which to base your concept, design and construction.

Professional attention from a TSA surveyor will reduce risk, repetition, possibly save you money and will ensure that your project receives the best possible attention.

TSA Contact Details

If you would like any more information about the TSA or its members or about other Information leaflets then please contact Rachel Tyrrell at:

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Glossary of Terms

TERM	EXPLANATION
PASSIVE TAG	A passive tag is a tag that does not contain a battery; the power is supplied by the reader. When radio waves from the reader are encountered by a passive tag, the coiled antenna within the tag forms a magnetic field. The tag draws power from it. In an RFID tag (as opposed to an RF tag), the circuits in the tags are then energised and the tag then sends the information encoded in the tag's memory.
ACTIVE TAG	A tag is an active tag when it is equipped with a battery or power supply that can be used as a partial or complete source of power for the tag's circuitry and antenna. Some active tags contain replaceable batteries for years of use; others are sealed units.
GNSS	GNSS (Global Navigation Satellite System) is a satellite system that is used to pinpoint the geographic location of a user's receiver anywhere in the world. Alternative GNSS systems are or will shortly become operational: the United States' Global Positioning System (GPS) and the Russian Federation's Global Orbiting Navigation Satellite System (GLONASS), and Europe's Galileo are three examples. Each of the GNSS systems employs a constellation of orbiting satellites working in conjunction with a network of ground stations.
BURIED ASSET	A buried asset, in terms of this document, is an item buried by Utility companies for the provision of services, ie water, gas, electricity, telecoms, etc. Assets can be classified as pipes, valves, hydrants, joints, and many other types.

Document Revision History

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