

**TYPE A EVALUATION**

**Of the**

**Model 3500 Nuclear Moisture Density Gauge**

**Dual Wall Rotational Molded Polyethylene**

**Part Number 205.1043**

**InstroTek<sup>®</sup>, Inc.**

**Revision 3, October 6, 2017**

## 1.0 Introduction:

This document contains the evaluation of InstroTek, Inc. shipping cases used for transport of nuclear moisture density gauges to class 7, Type A packaging requirements of 49 CFR 178.350

This document contains cases used for transport of InstroTek model 3500 and one of the Troxler Models 3401, 3411, 3430 or 3440. These gauges are primarily used for measurement of moisture and density of construction materials by construction, testing laboratories and highway agencies.

## 2.0 Common Name of the Container

Nuclear gauge shipping case

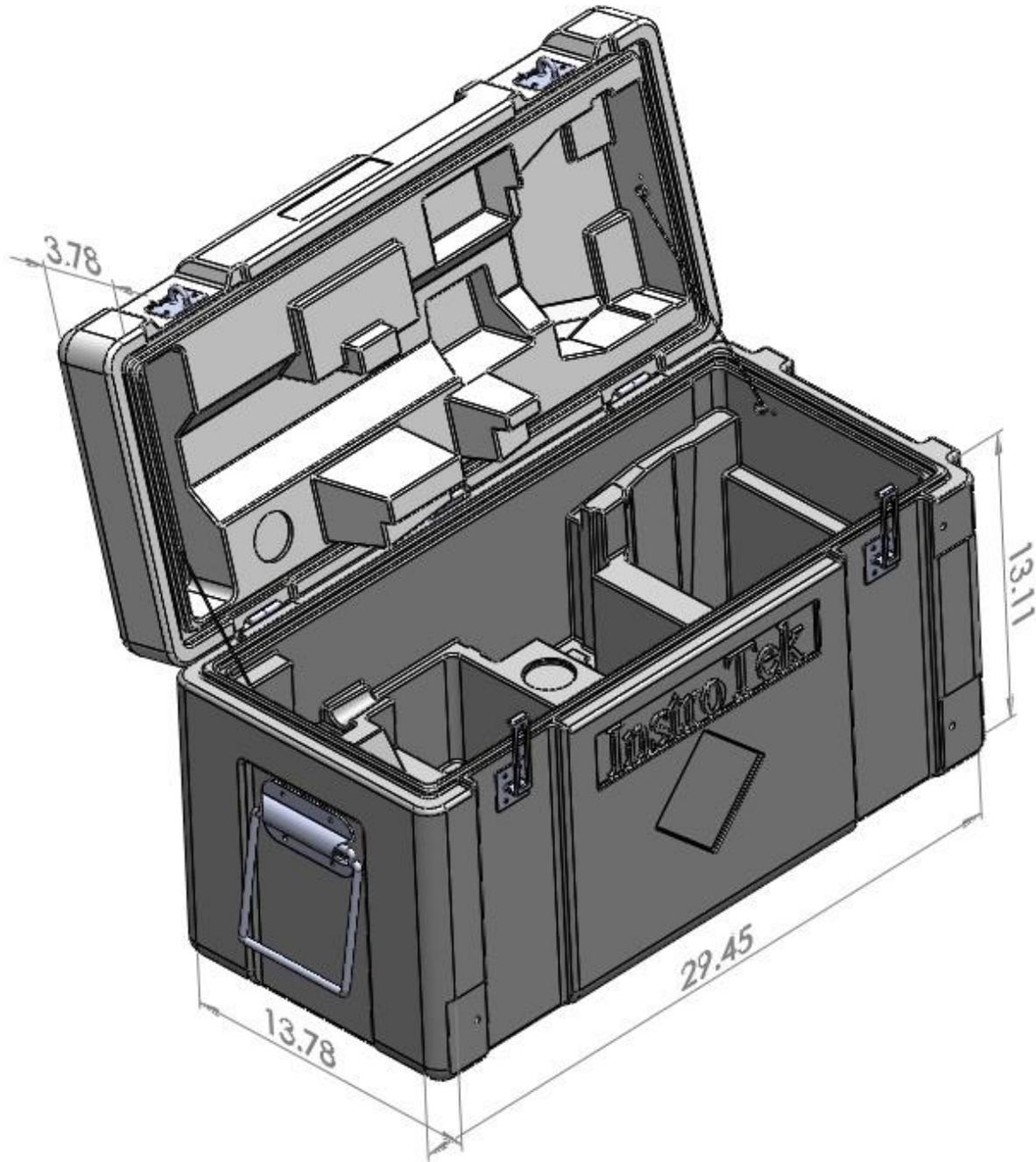
## 3.0 *Authorized contents*

The following items are authorized to be placed in the shipping case during transport. Type A tests were conducted according to 49 CFR 173.465 and the case contained the gauge and accessories listed below.

Moisture Density Gauge, InstroTek 3500, or one of Troxler 3401, 3411, 3430 or 3440	Chargers
Polyethylene Standard block	Locks
Drill Rod	Sledge Hammer
Extraction tool	Calibration, shipping and other gauge related paperwork
Scraper Plate	Manual

## 4.0 *Dimensions*

The overall outside dimension of the shipping case for Model 3500 is 29.45 inches wide, 13.78 inches deep and 16.89 inches high. The shipping case and its content weigh 95 lbs.



## **ALL DIMENSIONS IN INCHES**

### **5.0 *Packaging Description***

The shipping case consists of a plastic material with three handles. The handles can be used for securing the case to the truck or a vehicle. The handles can also be used for

lifting the entire case or transporting the gauge on provided wheels on solid surfaces inside a facility, when necessary. The inside of the case contains compartments clearly designed to place the different components of the gauge, including the gauge and the accessories required to conduct tests on the field. The plastic case is primarily designed for safe transport of the gauge and its accessories. Shielding of neutron and gamma radiation is included in each gauge and details are specified on the sealed source device registry.

## 6.0 Content of the Case During Type A Testing

The contents listed in Section 3 were included in the case during Type A tests conducted according to 49 CFR 173.465. A single new prototype case was used for all the TYPE A tests.

The Troxler 3440/3430 model gauges was taken through all the below tests in this Type A case. The difference between 3430 and 3440 models is only in the front panel design and software functionality. Both have the same aluminum base, shielding and plastic top shell. All other features of the 3430 gauges are exactly the same as 3440. The 3430 has one less battery pack, which does not significantly change the weight of this gauge as compared to 3440. Model 3401 and 3411 gauges were not tested in this Type A case. These gauges have the same base and shielding material as 3440 and 3430. The main difference between these gauges is in the top shell. The 3430 and 3440 gauges have a plastic top shell. Model 3401 and 3411 have aluminum top shell. Based on engineering judgment and historical performance, it is concluded that these gauges can safely be transported in this Type A case based on the fact that shielding in this package is included and is an integral part of the gauge itself. The case material and contents does not in any significant way contribute to reduction of dose rate and change in the Transport Index. In fact measurement of Transport Index in this case is identical to the values reported by the manufacturer. This case was designed to accept these gauges with the same design and material composition as the one used by the manufacturer. The weight of all these gauges, InstroTek model 3500, Troxler 3430, 3440, 3401 and 3411, range from 30 to 34 lbs, which is well within the performance limits of these case.

## 7.0 Type A Packaging Test, 49 CFR 173.465

Water Spray	Pass	See below
Free Drop	Pass	See below
Penetration	Pass	See below

Compression	Pass	See below
Vibration	Pass	See below

**7.1 Water Spray Test**

*(b) Water spray test. The water spray test must precede each test in the sequence prescribed in this section. The water spray test must simulate exposure to rainfall of approximately 5cm (2inches) per hour for at least one hour. The time interval between the end of the water spray test and the beginning of the next test must be such that water has soaked in to the maximum extent without appreciable drying of the exterior of the specimen. In the absence of evidence to the contrary, this interval may be assumed to be two hours if the water spray is applied from four different directions simultaneously. However, no time interval may elapse if the water spray is applied from each of the four directions consecutively.*

A four sided sprayer was constructed with PVC pipe to simulate rainfall equal to approximately 2 inches per hour. Using a one gallon bucket and a timer each of the four adjustable sprinkler heads were set to produce a total rate of 31.6 gallons per hour over an area of 25 square feet. A soak time of 2 hours was used after each application. The water spray test preceded all other tests.

While some moisture did penetrate the case there was no effect on the source containment system or the security features of the case. The structural integrity of the containers was not affected by the water spray tests.

**7.2 Free Drop Test**

*(c) The specimen must drop onto a target so as to suffer maximum damage to the safety features being tested, and:*

*(1) The height of the drop measured from the lowest point of the specimen to the upper surface of the target may not be less than the distance specified in table 10 of this section.*

*(less than 5000 kilograms distance =1.2 meters).*

*(2) For packages containing fissile material, the free drop test specified in paragraph (c)(1) of this section must be preceded by a free drop from a height of .3 m (1 foot) on each corner, or in the case of cylindrical packages, onto each of the quarters of each rim.*

- (3) For fiberboard or wood rectangular packages with a mass of 50 kg (110 pounds) or less, a separate specimen must be subjected to a free drop onto each corner from a height of 0.3m (1 foot).*
- (4) Cylindrical fiberboard (does not apply)*
- (5) The target for the free drop test must be a flat, horizontal surface of such mass and rigidity that any increase in its resistance to displacement or deformation upon impact by the specimen would not significantly increase the damage to the specimen.*

The case was loaded with contents in Section 3 and was dropped from a height of 4 feet onto a solid asphalt pavement. A ladder was used to accommodate the drop from a height of 4 feet. The point of impact on the container was selected to cause maximum damage to the safety features of the container. The case stayed in good condition with latches intact after the drop.

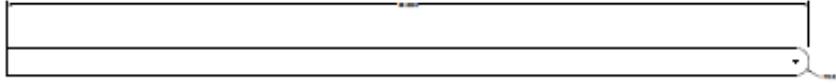
### **7.3 Penetration Test**

- (e) For the penetration test, the specimen must be placed on a ridged, flat, horizontal surface that will not move significantly while the test is being performed.*
- (1) A bar of 3.2 cm (1.25 inches) in diameter with a hemispherical end and a mass of 6kg (13.2 pounds) must be dropped and directed to fall with its longitudinal axis vertical, onto the center of the weakest part of the specimen, so that, if it penetrates far enough, it will hit the containment system. The bar may not be significantly deformed by the test.*
- (2) The height of the drop of the bar measured from its lower end to the intended point of impact on the upper surface of the specimen must be 1 m (3.3 feet) or greater.*

The above prescribed procedure was used for the penetration test. The case was placed on a concrete floor. A bar constructed for this penetration test was made from 1.25" diameter Naval Brass Alloy 464, with one end having a hemispherical geometry, and weighed 13.2 lbs (6 kg). The rod was dropped on the center of the shipping case from a distance of 1 meter.

The test results showed some minor cosmetic damage and marking. However, the rod never penetrated into the container or compromised the security features. Only cosmetic damage was the result and no structural damage was observed.

## Penetration Test Rod



Material is Naval Brass Alloy 464  
Rod 1.25 dia      Weight 13.2 LBS

### **7.4      Compression Test**

*(d) The specimen must be subjected for a period of at least 24 hours to a compressive load equivalent to the greater of the following (i) Five times the mass of the actual package; or(ii) The equivalent of 13 kilopascals (1.9 psi) multiplied by the vertically projected area of the package.*

This test required loading a heavy duty pallet with concrete blocks in order to achieve a load of no less than 13 kilopascals or 1.9 psi. The pallet tare weight was determined with the per brick weight. In addition the loaded pallet was weighed on a scale to confirm the calculation.

The vertically projected area was calculated based on the length and depth of the top surface of each container. A load was applied to this horizontal surface area which weighed no less than that area in square inches multiplied by 1.9 pounds per square inch.

The projected load for this case is approximately 785 lbs and the test load was 812 lbs. A fork lift was used to apply the load to the case and it remained undisturbed for 24 hours. The case was inspected after 24 hours of loading. The shipping case withstood the weight that was placed on top of the case and passed the compression test. The case and its safety features stayed intact.

### **7.5      Vibration Test**

*49 CFR 173.410 (f)The package will be capable of withstanding the effects of any acceleration, vibration or vibration resonance that may arise under normal conditions of transport without any deterioration in the effectiveness of the closing devices on the various receptacles or in the integrity of the package as a whole with loosening or unintentionally releasing the nuts, bolts, or other securing devices even after repeated use (see 173.24, 173.24a and 173.24b).*

A single shipping case and its contents as specified in section 3 were loaded on vibrating table that was built in house and vibrated at approximately 15 cycles per second at a displacement of ½ inches for 24 hours to simulate condition of transport. Following the

vibration test the container and its contents were inspected. No deterioration or loosening of components was detected.

Based on this testing, many years of engineering experience, and historical data on the transport of these cases, we can confidently conclude that these shipping cases with the contents included in section 3 will withstand the effects of vibration that arise under normal conditions of transport without any loss of integrity or effect on the containers security devices.

## **7.6 Compliance**

### ***173.410 General Design Requirements***

- a) The package is easily handled using the two handles located on the side of the package, in addition each of these handles are designed to be used in securing the package during transport.
- b) Each package, when lifted using the two handles as in normal use will support at least 3 times its single package weight. There are no other structural parts of the package that may be considered as useful for lifting.
- c) There are no protruding surfaces on the package.
- d) There are no pockets or crevices where water might collect.
- e) There are no additional features to this package.
- f) Radioactive material Special Form complies with this requirement

The package have been tested for vibration and used in transport for more than 10 years. An engineering assessment of the tests and historical data can be used to conclude that these packages suffered no deterioration in the effectiveness of the closing devices on the various receptacles or in the integrity of the package as a whole and without loosening or unintentionally releasing the nuts, bolts, or other securing devices even after repeated use. Current vibration testing, engineering assessment, and observational history confirm compliance with Sections 173.24, 173.24a, and 173.24b.

- g) There are no components that will react chemically.
- h) There are no valves in the package.
- i) For transport by Air-

- 1) The Type A package material is made from plastic polymers. The temperature of the accessible surfaces will not exceed the required limits
- 2) The components of the package are made from metals and plastics and will not change in strength or character in the temperature range  $-40\text{ }^{\circ}\text{C}$  to  $55\text{ }^{\circ}\text{C}$ .
- 3) The package contents are non-liquid special form.

**173.412 Additional Design Requirements for Type A packages**

- a) The package comes with positive interlocking latches. These latches feature an eyebolt through which a nylon wire tie or a lock may be inserted to demonstrate that the package has not been opened and has remained sealed.
- b) The package has dimensions 76.2 (30.0) length x 35.6 (14.0) width x 42.9 (16.9) height cm (inches) and satisfies the dimensional requirement.
- c) Containment and shielding is maintained during transportation or storage. The Special Form is further contained in the gauge, which is then contained in the package.
- d) The radioactive material in the gauge is special form. The Cs-137 source is secured permanently in a source rod that is locked during no use and transportation. The Am-241/Be is also inside the gauge. Both sources are shielded by tungsten and lead. The gauge source rod containing the Cs-137 source is locked prior to packaging and shipment. The gauge is locked in the Type A package as described in 173.412 (a)
- e) There is no gas generating materials inside this Type A package
- f) The material in this Type A package is Special Form and sealed and will not release any of its content
- g) There are no valves in this package
- h) The shielding is included in the gauge and has been tested extensively to ensure there is no unintentional escape of the radioactive materials.
- i) Failure of the handles which form the tie down system for the package will not impair the package from meeting the requirements of this subchapter. This is evident from the placement and method of attachment of the handles to the package.
- j) Performance requirement of this section-
  - 1) Demonstration of compliance as indicated in 173.461 has been included in the Type A report and the tests demonstrate compliance to 173.465.

2) From extensive dose measurements conducted during the Type A testing, no changes in the radiation profile was observed from before to after the tests. Furthermore, none of the critical components of the radiative device moved during any of the tests.

k) There are no liquids in this package

l) There are no gases in this package

***173.466 Additional tests for Type A packaging designed for liquids and gases***

There are no liquids or gases in this package

***173.467 Tests for demonstrating the ability of Type B and fissile materials packaging to withstand accident conditions in transportation***

This package does not meet Type B packaging requirements

***173.468 Test for LSA-III material***

This package does not meet Type B packaging requirements

***173.469 Special Form Certificate***

Special Form Certificate of Competent Authority can be made available with this package

## ***8.0 Conclusions***

Based on the results documented in Section 7 it is concluded that this case meets the all applicable requirements of 49 CFR 178.350, testing requirements of 49 CFR 173.465, and the package retains its safety integrity during Spray, Free Drop, Penetration, Compression and Vibration tests. Therefore this package can be specified as USA DOT 7A Type A shipping package for the transport of this model gauge that contains a maximum of 11 mCi Cesium 137 gamma sealed source and maximum 44 mCi Americium/Beryllium neutron sealed source.

8.1 Water Spray Test - While some moisture did penetrate the case there was no effect on the source containment system or the security features of the case. The structural integrity of the containers was not affected by the water spray tests.

8.2 Free Drop Test – On examination of the safety feature of the package there was no damage observed to the safety features tested. In addition there was no damage to the structural integrity of the package.

8.3 Penetration Test - While some minor cosmetic damage and marking occurred during this test the rod never penetrated into the container or compromised the security features. Only cosmetic damage was the result and no structural damage was observed.

8.4 Compression Test - The case withstood the weight that was placed on top of the case for 24 hours and passed the compression test. No visible damage occurred to the structural integrity, the latches or to the safety features of the package.

8.5 Vibration Testing- container and its contents were inspected. No deterioration or loosening of components was detected.