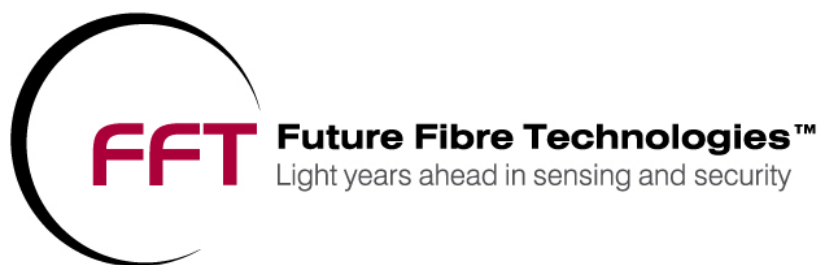


# **FFT Secure Pipe™ Installation Overview**



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## Secure Pipe Overview

In the USA between 1994 and 2001, the largest single contributor (38.8%) to pipeline damage, spills and leaks was due to an outside force – i.e. Third Party Interference (TPI). Clearly, the early detection of these TPI events, **before** any damage has actually occurred to the pipeline, would significantly improve the reliability of supply from pipelines, and minimize the risks of, and environmental damage due to leaks and spills.

In response to this need and with input and feedback from major pipeline research organizations and operators in the USA and Europe, Future Fibre Technologies developed FFT Secure Pipe™ - a significant and highly cost-effective Third Party Interference (TPI), physical disturbance and illegal tapping detection technology for the pipeline industry employing an advanced, distributed fibre optic sensor. FFT Secure Pipe™ is a monitoring system with the capability of detecting the **first signs** of surface activity or ground movement caused by external or abnormal forces, i.e. TPI, excavator or equipment setup, earthquakes, landslides, floods or stream scour. It also locates where the potential problem is on pipeline sections up to 40km long – quickly, reliably and accurately – to within 150 meters depending on cable type and location. It performs easily and reliably under a wide variety of operational and environmental conditions, with an extremely low false alarm and nuisance alarm rate.

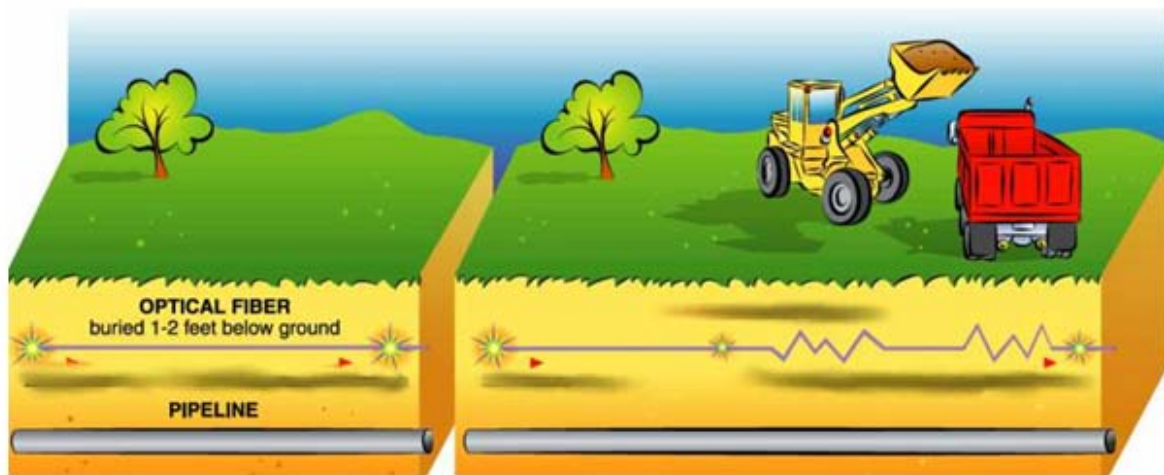
This technology provides a new dimension in detecting and locating pipeline TPI, by employing 3 unused singlemode fibres within the existing fibre optic pipeline communications cable as the sensing element. If no optical fibres are available, then a fibre optic cable can be laid above the pipeline as a sensing device to continuously monitor in real-time, any physical disturbances or TPI activity on or near the pipeline. The additional capacity within this cable can be used for telecoms, SCADA etc. The Locator technology employed in Secure Pipe allows users to identify the exact location of any disturbances to within 150m.

While the technology behind FFT Secure Pipe™ is sophisticated, its application in a system context is very simple. The basic system operates over pipeline spans of 40km with an industrial hardware platform (sensing controller) and Start Sensor at one end, and a passive termination device (or End Sensor) at the remote end. The only system component between these two ends is the fibre optic sensing cable itself. There is no electronics, power or maintenance required in the field.

By employing multiple FFT Secure Pipe™ systems networked together, you can monitor and protect hundreds, or thousands of kilometres of pipeline.

## How it Works

FFT Secure Pipe™ is effectively a fibre optic ‘microphone’, combining the characteristics of a piezo-electric transducer and strain gauge sensor, designed to detect disturbances generated by TPI activities and tampering, while discriminating between normal ambient conditions. Secure Pipe can detect and locate these illegal activities providing a warning **before** any damage is done to the pipeline – often at the time of the equipment setup as you can see in the picture below.



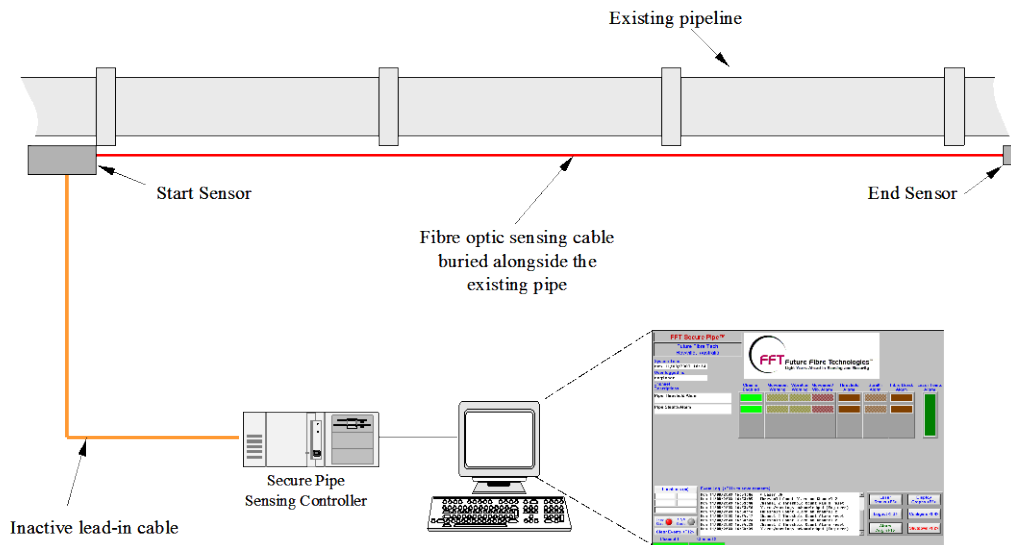
**Fig 1: Secure Pipe Detecting TPI**

This is in contrast to most conventional pipeline TPI detection systems, which tend to operate as a trip wire style system, where damage has to actually be done to the fibre optic cable or copper wire, so the OTDR (Optical Time Domain Radar) or TDR (Time Domain Reflectometers) can locate the damage. This is often too late and the cable will most likely have to be repaired after each incident.

The Secure Pipe system is very sensitive to ground movements and the frequencies of the sound or pressure waves generated by TPI. Through the use of intelligent signal processing, these can be isolated from other environmental signals for clear identification, with minimal false alarm and nuisance rates. This detection and signal processing technology is well proven, and is installed in numerous commercial, military and industrial applications.

As you can see in Fig 2, the system comprises an optical fibre cable laid in close proximity, above or adjacent to the pipeline (within one to three meters) and a Secure Pipe Sensing Controller, containing the opto-electronics, data acquisition hardware and signal processing software, installed at one end of the pipeline (section) to be monitored. The system can operate in a stand-alone mode, or interfaces can be provided for the industrial control systems usually encountered in pipeline management operations. FFT can supply FFT CAMS (a

Central Alarm Monitoring System) and integrate several FFT systems into this one central monitoring unit for ease of operation.

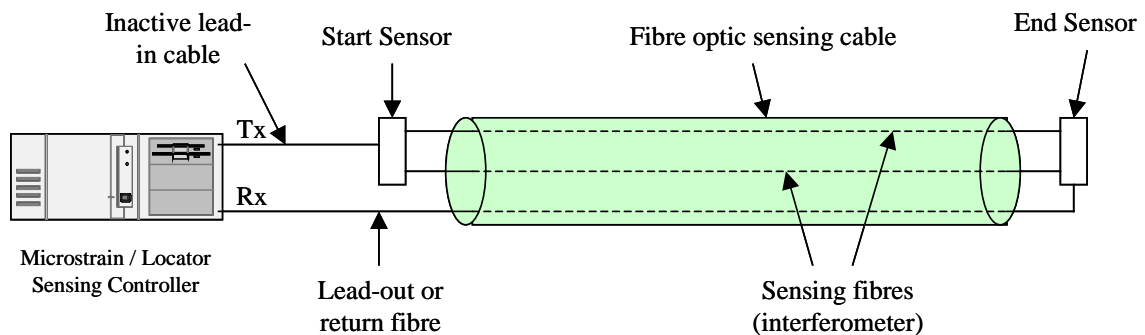


**Fig 2: Basic Secure Pipe Layout**

More commonly, if there is an existing fibre optic pipeline communications cable, which has three single mode fibres that are not in use, FFT Secure Pipe™ can often utilize these unused fibres rather than lay an additional sensing cable, reducing installation times and costs substantially. The sensitivity of FFT's Secure Pipe™ System on the other hand, is not significantly affected.

FFT Secure Pipe™ uses the singlemode optical fibres as its sensor, detecting movement, vibration and sound acting on the cable, what it is buried in, or what ever it is attached to.

Referring to Fig 3, the Microstrain/Locator sensor is based on interferometry where two of the fibres within the sensing cable form the arms of an interferometer. Using a coherent laser, CW light is propagated through the arms of the sensor. When there is an external interference on the sensing fibres (motion, sound or vibrations) an interference pattern will be generated. The Sensing Controller will detect this change and the FOSS software will interpret the effect as either an intrusion event, or reject it as ambient conditions.



**Fig 3: Secure Pipe System**

The Sensing Controller identifies the event and can, through the FOSS software, determine the type of event. Using the unique recognition features in FOSS, we can limit nuisance alarms created by ambient noise and nuisance events to minimal levels while ensuring >95% detection of intrusion events.

FFT Secure Pipe™ provides an unlimited amount of zones using 3 optical fibres within the one distributed sensor cable, and is able to detect and locate multiple tampering or intrusions events in real time.

The Locator portion of the system will locate any TPI or tampering to within 150 meters. This unique feature allows you to pinpoint the location of any interference or illegal activities along pipelines of hundreds of kilometres. It also reduces the number of systems required, since multiple fixed zones and the associated hardware are not required.

Power is not required along the pipeline for FFT Secure Pipe™ (other than at the sensing controller stations), nor is the sensing cable at risk of damage from electrical interference, lightning strikes, EMI, or RFI. The sensing cable is also intrinsically safe.

### ***Third Party Interference (TPI)***

In many situations pipeline owners and operators recognize the expense and inconvenience of accidental or deliberate attempts to physically interfere or tamper with the pipeline. FFT Secure Pipe™ provides the possibility of warning about such incidents **prior** to serious damage occurring.

In other cases, deliberate attempts are made to illegally tap into the contents of pipeline. The FFT Secure Pipe™ Third Party Interference capability is designed to minimize the possibility of these incidents by detecting activities at the set-up stage.

## **Sensing Distances**

A major advantage of using FFT Secure Pipe™ is the consistency of the detection response over pipeline distances of up to 40 kilometres without the need for any external power or hardware other than the fibre optic sensing cable itself. In a straight line, this distance is 40km (40km out plus 40km return = 80km light path).

The actual distance achievable is limited by an optical power budget of 25dB, which translates into a total optical path length of 80km depending on the quality of the fibre optic cable and the number and quality of the splices and general installation. The optical path length compromises the "lead-in", sensing cable length, and "lead-out" cable.

## **Zoning**

Via FFT CAMS, the Secure Pipe system has the flexibility to be configured either as a large single zone sensor or as multiple smaller zones. These zone lengths are software configurable, so you can break down the one sensor cable into multiple zones of varying lengths to correspond with the positions of CCTV's, lights etc. A matrix switcher interface is optionally available within FFT CAMS to interface and control Pelco P series switchers using ASCII Protocol.

If these zones are kept relatively short and manageable, then it is much simpler to locate with greater accuracy where a breach has occurred.

## **Interference Immunity**

One specific benefit of fibre optic based systems is their immunity to electromagnetic interference, particularly important for installations near high voltage electrical equipment, or in areas subject to lightning strikes, electromagnetic pulses, strong magnetic fields, or RFI.

## **Intrinsically safe**

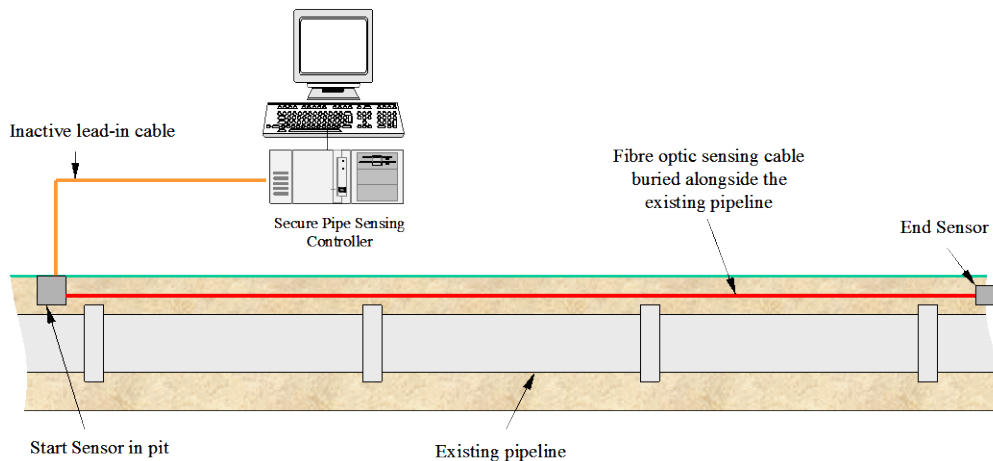
Another important aspect of FFT Secure Pipe™ is that no power, external electronics, or control hardware is required in the field other than for the sensing controller located at the start of pipeline. There is no power applied to or near the pipeline itself, and the start and end sensors are passive optical devices also requiring no power.

## **Interfacing**

FFT Secure Pipe™ systems have the flexibility to interface to a wide variety of local or remote security management systems so that it can integrate with supporting security technologies such as display systems, cameras, lights and audible alarms.

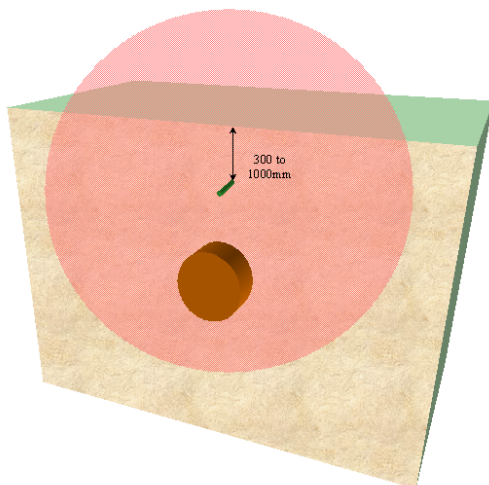
## Installing a New Sensing Cable

In its simplest form, to establish a protected pipeline, a single continuous FFT Secure Pipe™ optical fibre sensing cable is buried (or ploughed in) above the pipeline.



**Fig 4: Basic Secure Pipe Configuration**

The concept behind FFT Secure Pipe™ is the 'early detection' of a disturbance to the pipeline. For this reason, the physical positioning of the sensor cable in relation to the pipeline is important – if the sensor cable is buried too deep, then you may not detect surface activities immediately and you will have to wait for the TPI activity to penetrate below the surface before an alarm or location is generated. Conversely if the cable is not deep enough, then the cable itself may be inadvertently damaged by surface activity.



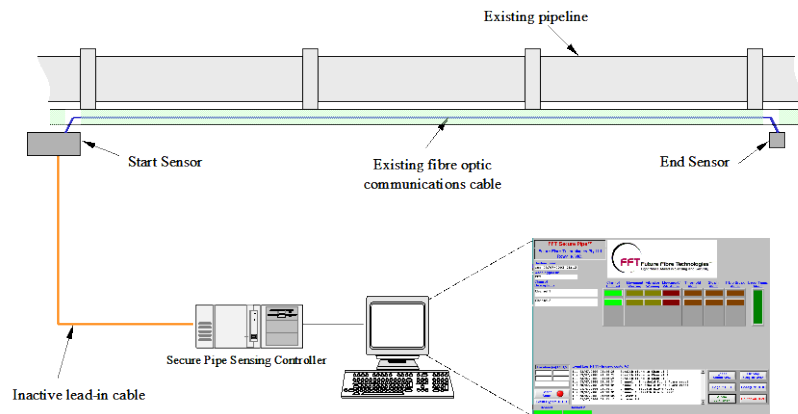
**Fig 5: Cable Depth**

The ideal position for the FFT supplied sensor cable is between 300 and 1000mm (1-3ft) from the surface directly above the pipeline.

Furthermore, if you are using an armoured cable, then as this is less sensitive than FFT's sensor cable, you definitely want this closer to the surface – at 300mm or 1ft deep.

## Utilizing the Existing Cable as the Sensor

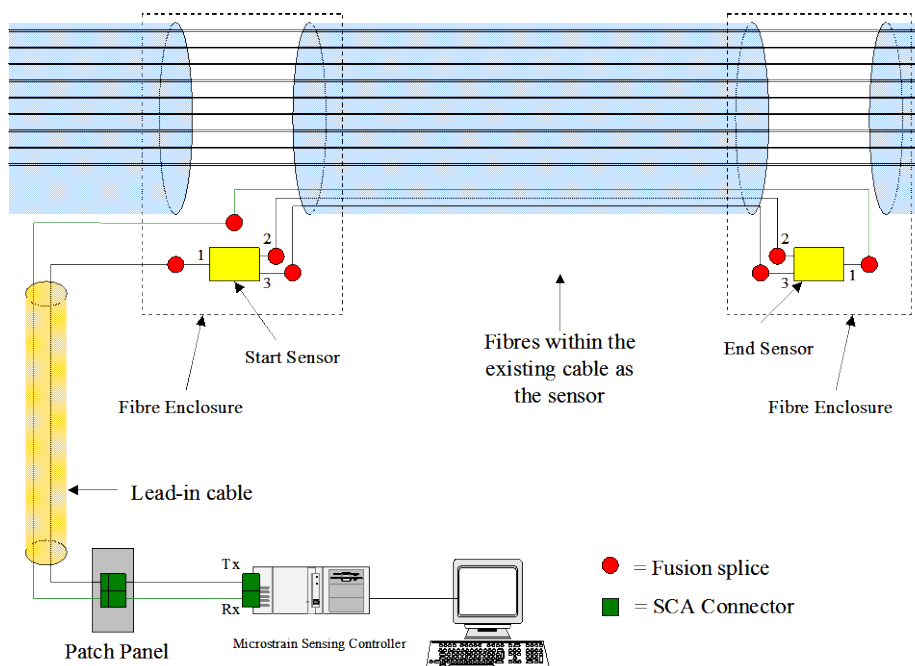
In the majority of pipeline installations and the preferred method, 3 unused singlemode fibres within the existing pipeline communications cables are used as the Secure Pipe sensor.



**Fig 6: Secure Pipe Installation using existing fibre optic cable**

In both of these installation examples, a non-sensitive feeder cable is installed between the Sensing Controller and the sensing cable buried alongside the pipeline.

The Start and End Sensors are spliced up as indicated in Fig 7. Sometimes they are fitted to the patch panels at each end rather than breaking out the cable. The actual installation method used depends on the individual installation.



**Fig 7: Splicing into an Existing Pipeline Cable**

**For more information on FFT Secure Pipe installation procedures, contact Future Fibre Technologies.**

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