

- Eliminates unit licensing and certification associated with nuclear materials usage
- No special operator training/certification or radiation monitoring requirements
- No special storage or transport problems
- User friendly, in-process, cost effective tool for any crew member
- Fast, reliable, rugged, accurate and repeatable readings in real time
- Provides GPS logging for database management
- Assure that compaction meets project specifications for solid foundations for civil infrastructure projects such as buildings, bridges, roads and dams



## Problems Solved

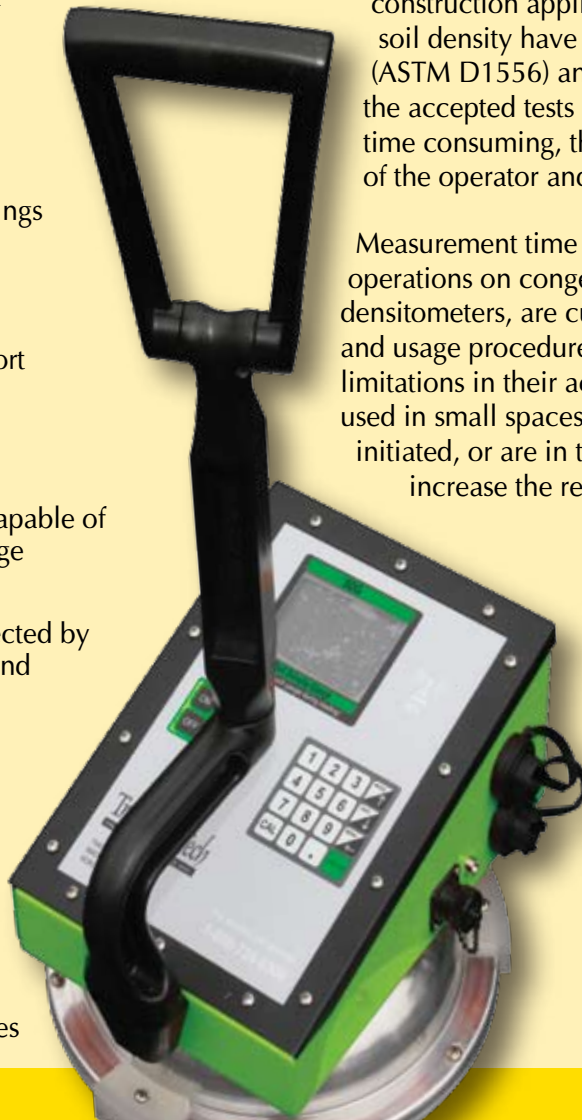
- Replace nuclear with non-radioactive energy source
- Assure that compaction meets project specifications for solid foundations for civil infrastructure projects such as buildings, bridges, roads and dams
- Improper repair of pavement openings (prevent revisits or call-backs)
- Safety hazards, traffic congestion, pollution and energy usage associated with pavement repairs
- Compaction irregularities in preparation of foundations and other civil infrastructure

## Advantages

- Eliminates unit licensing, certification and logistic impacts associated with nuclear materials usage
- User friendly, in-process, cost effective tool for each crew
- No special operator training / certification or radiation monitoring requirements
- Fast, reliable, rugged, accurate and repeatable readings in real time
- Provides GPS and logging for database management
- No Special Storage or Transport Considerations

## R&D Program

- Develop electronics design capable of precision wide frequency range measurement
- Electrical response of soil affected by moisture, gradation, salinity and soil type as well as density
- Response with frequency range contains information to separate effects
- Advanced computer models employed to characterize and optimize sensor design
- Demonstrate/field test early prototypes
- Produce production prototypes



## Program Objective

- Extend current PQI technology to SDG-use of electrical impedance measurement through electromagnetic generation of defined frequency spectrums
  - Multiple frequencies for detection measurements of soil characteristics

## Competition / Alternatives

- Nuclear-based densitometers - require penetrating probe & special licensing
- Soil cone penetrometers - require physical penetration (inaccurate and relies on operator interpretation; no data logging)
- Sand cone – time consuming; accuracy impacted by operator skill
- Soil stiffness gauges – look at resilient modulus of soil; current devices' results are highly operator dependant; do not provide the moisture content measurement necessary for knowledge of true strength characteristics of the soil

Density of compacted soil is the most important construction variable in the durability of soil sub-base for pavement, fills, and other construction applications. All current methods of measuring soil density have major limitations. The Sand Cone Test (ASTM D1556) and Rubber Balloon Test (ASTM D2167) are the accepted tests for field density measurement. These tests are time consuming, the results can be influenced by the skill level of the operator and they are destructive to the soil surface.

Measurement time is a critical issue for utility cut/repair operations on congested city streets. The alternative, nuclear densitometers, are cumbersome to use, require strict licensing and usage procedures, take several minutes to get data and have limitations in their accuracy, such as the known edge effects when used in small spaces (e.g. utility cut/repair). Many states have initiated, or are in the process of initiating, programs which increase the regulatory and logistical difficulties.

## Example Markets and Impact

- Utility cuts/excavations
  - NYC – 85% of pavement defects relate to utility cuts/repairs
  - Gas Technology Institute – proper monitoring of soil compaction reduces callbacks by up to 80%
- Helps ensure solid foundations for structures such as buildings, bridges, roads, dams and other civil infrastructure

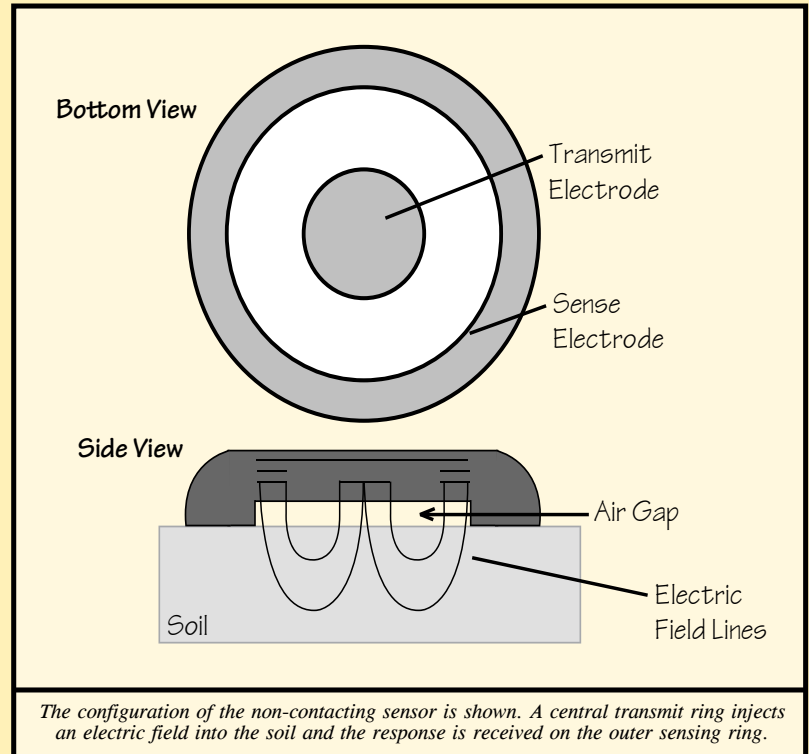
## TransTech's Solution

To meet the need for a fast, accurate, non-nuclear soil density/compaction and moisture gauge, TransTech Systems has developed an innovative alternative, the electrical impedance-based Soil Density Gauge (SDG) for use as a QC tool during the soil compaction process. The SDG builds upon the patented, and NOVA Award winning, Pavement Quality Indicator (PQI). Using advanced electrical impedance spectroscopy (EIS), the SDG is able to make fast, non-contact measurements of soil density and moisture content.

This novel approach permits separation of the effects of density and moisture content on the response of the soil to electromagnetic probing. The density, or compaction level, is measured by the response of the SDG's electrical sensing field to changes in electrical impedance of the material matrix. Since the dielectric constant of air is much lower than that of the other soil constituents, as density/compaction increases, the combined dielectric constant increases because the percentage of air in the soil matrix decreases. The SDG performs a calculation on the measurement data that enables the device to report the soil's density and moisture content.

Currently, the SDG is still under development and in the early stages of beta testing. The importance of this innovation is that soil density measurements can now be taken quickly and non-destructively, allowing necessary changes to the compaction process to be made immediately. It also makes it possible to take many more readings per hour on the job site, which helps ensure that the best possible level of compaction is attained.

Initially, the SDG was developed to address utility cut/repair operations. Several studies have shown that improper compaction of the fill prior to repaving is the major cause for failures in the street cuts made by utilities during installation, repair, or upgrading of buried equipment. The SDG can also be



used in any construction activity where proper soil compaction is critical to ultimate performance of engineered structures, such as pavements, foundations, dams, and embankments.

TransTech Systems' extended family of electrical impedance based systems, such as the Pavement Quality Indicator (PQI), that measures asphalt pavement density, and the Soil Density Gauge (SDG), are not only light-weight, but are also easy to use. Other electromagnetic sensors, including Time Domain Reflectometry (TDR) and Ground Penetrating Radar (GPR), have also been applied in various contexts to determine the moisture content and/or density of engineering materials, such as asphalt or soil. Both TDR and GPR are used to determine soil moisture and density by measurement of the electromagnetic propagation velocity in the medium. The TDR units require the insertion of two or more probes into the soil. Both TDR and GPR are typically complex and cumbersome to operate and require skilled operators.

One of the most appealing aspects of our innovative device is that any member of the construction crew can accurately and effectively operate TransTech's SDG without the need for extensive training or licensing, as opposed to the alternative devices mentioned above. The SDG is a unique tool that gives you a cost effective method for rapidly determining critical soil parameters of both density and moisture with the same convenient instrument.

## SDG SPECIFICATIONS

### OPERATIONAL SPECIFICATIONS:

#### Measurement Mode:

- Average - Averages five (5) readings and stores data including location, date and time. Stores 30 test records.

#### Functions:

- Wet & Dry Density, % Compaction, % Moisture
- Integrated Temperature Sensing - Real time temperature display 0° F to 350° F -17.7° C to 177.6° C

#### Soil Specifications:

- Designed to operate with standard soils used in civil construction projects.
- Requires inputs from standard
  - USCS Soil Classification (ASTM D2487)
  - Particle Size Distribution (ASTM D422)
  - Proctor Test (ASTM D698 and D1557)

### MECHANICAL SPECIFICATIONS:

- Unit Weight - < 12.8 lb. 5.8 kg
- Unit Dimensions - 13 in. x 11 in. x 9 in.  
33 cm x 27.9 cm x 22.9 cm
- Shipping Weight w/ Case - 29.4 lb. 13.3 kg
- Storage Box Dimensions - 17.5 in. x 21 in. x 11 in.  
44.5 cm x 53.3 cm x 27.9 cm
- Operating Temperature  
Ambient - 20° F to 110° F (-7° C to 43° C)  
Sample soil not frozen
- Storage Temperature - 0° F to 150° F (-18° C to +66° C)

### MEASUREMENT SPECIFICATIONS:

- Sensing Area - 11 in. diameter base allows optimum measurement on fine and coarse material types.
- Measurement Units - English or Metric, Keypad controlled inches or mm, lb/cu-ft or kg/cuM
- Measurement Display - Wet Density, Dry Density, % of Compaction, % of Moisture and GPS Data
- Measurement Depth - Designed for use on a standard 12" (30cm.) un-compacted layer of soil during or after compaction.

### ELECTRICAL SPECIFICATIONS:

- Microprocessor Controlled
- 4.0 Amp-hr NiMH Battery Pack (7.5 volts)
- Recharge Time - 4.5 hours
- Display - LCD Graphical Display 3.9" (320 x 240 Pixels)
- Battery Charger - US or European AC Chargers and 12 volt Auto Chargers
- USB Port

### OPERATIONAL FEATURES:

- Menu driven software with keypad functions
- Diagnostic Mode for operator troubleshooting
- User Programmable Target Density
- Built in Date and Time Stamp
- User Inputs for Soil Characteristics
- USB Flash Drive Compatible for Data Transfer
- USB Keyboard Data Entry
- Integrated GPS for Time and Location Stamp

### WARRANTY:

- Standard - 12 month
- Optional Extended Warranty - Customer CarePlan includes all adjustments, upgrades, battery replacement, complete annual preventive maintenance and return shipping.

### OPTIONAL ACCESSORIES:

- USB Portable Printer



Simple Solutions to Not-So-Simple Problems