

## **Appendix R**

### **Radioactive Material**

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# TROXLER

*The leader in construction test equipment*

## RoadReader™ Nuclear Density Gauges

Models 3430 & 3440



Model 3430



Model 3440



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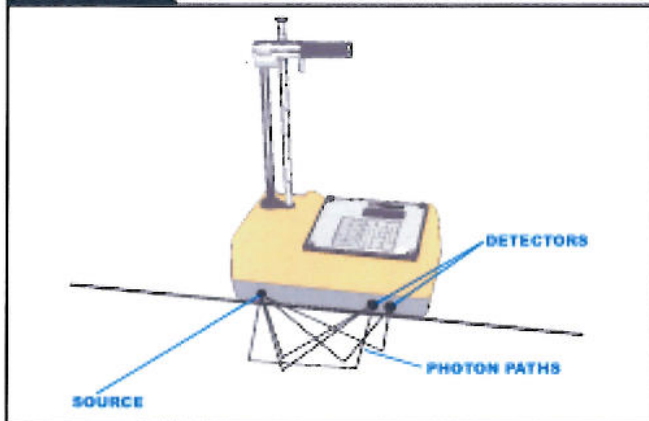
Winner of the 2003 IRF Global Road Achievement Award  
in the category of Technology, Equipment & Manufacturing

The Troxler RoadReader™ nuclear moisture / density gauges are used by many contractors, engineers, and highway departments for compaction control of soil, aggregate, concrete and full depth asphalt. The ASTM standard numbers D 2922, D 3017, D 2950, and C 1040 are met or exceeded by these gauges. Two test modes are available for density determination: direct transmission and backscatter. The operator selects the mode depending on the material type and thickness of the layer being tested. The Model 3430 is available with keypad, display and operator's manual in four languages and is the simplest, most economical gauge offered by Troxler. The Model 3440 provides 30 special functions, storage of up to 450 test records, an 18-month warranty and many more options that make it simple to operate and a necessity for all technicians.

# RoadReader™ Nuclear Density Gauge

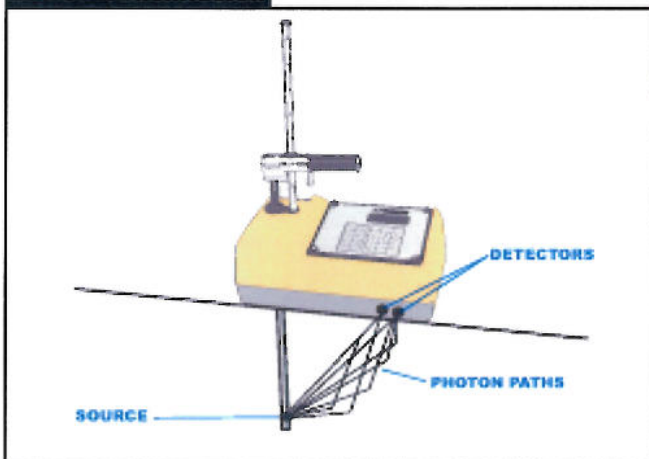
## Three Test Modes

### Backscatter



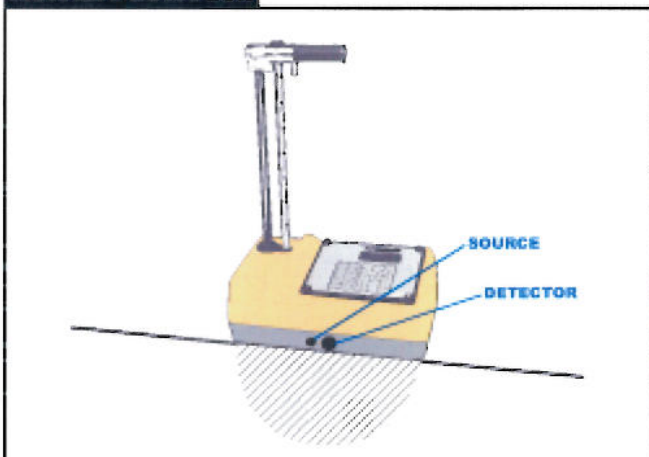
Backscatter is rapid and nondestructive. The gamma source and detectors remain inside the gauge which rests on the surface of the test material. Gamma rays enter the test material and those scattered through the material and reaching the detectors are counted. Backscatter is primarily used to determine density on layers of asphalt and concrete approximately 4" thick.

### Direct Transmission



The gamma source is positioned at a specific depth within the test material by insertion into an access hole. Gamma rays are transmitted through the test material to detectors located within the gauge. The average density between the gamma source and the detectors is then determined. Errors resulting from surface roughness and chemical composition of the test material are greatly reduced, and gauge accuracy is improved. Direct transmission is used for testing lifts of soil, aggregate, asphalt and concrete up to 12" in depth.

### Moisture Detection



The moisture measurement is nondestructive, with the neutron source and detector located inside the gauge just above the surface of the test material. Fast neutrons enter the test material and are slowed after colliding with the hydrogen atoms present. The helium3 detector in the gauge counts the number of thermalized (slowed) neutrons, which relates directly to the amount of moisture in the sample.



# SENTINEL 880

SERIES SOURCE PROJECTOR

880 SERIES MODEL

**ELITE**  
50Ci



880 SERIES MODEL

**SIGMA**  
130Ci



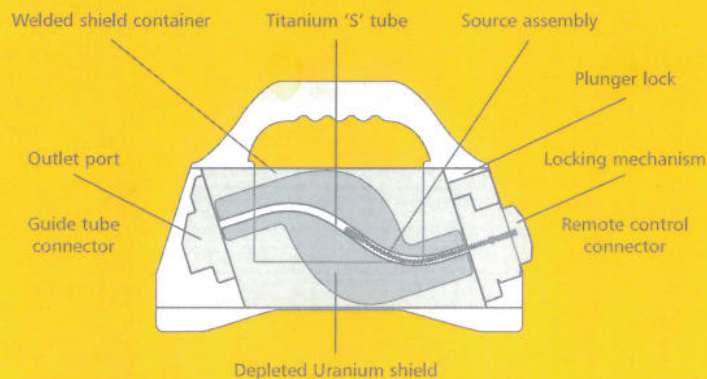
880 SERIES MODEL

**DELTA**  
150Ci

**PROJECTING EXCELLENCE  
IN INDUSTRIAL  
GAMMA RADIOGRAPHY**

**AEA TECHNOLOGY**  
QSA





The welded main body houses the source assembly safely stored inside a titanium 'S' tube within a depleted uranium shield



The exposure device continues to be a compliant Type B package even if the jacket has been removed, modified or damaged

Resilient one-piece plastic jacket protects main body, outlet port, lock mechanism and labels from wear and accidental damage

Comfortable carrying handle with slip-resistant contoured grip

The jacket can be drilled to accept threaded inserts when adapting the device for individual applications and is easily replaced to extend the projector's working life



Shaped base and feet and low center of gravity provide greater all round stability on convex and concave surfaces



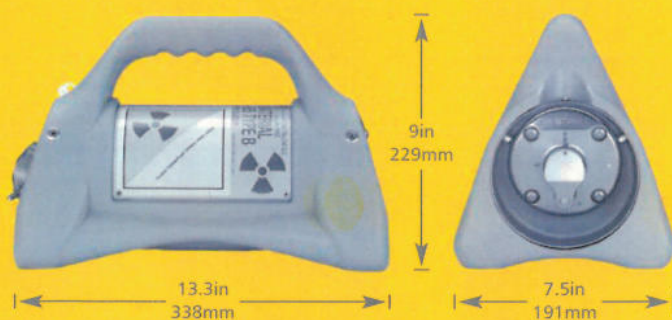
## Exposure device

Sentinel Model 880 Delta, 880 Sigma and 880 Elite source projectors are portable, lightweight and compact industrial radiographic exposure devices. The exposure device body consists of a titanium 'S' tube and cast depleted Uranium (DU) shield contained within a 300 series stainless steel tube with stainless steel discs welded at each end forming a cylinder shaped housing. The discs are recessed to provide protection for the rear mounted locking mechanism and front mounted outlet port.

The horizontally oriented design allows the locking mechanism, source assembly connector and outlet port to be easily operated, simplifying connection of source guide tubes and projection sheaths.

The internal void space of the housing is filled with polyurethane foam to prevent the ingress of water or foreign material but is open to atmospheric pressure.

The exposure device body, containing the DU shield, locking mechanism, outlet port, protective covers and required labels, comprises the radioactive material transport Type B package.



## Removable jacket

An impact resistant plastic jacket surrounds the exposure device to protect labels and provide the means for carrying and placement during radiographic operations. The jacket, incorporating a contoured handle and a quadruped base for stable positioning, is not part of the Type B transport package and may be removed or modified for certain applications such as when the exposure device is securely mounted to a pipe-crawler locomotive or a pipe-liner sled.

The three models are differentiated by jacket color, yellow for the 880 Delta, black for the 880 Sigma and blue for the 880 Elite.

## Guide tube interface

Unique outlet port design simplifies guide tube connection/disconnection, without an elevation of radiation levels and prevents the source assembly from being projected unless a guide tube is safely attached.

Integral outlet port shield eliminates the need for additional shipping plug





## Applications

Model 880 series source projectors are used for industrial applications of gamma radiography, mainly with Iridium-192, to inspect materials and structures in the density range of approximately  $2.71\text{g/cm}^3$  through  $8.53\text{g/cm}^3$ . Low energy isotopes can be accommodated to permit radiography of materials and structures of thin sections of steel and low-density alloys.

The 880 series exposure devices are also designed for use with low activity sources with high photon energies for mass absorption (gamma scanning) studies of high-density materials up to  $18.7\text{g/cm}^3$ .

# 880

SERIES SOURCE PROJECTOR

MODEL

## ELITE

50Ci

IDEAL FOR USE WITH  
LOW-ENERGY ISOTOPES  
AND LOWER ACTIVITY  
IRIDIUM-192 SOURCES

MODEL

## SIGMA

130Ci

OPTIMIZED FOR USE WITH  
INDUSTRY-STANDARD  
IRIDIUM-192 AND SELENIUM-75  
SOURCE ACTIVITIES

MODEL

## DELTA

150Ci

THE LIGHTEST 150Ci DEVICE  
CURRENTLY AVAILABLE



Connections are compatible with  
standard (660 type) remote controls  
and source guide tubes

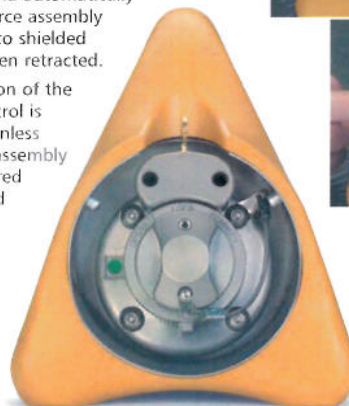
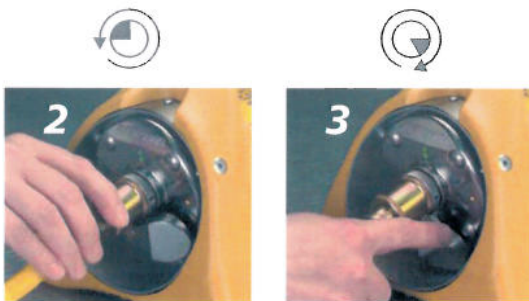
## Control interface

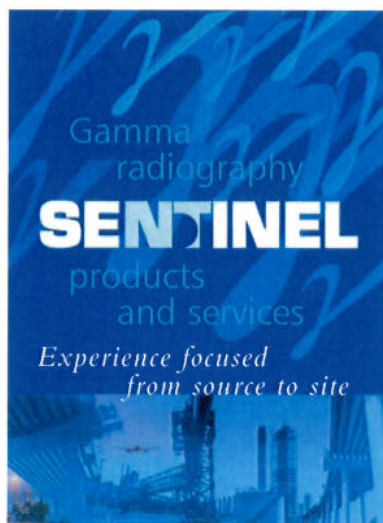
Locking mechanism prevents  
unintentional remote control  
operation and automatically  
ensures source assembly  
is returned to shielded  
position when retracted.

Disconnection of the  
remote control is  
prevented unless  
the source assembly  
is fully secured  
and shielded



Lock slide  
is easily  
reset with  
fingertip





## Sales

Americas, Canada,  
Asia-Pacific, Middle East

**Sentinel**  
AEA Technology QSA  
6765 Langley Drive, Baton Rouge  
Louisiana 70809  
USA  
Tel +1 225 751 5893  
Toll Free +1 800 225 1383  
Fax +1 225 756 0365 or  
+1 225 751 8082

## Sales

Europe, Scandinavia,  
Africa, India

**Sentinel**  
AEA Technology QSA GmbH  
Gieselweg 1, Braunschweig 38110  
Germany  
Tel +49 5307 932 396  
Fax +49 5307 932 194

## Manufacturing

**Sentinel**  
AEA Technology QSA  
40 North Avenue, Burlington  
Massachusetts 01803  
USA  
Tel +1 781 272 2000  
Fax +1 781 273 2216

[www.aeat-qa.com](http://www.aeat-qa.com)

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BR-001 February 2004



## Technical specifications

### Model series

880 Delta, 880 Sigma and 880 Elite.

### Primary application

Industrial gamma radiography.

Dimensions (all models)	Weight of exposure device
<b>Length</b> 13.33in (33.8cm).	Delta 52lb (23.6kg).
<b>Width</b> 7.5in (19.1cm).	Sigma 52lb (23.6kg).
<b>Height</b> 9in (22.9cm).	Elite 42lb (19.0kg).

### Activity of depleted Uranium shield

Delta 5.4mCi (200MBq), Sigma 5.4mCi (200MBq), Elite 3.8mCi (141MBq).

### Certification

Type B(U) package, USDOT Certification Number USA/9296/B(U)-96.

### Accreditation

Sentinel 880 Delta, Sigma and Elite models are designed, tested and manufactured to meet the requirements of ANSI N432-1980, ISO 3999-1 2000E, IAEA TS-R-1 (1996), USNRC 10CFR34, 10CFR71 and 49CFR173. Additionally, the exposure devices are designed, manufactured and serviced under a QA program that has been accredited to ISO 9001 (2000) and approved in accordance with USNRC 10CFR71, Subpart H. The QA program also includes the reporting requirements of USNRC 10CFR21 for suppliers of source and byproduct materials.

### Construction

**Exposure device** Depleted Uranium (DU) shield encased within a welded tubular stainless steel shell with stainless steel end plates. Interior void space filled with rigid polyurethane foam.

**Removable jacket** One-piece, high impact resistant, plastic jacket incorporating a carrying handle and base.

### Materials

Titanium 'S' tube, DU shield, 300 series stainless steel tubular shell and plates, aluminum, brass, tungsten and polyurethane.

### Maximum capacities

Delta 150Ci (5.55TBq), Sigma 130Ci (4.81TBq), Elite 50Ci (1.85TBq) of Ir-192.

### Source assembly and authorized contents

USNRC Model Number: A424-9 source assembly with a doubly encapsulated Ir-192 sealed source. The IAEA/USDOT Special Form Certificate number is USA/0335/S. In addition, the following isotopes may also be utilized in the 880 series exposure devices.

Isotope	Ytterbium-169	Selenium-75	Iridium-192	Cobalt-60
<b>Assembly model number</b>	918	A424-25W	A424-9	A424-19
<b>Gamma energy range</b>	8-308keV	66-401keV	206-612keV	1.17-1.33MeV
<b>Half life</b>	32 days	120 days	74 days	5.27 years
<b>Approximate steel working thickness</b>	2-20mm	3-29mm	12-63mm	50-150mm

### Device/source maximum capacity

<b>880 Delta</b>	20Ci	0.74TBq	80Ci	3.00TBq	150Ci	5.55TBq	65mCi	2.40GBq
<b>880 Sigma</b>	20Ci	0.74TBq	80Ci	3.00TBq	130Ci	4.81TBq	25mCi	925MBq
<b>880 Elite</b>	20Ci	0.74TBq	80Ci	3.00TBq	50Ci	1.85TBq	25mCi	925MBq

### Controls and guide tubes

Compatible with standard (660 type) remote controls and source guide tubes.

### Inspection requirements

Daily pre-operational inspection for obvious damage to the system.

### Maintenance requirements

Most national regulations require inspection and maintenance of the system at quarterly intervals. The complete annual servicing ensures the integrity of the system.

Shorter frequencies of inspection and maintenance are required when the system is operated under severe operating environments. In some cases, the system should be serviced immediately after certain jobs in severe environmental working conditions.

### Operating temperature range

-40°F to 300°F (-40°C to 149°C).