3-D Integrity Management works with Smartec who has developed an innovative system based on fiber optic technology to detect leaks. The flow of water inside a dam modifies the temperature of crossed zones. Analysis of the temperature distribution, using a suitable algorithm enables the identification of the exact zone of leakage. The rough temperature data are not enough to localize a leak, since external factors (e.g. rain, seasonal temperature variations) can influence the measures and bring to erroneous conclusions.

The distributed temperature sensors (DTS), based on Raman optical fiber, allows the monitoring of all kinds of dams and dikes with high spatial and temperature resolutions. We offer a wide range of acquisition units able to satisfy all technical requirements.

**Main Monitoring System Specifications**
- Localization of leaks with better than 1m accuracy over distances of 30km and more
- Accurate identification of leakage path
- Precise temperature mapping with 0.01°C resolution and 0.1°C accuracy
- Autonomous and continuous monitoring 24/7
- Rugged and durable cable construction for direct embedding in soil or concrete
- Easy and quick to install, use and maintain
- Can be combined with distributed strain sensors for soil stability monitoring
- Immune to electromagnetic fields, corrosion and rodent resistant
- Remote monitoring and alerting

**Integrity Management Solutions**
- Monitoring system design and supply of all components
- Installation and commissioning of the system
- Training
- Data analysis and interpretation

**Project References**
- Koudiat Acerdoune Dam  (RCC type)  Algeria (2006-2009)
- Artificial Water Reservoir  (Dike type)  Spain (2007-2008)
- Nam Ngum II Dam  (CFRD type)  Laos (2008-2010)
- Kalivac Dam  (CFRD type)  Albania (2007-2011)
- Laguna Seca Dam  (Rock-filled type)  Chile (2009)
- Siah Bisheh Dam  (CFRD type)  Iran (2009)
- Landfill waste  (Dike type)  Chile (2011)
- Biolixiviation Valley  (Dike type)  Chile (2012)
- Krsko  (Dike type)  Slovenia (2012)
Fiber Optic Leakage Detection System

Thanks to fiber optic technology and years of experience, our solution is able to detect and localize leakage points every meter over long distances. The monitoring system can be based on an active or passive approach.

The active method (also known as Heat Pulse Method - HPM) is preferred when the expected temperature variations between the water (liquid) and the soil is small. Controlled heating (and releasing) of the FO cable allows amplification of the temperature change, facilitating accurate monitoring. The Heat Pulse Method is described in the figure below. Temperature differences can be seen between zones with slow (low) and fast (copious) seepage.

Alternatively, the passive method is preferred in applications when larger temperature changes are expected, or the cable is many kms long. The installation is quick, easy and durable, as the optical fibers are protected by a stainless steel armoured reinforced cable.

Customized monitoring software is offered enabling the client to see the position of the sensor in the structure, as well as the exact location of an event when alarm or warnings occur. The real-time data gathered by the monitoring solution can also be uploaded to a private and protected website for further analysis and/or archiving.

Internal Erosion

Seepage through an embankment (earth and tailing dam, dike etc) can induce the movement of soil particles. This phenomenon, as known as internal erosion and has been identified as one of the most important causes of failure. Detecting internal erosion is difficult at an early stage, so DTS is increasingly recommended by designers as an essential monitoring solution for the safety management of the dam.

New Dams

During the construction of any type of dam, the FO monitoring system provides important temperature real-time data. Therefore it’s suggested installing DTS cable at strategic and critical access points e.g. foundation level, behind the cutoff wall or grout curtain, near the drainage system, in the dam’s body or at plinth level behind the concrete face.

This approach gives valuable information to the designers such as the concrete curing temperature variations during construction phases, and verification of thermal and infiltration design assumptions during its life span.

Existing Dams

When a dam is already built the installation of DTS is limited to some zones e.g. the toe on the downstream face, inside the galleries or other points that can become accessible during maintenance phases.