

SHAPEARRAY

ShapeArray is your smart solution for geotechnical monitoring.

An integrated, streamlined approach to reducing risk.

**DEFORMATION CAPTURE SIMPLIFIED.**





# SHAPEARRAY

ShapeArray is an integrated measuring tool that measures deformation in soil and structures in real-time. The instrument can be used vertically, horizontally, or in an arc, to measure lateral deformation, settlement, or convergence. ShapeArray's design—rigid stainless steel sensorized segments connected by flexible joints—is durable and allows for simple installation from its shipping reel. Every segment of ShapeArray contains three MEMS tilt sensors, a microprocessor and digital temperature sensor.



# EASY. RESILIENT. SAAV



## CASING CAP

holds SAAV in compression.

## EXTENSION TUBES

occupy space at top, if sensors are not needed near the surface.

## SENSORIZED SEGMENTS

With the cyclical installation system (patent pending), segments zigzag within the casing, enabling easy installation and the re-use of casings.

## SILENT SEGMENTS

occupy space at the bottom, if sensors are not needed there. Can be added or removed in the field.

# EXTENSION TUBES & SILENT SEGMENTS

SAAV is designed to provide maximum flexibility and control. Extension tubes and silent segments permit placing the SAAV's sensorized segments in a region of interest.

# CYCLICAL INSTALLATION

The cyclical installation system (patent pending) enables a stable fit into either new or distorted casings up to 100 mm in diameter. SAAV takes reel-to-hole installation to a new level. No other inclinometer system is as easy or resilient to deformation.

# SAAV

The most advanced ShapeArray makes installation even simpler with off-the-reel cyclical installation into casings up to 100 mm in diameter. Optional silent segments offer flexibility for users to control the location of the sensorized zone.



**Segment Length:**

500 mm

**Installation:**

Vertical/Horizontal/  
Convergence<sup>1</sup>

**Applications:**

Permanent/Temporary



# PHYSICAL PROPERTIES

SEGMENT LENGTH	500 mm (Joint centre to joint centre)
CASING INSIDE DIAMETERS	47 mm to 100 mm (Other sizes late 2017)
STANDARD LENGTH OF SAAV	0.5 m to 150 m (500 mm segments)
CUSTOM LENGTH OF SAAV	Over 150 m (Contact Measurand for details)
LENGTH OF FIBERGLASS EXTENSION	1 m to 100 m
LENGTH OF COMMUNICATION CABLE	15 m standard
ACCURACY OF DEFORMATION RELATIVE TO STARTING SHAPE <sup>234</sup>	± 1.5 mm for 32 m ShapeArray
RESOLUTION OF SINGLE SEGMENT <sup>45</sup>	± 1 arcsecond

<sup>1</sup> Horizontal and convergence installation available late 2017.

<sup>2</sup> One-sigma value, based on cyclical installation in 59 mm ID casing. Accuracy degrades as square root of length.

<sup>3</sup> Value based on AIA (Average in Array) setting of 1000 samples.

<sup>4</sup> Specification is for 3D mode within ± 20° of vertical. Vertical accuracy degrades with angular deviation from the vertical.

<sup>5</sup> RMS calculated from published noise figure of sensor (verified by Measurand Inc.) and bandwidth of system using highest AIA setting of 25,600 samples.

# SAAF

Versatile and flexible, SAAF is the most popular ShapeArray model. A range of available segment lengths tailors spatial resolution and maximum curvature. Ideal for long-term monitoring horizontally, vertically, or in an arc.



**Segment Length:**

200, 305, and 500 mm

**Installation:**

Vertical/Horizontal/  
Convergence

**Applications:**

Permanent

# PHYSICAL PROPERTIES

SEGMENT LENGTH <sup>1</sup>	200, 305, 500 mm (Joint centre to joint centre)
CASING INSIDE DIAMETERS	27 mm ID PVC
STANDARD LENGTH OF SAAF	0.305 m to 60.96 m (305 mm segments), 0.5 m to 150 m (500 mm segments)
CUSTOM LENGTH OF SAAF	Over 150 m (Contact Measurand for details)
LENGTH OF PEX TUBING	1.5 m standard
LENGTH OF COMMUNICATION CABLE	15 m standard (13.5 m extends past PEX tubing)
ACCURACY OF DEFORMATION RELATIVE TO STARTING SHAPE <sup>234</sup>	± 1.5 mm for 32 m ShapeArray
RESOLUTION OF SINGLE SEGMENT <sup>45</sup>	± 2 arcseconds

<sup>1</sup> Custom segment lengths between 200 mm and 305 mm are available at extra cost.

<sup>2</sup> One-sigma value, based on cyclical installation in 27 mm ID casing. Accuracy degrades as square root of length.

<sup>3</sup> Value based on AIA (Average in Array) setting of 1000 samples.

<sup>4</sup> Specification is for 3D mode within ± 20° of vertical. Vertical accuracy degrades with angular deviation from the vertical.

<sup>5</sup> RMS calculated from published noise figure of sensor (verified by Measurand Inc.) and bandwidth of system using highest AIA setting of 25,600 samples.

# SAAX

Purpose-built with longer one metre segments for heavy duty horizontal installation: soil settlement, rail-line deformation, and pipeline monitoring.



**Segment Length:**  
1000 mm

**Installation:**  
Horizontal

**Applications:**  
Permanent/Temporary

# PHYSICAL PROPERTIES

SEGMENT LENGTH	1000 mm (Joint centre to joint centre)
STANDARD LENGTH OF SAAX	1 m to 150 m
CUSTOM LENGTH OF SAAX	Over 150 m (Contact Measurand for details)
LENGTH OF PEX TUBING	1.5 m standard
LENGTH OF COMMUNICATION CABLE	15 m standard (13.5 m extends past PEX tubing)
ACCURACY OF DEFORMATION RELATIVE TO STARTING SHAPE <sup>234</sup>	± 1.5 mm for 32 m SAAX
ACCURACY OF ABSOLUTE SHAPE <sup>1234</sup>	± 10 mm for 32 m SAAX
RESOLUTION OF SINGLE SEGMENT <sup>3456</sup>	± 2 arcseconds

<sup>1</sup> Measured at 20°C, with X mark facing a consistent direction.

<sup>2</sup> Long term measurement value based on field measurements of vertical arrays > 1 year of operation.

<sup>3</sup> Value based on averaging 1000 frames per reading.

<sup>4</sup> Specification is for 3D mode within ± 15° of vertical.

<sup>5</sup> Short-term measurement ≤ 24 h.

<sup>6</sup> RMS calculated from published noise figure of sensor (verified by Measurand Inc.) and bandwidth of system using highest AIA setting of 25,600 samples.



# SAASCAN

Built for rapid deployment and repeated use. The instrument of choice for one-shot verification of the alignment of jet-grouting holes. Thick-walled 500 mm segments provide great spatial detail and resist damage.



**Segment Length:**  
500 mm

**Installation:**  
Vertical/Horizontal/  
Convergence

**Applications:**  
Temporary

# PHYSICAL PROPERTIES

SEGMENT LENGTH	500 mm (Joint centre to joint centre)
STANDARD LENGTH OF SAASCAN	0.5 m to 50 m
CUSTOM LENGTH OF SAASCAN	Over 50 m (Contact Measurand for details)
LENGTH OF UNSENSORIZED NEAR-CABLE END	8.2 m standard (Includes 330 mm Cable Terminator Segment and 7900 mm Hydraulic Hose)
LENGTH OF COMMUNICATION CABLE	15 m standard
ACCURACY OF DEFORMATION RELATIVE TO STARTING SHAPE <sup>245</sup>	± 1.5 mm for 32 m SAAScan
ACCURACY OF ABSOLUTE SHAPE <sup>1245</sup>	± 10 mm for 32 m SAAScan
RESOLUTION OF SINGLE SEGMENT <sup>3456</sup>	± 2 arcseconds

<sup>1</sup> Measured at 20°C, with X mark facing a consistent direction.

<sup>2</sup> Long term measurement value based on eld measurements of vertical arrays > 1 year of operation.

<sup>3</sup> Short-term measurement ≤ 24 h.

<sup>4</sup> Value based on averaging 1000 frames per reading.

<sup>5</sup> Specification is for 3D mode within ± 15° of vertical.

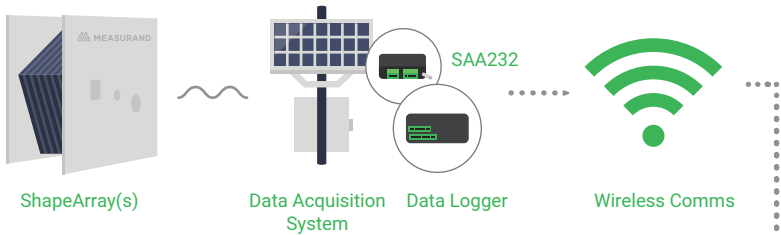
<sup>6</sup> RMS calculated from published noise figure of sensor (verified by Measurand Inc.) and bandwidth of system using highest AIA setting of 25,600 samples.

# DATA COLLECTION AND VIEWING

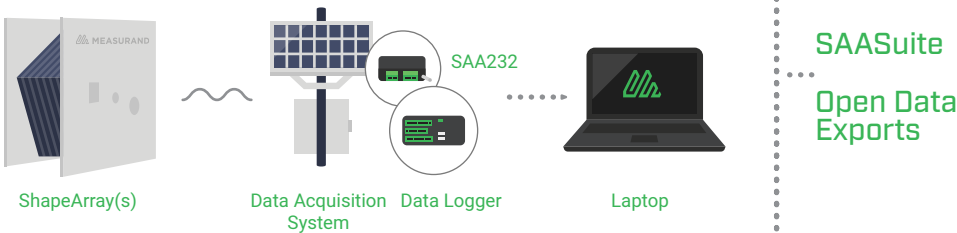
Geotechnical Observations take export files from SAASuite for use in our presentation packages, Atlas and Geodaisy. Atlas is an efficient tool for graphically presenting data from all types of instrumentation and can be used to raise alarms to real-time events. Geodaisy is Geotechnical Observations' in-house software for analysing and interpreting the results of real-time data. It includes a wide range of tools for analysing the results from ShapeArrays.



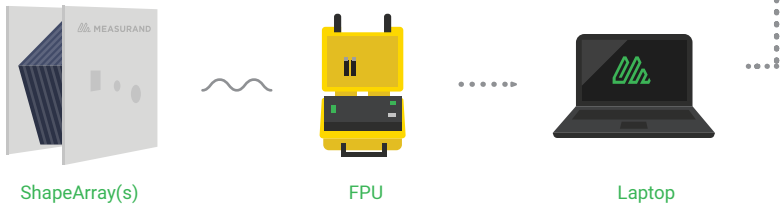
### Auto Collection / Retrieval



### Auto Collection / Manual Retrieval



### Manual Collection / Retrieval





## INSTALLATION SUPPORT

When complex or uncertain installation conditions face our clients, Geotechnical Observations, supported by Measurand, is able to assist with technical experts in the field. We believe that providing onsite technical advice and training gives your team a solid foundation to get valuable and actionable data from ShapeArray's real-time deformation monitoring.

## AFTER SALE SUPPORT

In-house support is provided by Measurand's technical staff with industry experience, ready to provide assistance with your ShapeArray instrumentation. An online library and support portal make it simple to collect, process, and view your data. For situations that require closer attention, support staff are available via telephone and email.

A worker in a high-visibility orange vest and blue pants is standing on a metal platform inside a large, curved tunnel. The worker is reaching up to touch the ceiling of the tunnel. The tunnel's interior is filled with various mechanical components, pipes, and structural elements. The lighting is dim, and the overall tone of the image is greenish-blue.

ONE PRODUCT.  
ONE FOCUS.  
YOUR SOLUTION.



MEASURAND IS THE  
INDUSTRY STANDARD  
FOR REAL-TIME  
GEOTECHNICAL  
MONITORING

# SECTORS

A photograph of an urban construction site. In the foreground, there is a large pile of dirt and debris. In the background, a building with a distinctive dome is visible under a cloudy sky. A yellow excavator is partially visible on the left side of the frame.


URBAN CONSTRUCTION

An aerial photograph of a mining operation. The image shows a large, deep, and irregularly shaped tailings pond with a mix of brown, orange, and grey colors. Several winding roads or paths are visible within the pond area, and the surrounding landscape appears rugged and industrial.


MINING & TAILINGS PONDS

A photograph taken from inside a tunnel. A worker wearing an orange safety vest and a hard hat is standing on a metal platform, reaching up towards the ceiling of the tunnel. The tunnel walls are smooth and white, and various pieces of equipment and machinery are visible in the background.

TUNNELS

A photograph of a steep, rocky hillside. The hillside is covered with loose rocks and debris, indicating a potential geohazard. A road or path runs along the base of the hill, and some trees are visible on the left side of the frame.

GEOHAZARDS

A photograph of a large concrete dam structure. The dam has multiple vertical supports and a wide, flat top. Water is visible behind the dam, and the surrounding area appears to be a construction or maintenance site. The sky is overcast.

DAMS & LEVEES





US ROUTE 2 LANDSLIDE

Traffic diverted before  
catastrophic failure

# SHAPEARRAYS PROVIDE EARLY WARNING AND THEN SURVIVE MASSIVE SLIDE


Steep river banks and clay soil near highways have led to numerous slide events near Crookston, MN, over the past 50 years. In 2003, a landslide in downtown Crookston caused significant property damage, leading the Minnesota Department of Transportation (MnDOT) to investigate new monitoring solutions. The department had used traditional inclinometers, but were interested in automation and remote collection of data. MnDOT installed ShapeArrays in two roadway sections on US Route 2 experiencing stress related to erosion and soil instability.

ShapeArray data revealed that soil movements at the Crookston East site were deeper than anticipated. Experts determined that the slope was no longer creeping and a major failure was occurring. The MnDOT closed the westbound lanes of US 2 and detoured traffic on Sept. 15, 2008. Ten days later, a large progressive landslide occurred, dropping a 150 metre section of highway three metres. The slide continued over several days. ShapeArray helped engineers ensure that no members of the public were hurt during the sliding event. ShapeArray survived unprecedented deformation during and after the event. The system remains in place and provides valuable data to the MnDOT.

[See more case studies at measurand.com](https://measurand.com)

Reference:

Dasenbrock, D. D. (2010) Automated Landslide Instrumentation Programs on US Route 2 in Crookston, MN. *Proceedings of the UMN 58th Annual Geotechnical Engineering Conference*. Continuing Education and Conference Center, St. Paul Campus: University of Minnesota.



ŽELAZNY MOST

Europe's largest tailings  
pond demanded deep  
ShapeArray monitoring



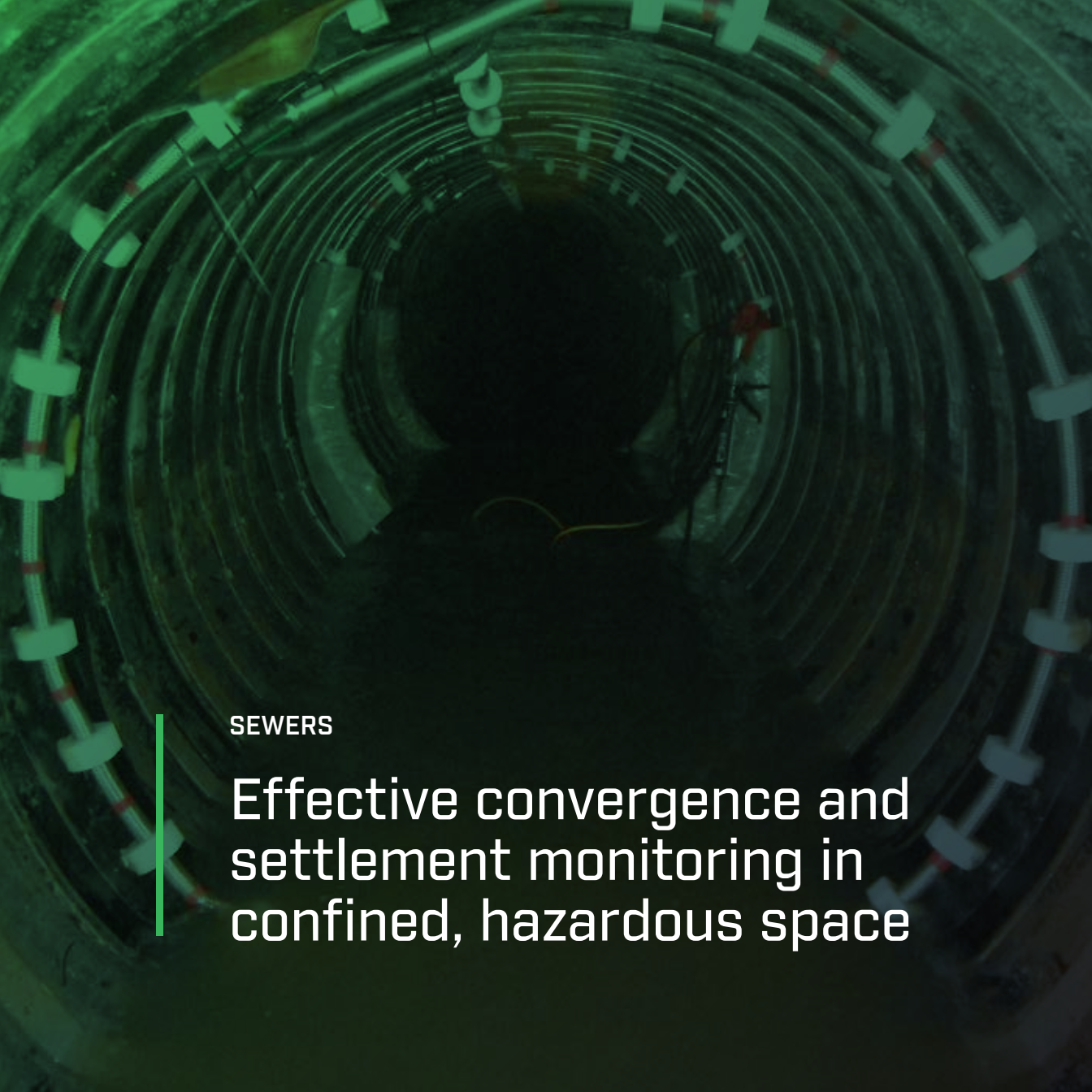
# SHAPEARRAY PROVIDE RISK REDUCTION FOR CHALLENGING SOIL FOUNDATION CONDITIONS

With a development capacity of over 1.1 billion cubic metres, that accepts 80,000 tonnes of tailings each day, the Żelazny Most Reservoir plays an essential role in Poland's economic activity. When the engineers at the Żelazny Most Reservoir began to suspect that the ground beneath Europe's largest copper tailings pond might be moving, they needed new monitoring solutions.

ShapeArray enabled monitoring at an unprecedented depth, which provided Żelazny Most Reservoir's owners, KGHM Polska Miedz, a way to monitor slope stability and deformation in the dam foundation.

ShapeArray is part of a monitoring program at the reservoir to accommodate the tailings produced by three copper mines in the area.

[See more case studies at measurand.com](https://measurand.com)



SEWERS

Effective convergence and  
settlement monitoring in  
confined, hazardous space

# REAL-TIME DATA ALLOWS DESIGN VERIFICATION AND IMPROVES WORKER SAFETY

When designers of the Crossrail tunnel underneath London's streets encountered obstacles such as brick sewers, they installed ShapeArrays to monitor convergence and settlement. The Mid-level sewer lay just a few metres above a hand excavated cross-passage between the existing Bond Street Station and a new ticket hall on London's busy Oxford Street.

Working with electrical instrumentation inside potentially explosive environments can be dangerous and following detailed discussions with Thames Water, it was decided that the ShapeArrays should be protected with ATEX certified conduits. Geotechnical Observations sourced suitable protective sleeves and worked closely with Thames Water and Measurand to deliver a safe and reliable system. ShapeArrays were installed around the internal circumference of the sewer to measure convergence and along the crown of the sewer to measure settlement as tunnelling occurred beneath the sewer.

ShapeArray's low profile does not obstruct flow in tunnels and eliminates the need for workers to enter the potentially dangerous environments to collect data. The system has also been used in live railway tunnels.

See more case studies at [measurand.com](https://measurand.com)



BASEMENTS AND DEEP EXCAVATIONS

ShapeArray measured  
retaining wall deflection,  
reduced construction  
time and costs

# MEASUREMENT DATA ALLOWS ENGINEERS TO EXECUTE A VALUE ENGINEERING PROPOSAL

Whilst constructing a new £1 billion station at Tottenham Court Road in London's West End, engineers planned five levels of temporary props to bolster and stabilize the retaining walls. Geotechnical Observations installed nine ShapeArrays vertically into the retaining walls to measure deflection. Engineers set a number of different alarms to notify staff when movement exceeded their thresholds. The data produced by the ShapeArrays allowed our engineers to help draft a Value Engineering (VE) proposal to omit a planned propping level. The data showed that forces acting on the retaining walls were within allowable tolerances without the additional prop. The client accepted the VE proposal, which resulted in significant savings to the project and eliminated 26 days of scheduled construction.

[See more case studies at measurand.com](https://measurand.com)

Reference:

Thurlow, P., & Lipscombe, R. (2014). The Use of Shape Accel Arrays (SAAs) for Measuring Retaining Wall Deflection. In J. Wolosick, A. Marinucci, S. Ballenger. *Proceedings of the 39th Annual Conference on Deep Foundations*. Atlanta, GA: DFI.



NORTHERN LINE EXTENSION

# ShapeArray is the new standard

Following the very successful use of ShapeArrays on the Crossrail project in London, contractors again turned to them for monitoring the construction of an extension to the Northern Line on London Underground's network. On this project ShapeArrays were, for the first time, written into the monitoring specification in preference to other forms of in-place measuring equipment. Geotechnical Observations installed ShapeArrays into the vertical retaining walls for two shafts and two station boxes, as well as three existing railway tunnels. Installing instruments into live railway tunnels brought many new challenges and new methods of fixing had to be developed, but as always Geotechnical Observations and Measurand rose to the challenge.



# CONTACT US

Geotechnical Observations' vision is to be your preferred supplier of structural and geotechnical instrumentation and monitoring services. That is why we have partnered with Measurand, who strive to design and manufacture superior monitoring products. Together we provide the customer service to match this. From sales to installation to support our joint aim is your satisfaction. Geotechnical Observations is the exclusive distributor of Measurand's products in the UK and Ireland.

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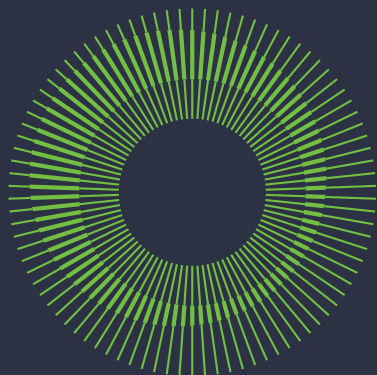
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Trusted Monitoring Solutions



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