



Soil Density Gauge



Operator's Handbook

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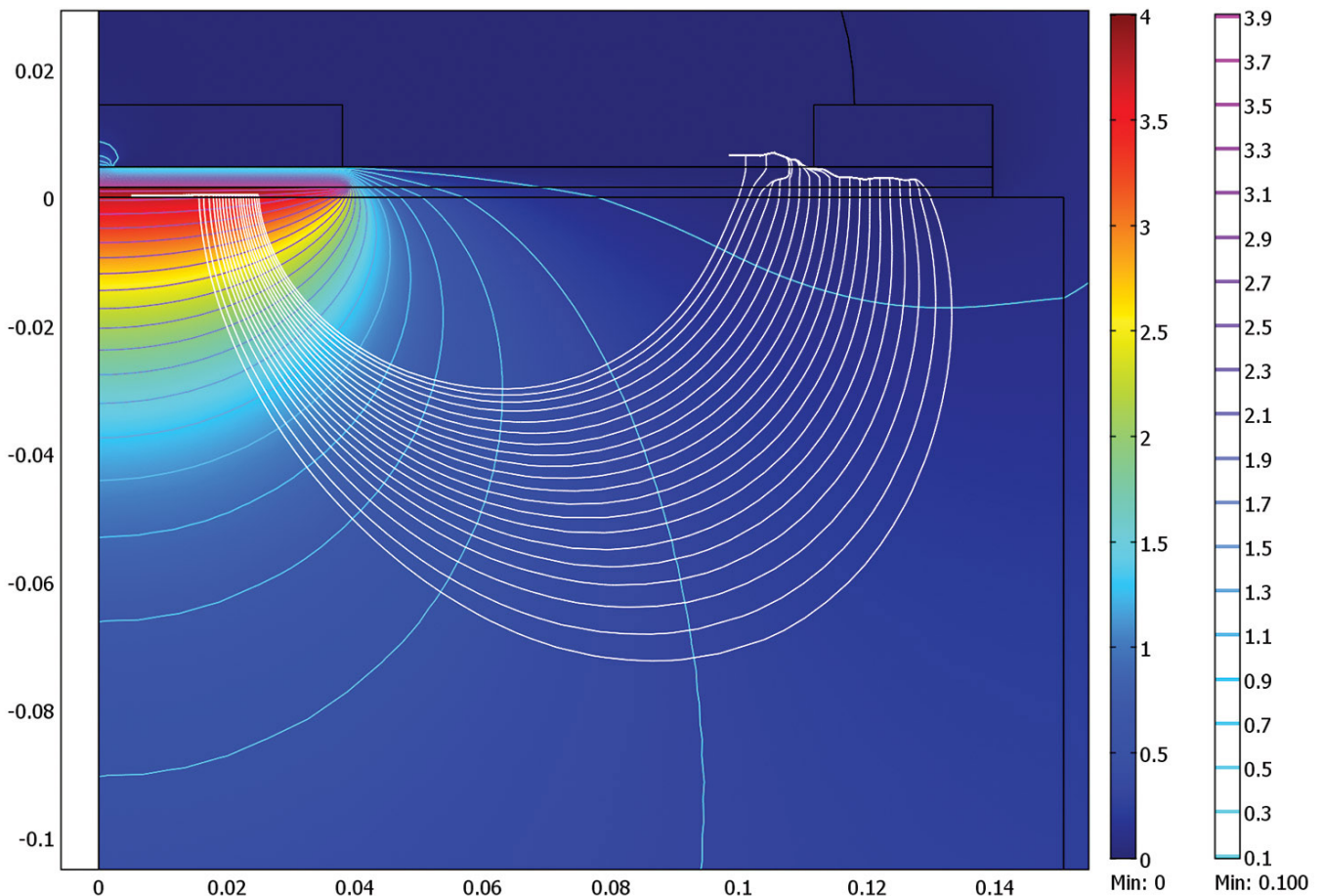
Introduction

TransTech's Soil Density Gauge model SDG 200 utilizes state of the art technology to achieve accurate soil density readings. It's primary features are:

- No special license or radioactive materials required
- Lightweight and easy to use
- 12 hours of portable operation
- Measures density in common units (lb/ft³ or kg/m³)
- Measures percent moisture
- Stores volumes of readings on internal data logger
- Data download via USB flash drive (semicolon delimited text file format)

Measurement Technology

Using electrical impedance spectroscopy (EIS) the SDG 200's measurement 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 200'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 200 performs a calculation on the measurement data that enables the device to report the soil's density and moisture content.



Application Summary

The SDG 200 is intended primarily for making density measurements on a standard 12 inch lift of soil during or after compaction. It is designed to measure coarse and fine grained materials common in standard soils used in civil construction projects. After configuring the gauge with soil properties from a standard particle size distribution report (**ASTM D422**) and Proctor test (**ASTM D698 and D1557**) the SDG 200 will provide reliable and consistent measurements.

Safety

Every effort has been made to make the Soil Density Gauge SDG 200 convenient to use and inherently safe. The SDG 200 uses non-nuclear, low-voltage direct current to obtain measurements, therefore, there are no badges, licensing, storage or transport concerns. Like any instrument, however, the user should exercise care and common sense in its use to prevent mishaps.

Warning

**Do not use the unit on or near electrical wiring.
A potential shock hazard exists if contact is made with the exposed wiring.**

Warning

**Use care in handling the unit. Personal injury can occur through improper handling.
Take proper care to avoid accidentally dropping the unit.**

Warning

Unauthorized disassembly of the unit will void the warranty.

Warning

Shipping the gauge with the batteries inside is not recommended.

Caution

Charging the gauge overnight or unattended is not recommended

Caution

Turn the unit off when not in use and during transport.

Caution

**Be sure not to switch standardization plates with other gauges. Check the
Serial Numbers located on the gauge and on the plate to be sure they match.**

Operating Requirements

Ambient Temperature: -4° to 104° F (-20° to 40° C)

Relative Humidity: 10% to 90% noncondensing

Note: Exposing the equipment to high altitude or extreme temperature may reduce life of the equipment.

Disclaimer: TransTech reserves the right to change or modify product design, construction, specifications, or materials without prior notice and without incurring any obligation to make such changes and modifications on TransTech products previously or subsequently sold.

Controls & Components - Contents

The SDG 200 is packaged and shipped with the following components. Contact TransTech Systems customer service if any of the parts are missing.

- SDG 200 unit
- Standardization Plate
- Storage / shipping case
- Operators Quickstart Guide
- CD Manual
- SDG 200 handle
- 120 / 220V AC to 12V DC battery charger
- 12V DC Car Charger
- Battery Pack



SDG 200



Standardization Plate
(To remain in case)



Charger



DC Cord



AC Cord



Handle

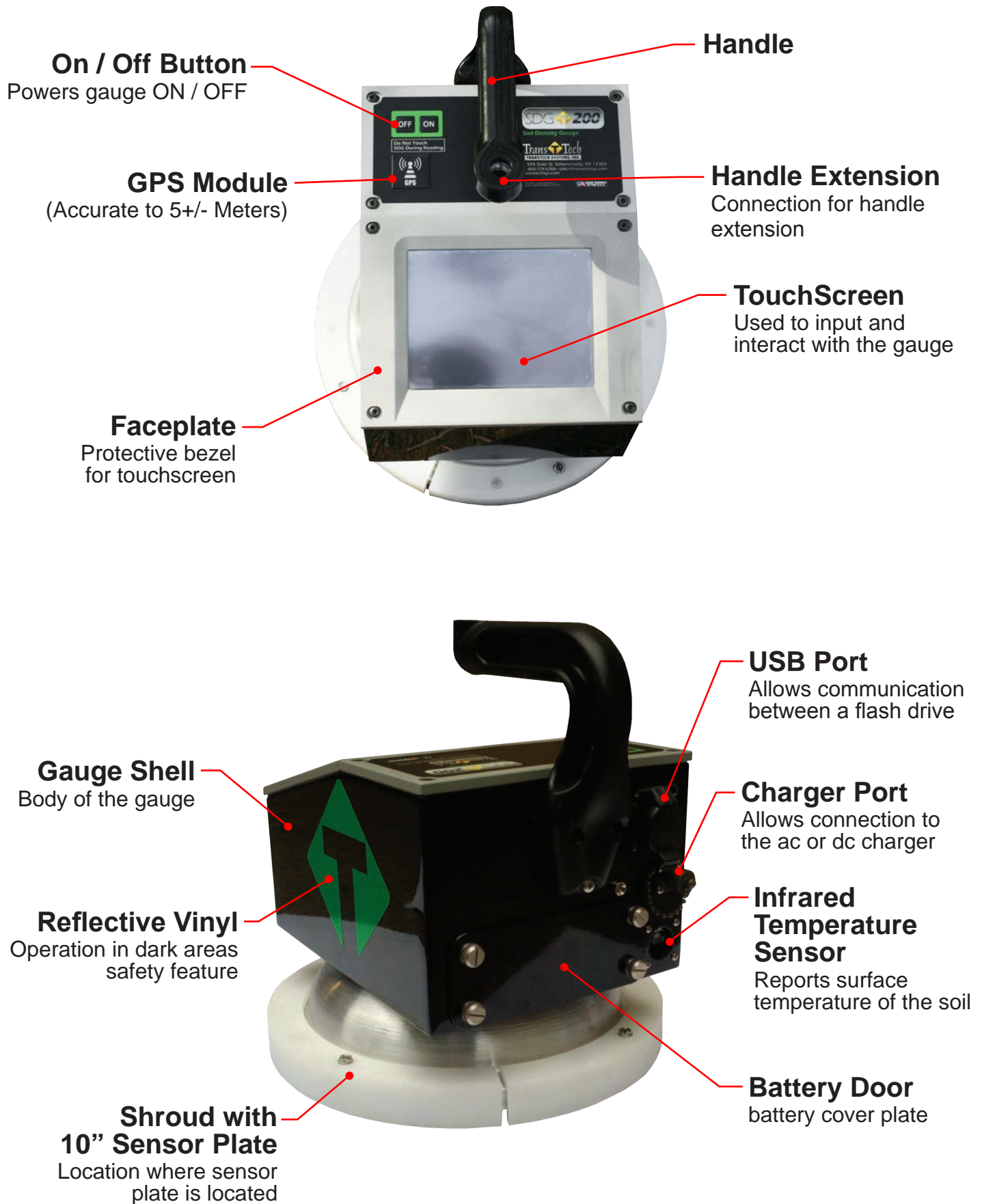


CD Manual



QuickStart Guide

Gauge Features

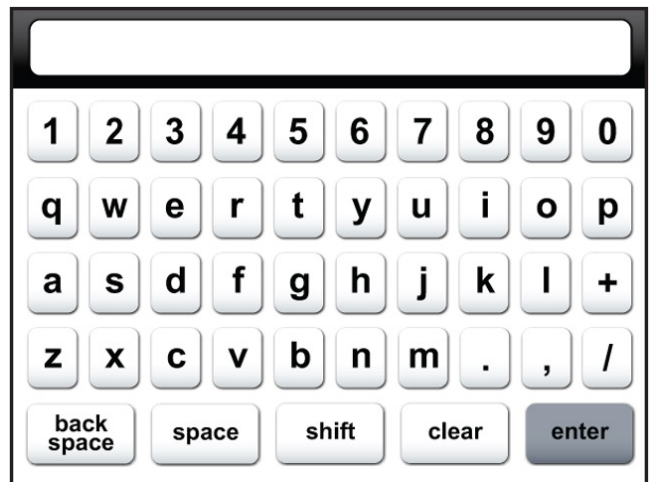
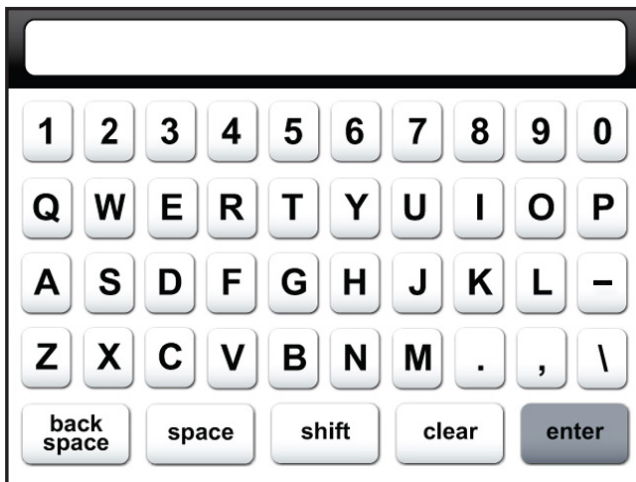




External / Internal Controls




External controls on the SDG 200 consist of an ON / OFF switch and a 480x640 VGA touch screen display for navigating through the user interface and entering alpha/ numeric data.

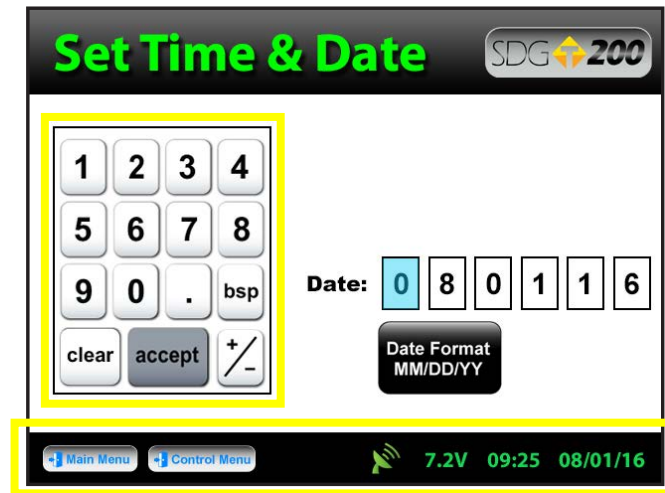
Be sure not to drag your finger from one button to the next. A firm yet light touch is all that is needed to navigate from screen to screen.



Unique yet consistent icons are located on most screens for easy one touch navigation. When data input is required of the operator the screen will display the above keyboard. Toggle from upper to lower case letters using the **Shift** button . The upper case keyboard provides the option of a minus key while the lower case keyboard provides the plus key. Once editing is completed simply press **Enter**  to save and return to the previous screen.

External / Internal Controls

The numeric keypad as shown in this example allows for only numbers and a decimal point. Press **Accept**  to save your entry and in most cases return to the previous screen.



The **status bar** is located at the bottom of the screen (excluding the keyboard screens) and will continuously update the remaining voltage of the batteries while displaying the date, time and status of the GPS.

Power Save / Auto Shut Down

The SDG 200 has a built in power saving mode. If there are no buttons pressed after approximately 20 minutes the unit will go into a power saving mode. Pressing any key will wake the SDG 200 for continued use. If the SDG 200 is left on for an hour without any buttons being pressed, it will shut itself down, to conserve battery run time

Setting up the SDG 200

Prior to using the SDG 200 for the first time the gauge will need to be configured to make measurements and record data correctly.

The following steps must be completed before operating the SDG 200:

1. Installing and charging the batteries
2. Starting the software
3. Set the local time / set date
4. Set up the GPS
5. Select units of measurement
6. Define the material being tested (Material Details)
7. Define project details

Installing Batteries



You will find a plate on the back of the SDG 200 with 4 spring loaded bolts.

1. Turn each bolt approximately 2 full turns until the spring releases
2. Remove the plate from the gauge
3. Next you will find a wire with a connector, disconnect the battery from the gauge
4. Then pull the nylon strap to slide the battery out of the compartment.
(Do not pull the battery by the connector wire, doing so could damage the battery)

Charging Batteries

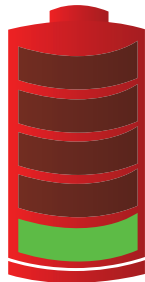
1. Turn the SDG 200 unit OFF
2. Connect the charger to the charger connector located on the back of the SDG 200
3. Plug the charger into a standard AC outlet
4. The red indicator lamp will turn green to indicate that the batteries are charged (approx. 4hrs)
5. Unplug charger from the power source before disconnecting the charger from the SDG 200

Battery Care Tips

- Whenever uncertain about the battery charge level or condition, recharge it
- The battery will self-discharge and should **NOT** be left uncharged for more than 30 days
- An occasional complete discharge followed by a full recharge is recommended
- **NEVER** drop the battery as this can damage the internals
- **DO NOT** store in freezer or expose to extreme heat
- Battery should be fully charged before use

Battery Voltage

Battery voltage can be viewed on the status bar located at the bottom of all screens. A fully charged battery will display **over 8 volts**. The battery voltage will decrease as the SDG 200 is used. A low battery voltage icon will be displayed at approximately **6.5 volts**.







Low Battery Indicator



The gauge will continue to operate until the battery can not supply enough voltage to complete a measurement. Once this happens, the gauge will automatically shut down and will not restart until charged. Depending on the condition of the batteries, once the voltage drops below 6 volts, the gauge may be able to take about 12 to 15 additional readings. **It is important to re-charge the battery after each use.**

Starting the Software



Pressing the **ON** button will power on the SDG 200. After a few seconds the TransTech splash screen will appear followed by the Main Menu screen. The Main Menu screen will display five options, **Start SDG200**,  **Calculator**,  **Contact TransTech**,  **GPS Control**,  and **Update Software**. 

Main Menu



Start button opens the Control Menu screen



Contact button displays TransTech and distributor contact information



Calculator button opens the built in calculator





Update Software button opens the software update screen



GPS Control button opens the GPS Settings screen

Local Time and Change Date Format



You may set the date and time in two locations. From the Main Menu, press **Set Time & Date** located on the status bar  or from the Control Menu press **Date & Time**. 

Local Time and Change Date Format



Set Time & Date

Set Time Time: 0 9 2 5

Set Date Date: 0 8 0 1 1 6

Date Format
MM/DD/YY

Main Menu Control Menu 7.2V 09:25 08/01/16

Set Time & Date

Time: 0 9 2 5

1 2 3 4
5 6 7 8
9 0 . bsp
clear accept +/-

Main Menu Control Menu 7.2V 09:25 08/01/16

To set the time, press the **Set Time** button. Press the appropriate numbers for the time in 24 hour format. Once you are satisfied with your entry, press **Accept** to save and return to the previous screen.

Set Time & Date

1 2 3 4
5 6 7 8
9 0 . bsp
clear accept +/-

Date: 0 8 0 1 1 6

Date Format
MM/DD/YY

Main Menu Control Menu 7.2V 09:25 08/01/16

Set Time & Date

1 2 3 4
5 6 7 8
9 0 . bsp
clear accept +/-


Date: 0 1 0 8 1 6

Date Format
DD/MM/YY


Main Menu Control Menu 7.2V 09:25 08/01/16

To set the date, press the **Set Date** button. The date will display in either the MM/DD/YY or DD/MM/YY format which may be toggled from the button located on both screens. As you did with the time, press the appropriate numbers for the date in the format chosen. Press **Accept** to save and return to the previous screen. **(Note: Date will be preset by the factory)**

Setup the GPS

Setting up the GPS is nothing more than turning it on and waiting to connect to satellites. The GPS feature can take up to 15 minutes to connect to satellites depending on your location. From the **Main Menu**, press **GPS Control**.  GPS status can be toggled ON or OFF.




When the GPS is **enabled** the satellite icon on the status bar turns from red to green.  



GPS formatting can also be toggled from the **Universal Transverse Mercator (UTM)** grid to **Latitude/Longitude (LAT-LON)**. Initially the display will read Sats 0 for both formats until connections have been made. The above examples show a connection to five satellites (Sats 5) in both formats. GPS locations will appear on the bottom left corner of the soil reading screen and will store with each reading when **enabled**.

Control Menu



From the **Main Menu** press **Start SDG 200**  to enter the **Control Menu**. From this menu, you will find the icons listed below.



Opens the material details screen



Starts the standardization process



Opens the project details screen



Opens the diagnostics screen



Opens the data management screen, where you can delete, download and print job files



Opens the time and date screen




Opens the units screen, where you can toggle lbs/ft³ to kg/m³, F° to C°, or in. to mm.



Starts the measurement process

Select Measurement Units



From the **Control Menu**, press **Units**.  Density, Depth and Temperature can be toggled independently between system international (SI “metric”) and U.S. customary units. For example, you can set the density to **lb/ft³** while the depth is set to **inches** and temperature is set for **celsius**.



Project Details



The SDG 200 is configured to store 20 unique projects that are identified by user entered descriptions. If 20 projects have been defined in the SDG 200 and a 21st project is required, one of the original 20 will need to be modified to reflect the new project. The details of the new project will need to be input by editing the details of a previously stored project. Once the old projects are overwritten with new information, the old information is gone and the new information is saved in the gauge. Previously stored data files with the old material information will not be overwritten.

You may revisit each project at any given time to continue taking readings. Data from readings taken within each project will store in the order of which they were taken. If material details change within a project or project details are added, data for readings taken after the changes will continue to store in the same data file in the order of which they were taken. Only by changing the project name itself will the data be stored in a separate data file.



Project Details

The default projects stored in a new SDG 200 will have generic project names (i.e. Project1, Project2, etc) along with generic project details (i.e. My Street, My Road, Contact). The Project Details screen will resemble the Material Details screen such that you are able to select your project using the up and down arrows.   The green highlighted project **Rt 67 & 30** is the **CURRENT PROJECT**. Readings taken will store in a data file using the **CURRENT PROJECT NAME**. If the gauge is shutdown, the current project prior to shutdown will remain the current project when started back up. Keep track of your projects by entering detailed information into project details.



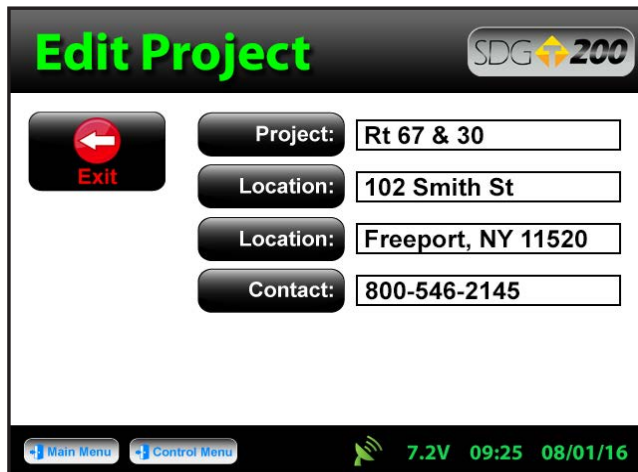
Editing Project Details








From the **Control Menu**, press **Project**  to enter the **Project Details** screen. The project highlighted in green **Rt 67 & 30** is displayed in detail on the right. To edit the details of this project, press **Edit Project**. 


Editing Project Details

Edit
Project



There are four black buttons labeled Project,  Location,  Location,  and Contact.  By pressing one of these labeled buttons, you will enter the keyboard screen which will allow you to edit and save information for that project.

For example, press **Project**,  the keyboard will open allowing you to change the default name. Press **clear**  if you would like to start over with a new name. Press **shift**  to toggle from lowercase to uppercase letters. Once editing has been completed, press **Enter**. 

Press **Exit**  to save the project information and return to the project details screen.

Define, Edit or Upload Material Properties



The density determined by the SDG 200 is highly material dependent. It is extremely important that the material properties from the **proctor test** and **gradation report** for the soil being tested are input accurately into the gauge.

The SDG 200 is configured to store 20 unique materials that are identified by user entered descriptions. If 20 materials have been defined in the SDG 200 and a 21st material is required, one of the original 20 will need to be modified to reflect the material properties of the new material. The properties of the new material will need to be input by editing the properties of a previously defined material. Once the old material properties are overwritten with new information, the old information is overwritten and the new information is saved in the gauge.

The SDG 200 will have default defined materials stored in each of the 20 unique locations. The following sequence explains how to input new material properties through the keypad or by USB upload and how to edit previously input material definitions.

Define, Edit or Upload Material Properties



Note: Be sure that the units of the gauge are set for the same units as the material you are uploading. For example, if the gauge is set in U.S. Customary units (ex: 150 lb/ft³) and you upload the material in SI units (2402.8 kg/m³) the gauge will notify you that the density is out of range. However, it will continue to load the material. If you switch to SI units **AFTER** the material has been loaded, the density would convert the 2402.8 as if it were in lb/ft³ and result in 38,489.2 kg/m³. Correct this by deleting the material, change the units of the gauge and reload the material or by simply editing the density in the material setup.





See Part 5 for explanations of the Material Properties.

See Part 6 for explanations of gradation and Proctor test reports.

See Appendix A for explanations of the MTL Generator

Defining and Editing a Material



Use the green up or down arrows   to select a new material for editing or change an existing material. The green highlighted material is the **CURRENT MATERIAL**  that the gauge will use when taking readings. Prior to exiting this screen, be sure this is the material you want and the information to the right has been verified. Press **Control Menu** on the status bar  to return to the Control Menu. If the gauge is shutdown, the current material prior to shutdown will remain the current material when started back up.

Note: The sum of **%Greater than 3 inches**, **%Gravel**, **%Sand**, and **%Fines** must add up to 100%. The default values programmed in the SDG 200 software add up to 100%. As soon as one of those values is edited, the sum will no longer add up to 100% and an error message will be displayed. However, after the initial error the gauge will allow you to exit and begin taking readings.



THIS IS NOT RECOMMENDED AND WILL GIVE INACCURATE RESULTS!!

Note: **Max Dry Density** and **Dry Density Offset** must be entered in the same units in which the gauge is configured to output results. For example, if the gauge is configured to measure in lb/ft³, input Max Dry Density in lb/ft³

Defining and Editing a Material

Edit
Material



From the **Control Menu**, press **Material**  to enter the Material Details screen. The material highlighted in green **Coarse** is displayed in detail on the right. To edit the details of this material, press **Edit Material** .



There are fifteen material properties for each material. Eight of these material properties are listed on page one of the edit material screen and the remaining seven are listed on page 2. Each can be edited individually by pressing its corresponding label which prompts a keyboard or alpha numeric keypad.

Defining and Editing a Material

Edit
Material


Edit Material SDG 200

Max Dry Density lb/ft³
130.0

1 2 3 4
5 6 7 8
9 0 . bsp
clear accept +/-

Main Menu Control Menu 7.2V 09:25 08/01/16

1 2 3 4 5 6 7 8 9 0
q w e r t y u i o p
a s d f g h j k l +
z x c v b n m . , /
back space space shift clear enter

Once editing is complete, press the **Back** button  located on page 2 of the edit material screen to verify your changes on the material details page.

Material Details SDG 200

Super Fine
Coarse
Fine

Material ID: Coarse
Description: Grainy
Depth: 6.0
Max Dry Density: 130.0
Opt Moisture: 7.6
Wet Density Offset: 0.0
% Moisture Offset: 0.0
% Larger than 3": 0.0
% Larger than 3/4": 1.3
% Gravel: 6.4
% Sand: 87.6
% Fines: 6.0

PL: 0.0
LL: 0.0
Cu: 4.4
Cc: 0.94

Edit Material
Upload Material

Main Menu Control Menu 7.2V 09:25 08/01/16

Setting Measurement Offsets


The SDG 200 has been designed to determine the moisture and density in a compacted soil sample without the need for any offsets. The ability to measure moisture and density is based on an empirical model that was developed by studying common soil types at near optimum moisture contents with typical particle size distributions. As the SDG 200's measurement performance is based on this empirical model, there will be occasions where the soil being measured is so different from one that has been studied previously that an offset may be required to enable the SDG 200 to produce acceptable results.

Setting Measurement Offsets

Offsets for **Wet Density** and **% Moisture** can be set manually by the operator in cases where the SDG 200 does not appear to be comparing favorably to collocated measurements. The offsets are simply **added to** or **subtracted from** the Wet Density and % Moisture calculated by the SDG 200. Dry Density, Volumetric Moisture, and % Compaction are then recalculated based on the offset values of Wet Density and % Moisture.

The Wet Density and % Moisture offsets are saved in each data record with the results of the corresponding test in the **.mnt file**.

Wet Density and % Moisture offsets are entered into the SDG 200 as a material property and are displayed and edited identically to other material properties.

Wet Density and % Moisture Offsets can be either **negative** or **positive**. To enter a positive offset simply type in the offset value that will be added to the current measurement. To enter a negative offset, use the (+/-) key  to enter a negative sign then enter the value that will be subtracted from the measured value. After the offsets are applied to the Wet Density and % Moisture, Dry Density and Volumetric Moisture are calculated by the SDG 200 as follows:

$$\text{Dry Density} = \frac{\text{Wet Density}}{1 + \left(\frac{\text{Water Content \%}}{100} \right)}$$

$$\text{Volumetric Moisture} = \text{Wet Density} - \text{Dry Density}$$

The % Moisture Offset is input as a percentage. For example, if the SDG 200 is consistently measuring % moisture as 7.5% and a collocated reference measurement is consistently measuring 5%, inputting an offset of -2.5 will adjust the SDG 200 to yield results similar to your reference measurement.

The Wet Density offset is input in units of mass/unit volume. If the gauge is set to operate in kg/m³, the offset will need to be entered in kg/m³. If the SDG 200 is configured to operate in lb/ft³, the density offset will need to be entered in lb/ft³.

- **The moisture, density, and compaction values displayed by the SDG 200 and logged in the .mnt file reflect the application of the user selected offsets**
- **Failing to enter the Wet Density Offset in the same units that the SDG 200 is configured to measure in may result in significant errors.**

Determining Offset Values

Methods used to determine what offsets are appropriate will vary from application to application, but will all generally follow the same steps. In order to determine an offset, a reference measurement will be required. That reference may include one or more of the following: a Nuclear Density Gauge, Oven Dry Moisture Measurements, Speedy Moisture Measurements, Sand Cone Apparatus, Balloon Density Apparatus, Density Drive Cone or other applicable equipment.

Multiple measurements should be taken at three to five representative locations with both the SDG 200 (make sure both offsets are set to 0) and your appropriate reference equipment. Note the results by each method at each location and determine the average difference between the SDG 200 results and the reference measurement results. This average difference will be your offset. If the SDG 200 measures lower than your reference measurement your SDG 200 offset will be positive. If the SDG 200 measures higher than the reference gauge, your SDG 200 offset will be negative.

At a particular location, if you are not able to get repeatable measurements with either the SDG 200 or your reference equipment, there may be an anomaly in the soil that effects the equipment and a new location should be selected.






The SDG 200 currently uses an emperical model to determine the in-place wet density and water content. Correlating the gauge to an alternate method is required for determination of absolute density and water content values.

!!Arbitrary selection of offsets is not recommended!!

Uploading a Material



A material definition that has been set up using the **SDG 200 Gradation Calculator** and saved on a USB flash drive can be uploaded to the SDG 200.

From the **Material Details** screen choose the material name you wish to overwrite by pressing the up or down arrows.   The green highlighted material name displayed prior to uploading the material  will be the location the new material will be stored. The information that is stored in this location will be overwritten and you will not be able to retrieve it again. Once you have made your choice, press **Upload Material**.  Be sure to have your USB drive inserted into the USB port located on the back of the gauge. Press **Upload** 

Uploading a Material

Upload
Material

Material Details SDG 200

Material ID: Coarse
Description: Grainy
Depth: 6.0
Max Dry Density: 129.9
Opt Moisture: 7.6
Wet Density Offset: 0.0
% Moisture Offset: 0.0
% Larger than 3": 0.0
% Larger than 3/4": 1.3
% Gravel: 6.4
% Sand: 87.6
% Fines: 6.0

Super Fine
Coarse
Fine

Edit Material
Upload Material





Main Menu Control Menu 7.2V 09:25 08/01/16

Upload Material SDG 200

Insert USB memory stick then press **Upload**

Upload

Main Menu Control Menu 7.2V 09:25 08/01/16

The file name of the materials located on the USB drive will appear on the left and some details identifying that specific material will be displayed on the right. Use the up or down arrows   to highlight the material you wish to upload. Once verified, press **Select**  to upload the material information into the gauge. Continue to select additional materials to upload or press **Back**  to view the uploaded material in detail.

Upload Material SDG 200

You must select a material you would like to delete in order to make space for the new uploaded material

Fine4
Coarse2
Coarse3

Description: Grainy
Max Dry Density: 130.0 lbs/ft³
Opt Moisture: 7.6

Back Select

Main Menu Control Menu 7.2V 09:25 08/01/16

Material Details SDG 200

Material ID: Coarse2
Description: Grainy
Depth: 6.0
Max Dry Density: 130.0
Opt Moisture: 7.6
Wet Density Offset: 0.0
% Moisture Offset: 0.0
% Larger than 3": 0.0
% Larger than 3/4": 1.3
% Gravel: 6.4
% Sand: 87.6
% Fines: 6.0

Super Fine
Coarse2
Fine

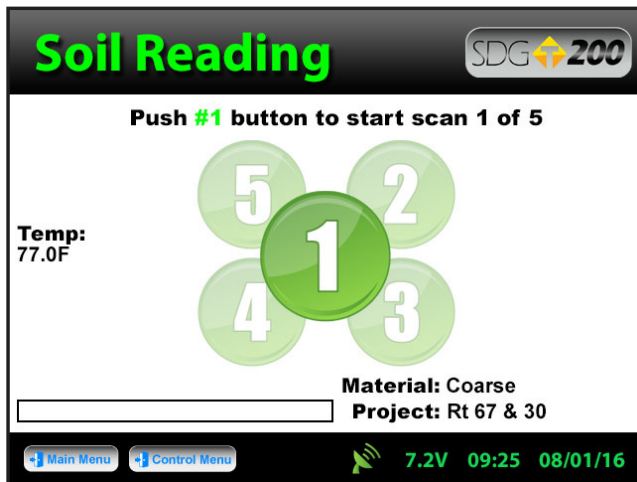
Edit Material
Upload Material

Main Menu Control Menu 7.2V 09:25 08/01/16

Note: Be sure that the units of the gauge are set for the same units as the material you are uploading. If the gauge was set in U.S. Customary units (ex: 150 lb/ft³) and you upload the material in SI units (2402.8 kg/m³) the gauge will notify you that the density is out of range. However, it will continue to load the material. If you switch to SI units AFTER the material has been loaded, the density would convert the 2402.8 as if it were in lb/ft³ and will result in 38,489.2 kg/m³. Correct this by deleting the material, change the units of the gauge and reload the material or by simply editing the density in the material setup.

See Appendix A for explanations of the SDG MTL Generator

Part 2: Running a Test - Measurement Pattern



A complete test consists of five individual measurements taken in a **cloverleaf pattern** at the test location. Each of the five measurements takes about 10 seconds. The SDG 200 is placed in position 1 for the first measurement and moved clockwise around position 1 as indicated in the illustration above. Upon completion of each reading, the SDG 200 will prompt the operator to move to the next location.

Surface Preparation

While the SDG 200 unit stands off from the soil, surface condition is still important. It is necessary for the soil surface to be free from any loose and disturbed material, stones, large air pockets or divots and other debris. It is also important that the soil surface be smooth. If it is not, smooth out the surface or move the unit to a location where the surface is smoother. The SDG 200 should not rock side-to-side when placed in a location to take a measurement. If it does, move it to a new location or remove the obstacle that is causing the rocking being careful to not measure on top of any divot left by removal of the object.

Large metal objects should not be within three feet of the gauge or underneath the soil while taking measurements. Measurements within ten feet of buried power lines should be avoided. When possible, measurements taken with an SDG 200 near an edge or vertical obstruction should be taken at least three inches from that edge.

When placing the SDG 200 at a location for a measurement, do not push down on the unit to seat the unit in place. Set the unit down on the surface and check to see if it rocks side-to-side. Do not touch the SDG while it is taking a measurement.

Measure Density



Turn the SDG 200 on by pressing the ON button. After a few seconds the TransTech Systems splash screen will appear followed by the Main Menu screen.





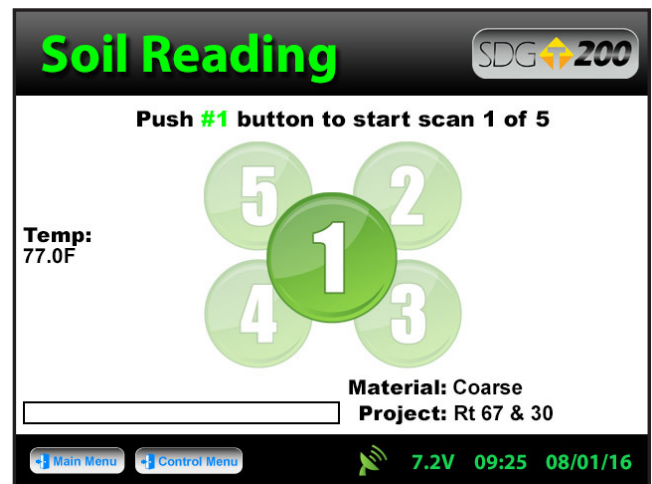
The Main Menu screen will display five options, **Start SDG200**, **Calculator**, **Contact TransTech**, **GPS Control** and **Update Software**.





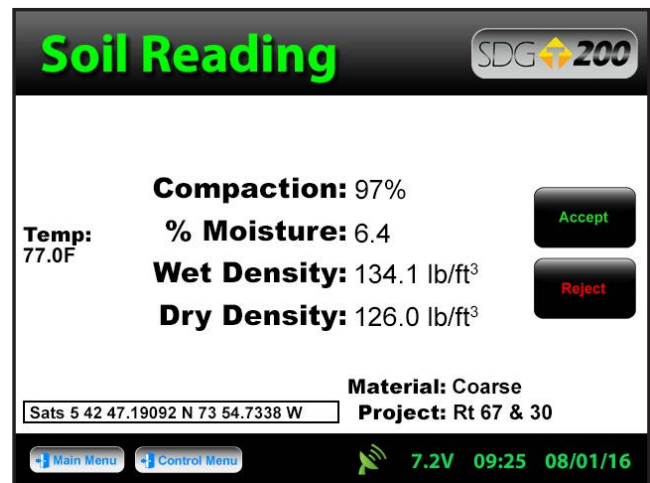
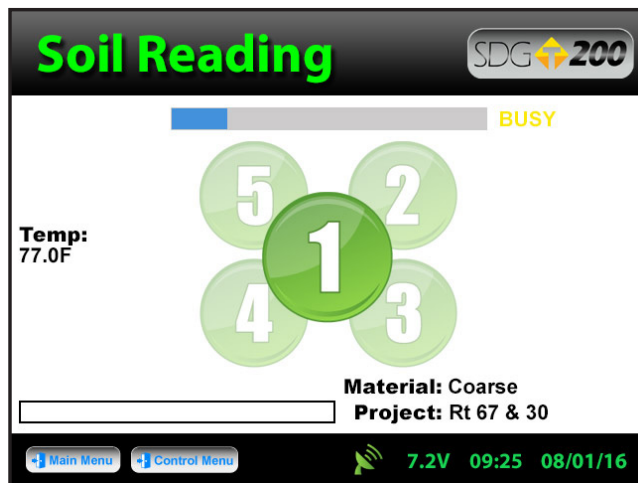
From the **Main Menu**, press **Start SDG 200** to enter the **Control Menu**. Press **Material** to display and verify the details of the current material that will be used for this test. Once verified, press **Control Menu** on the status bar to return to the Control Menu.



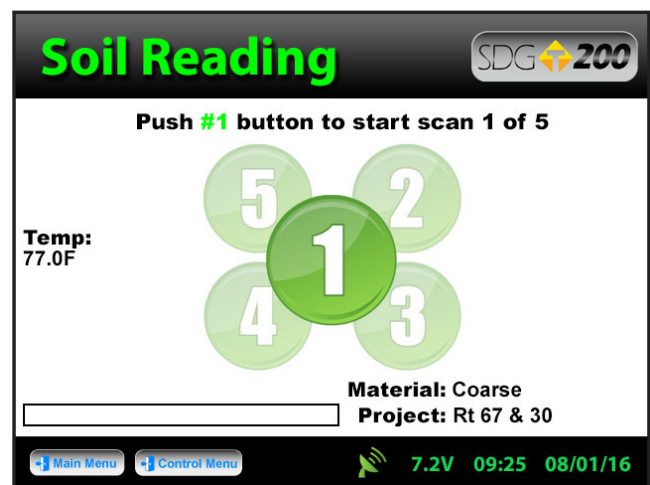
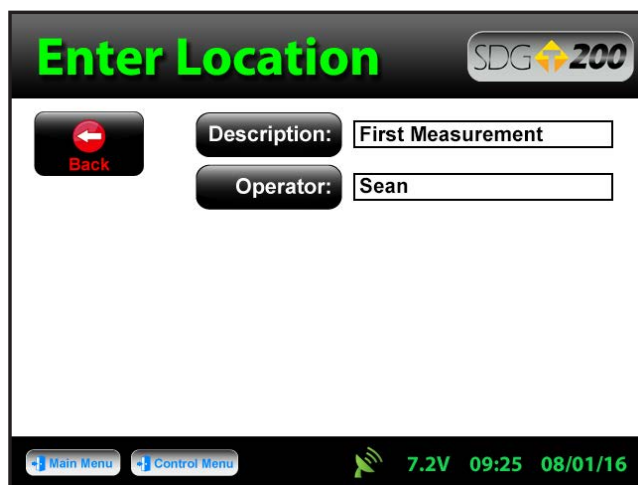
Press **Project**  to verify the project name that the data will save under as well as the project details. Once verified, press **Control Menu**  on the status bar to return to the Control Menu.



Press **Measure**  to enter the **Soil Reading** screen. The name of the material to be tested and project are displayed for verification in the bottom right corner. The temperature of the soil is displayed on the left side of the screen, below that the GPS information is displayed. The cloverleaf measurement pattern is displayed for your convenience with the highlighted position being the current position to measure. 






Position the gauge on the soil in position 1 as it appears on the screen and press **1**. **Do not touch the gauge while it is busy taking a measurement.** When reading 1 is complete, the gauge will prompt you to move to location 2. Move the gauge to position 2 and press **2** to continue. Repeat these steps for the remaining three measurements. After the fifth measurement has been taken, the in-place density and moisture content will be calculated and displayed on the screen. Here you can choose to **Accept** or **Reject** the recording of the averages into the data file.



If you press **Reject** the reading will not be stored and you will return to the main soil reading screen to continue taking measurements. If you press **Accept**, you will enter the **Enter Location** screen allowing for a description of the location to be entered as well as the operator name. This information will be stored in the data file and will remain for future readings until edited. Once editing is complete, press **Back** to save the description and return to the main soil reading screen to continue taking measurements.

Select Alternate Material Profile



At any time you wish to change the material profile to be used for testing you may do so. From the **Control Menu**, press **Material**.  Use the green up and down arrows   to select the material profile you would like to use. The green highlighted material will be the active material profile. **Coarse2** Return to the soil reading screen and begin testing. **Take note that these readings will be stored under the same project name that you were just using (the current project).** The data file name will be the same as the project name and will consist of the details on any and all materials used while that project name is current or active. **Only by changing the current project name will you receive a separate data file.**

Part 3: Data Storage and Downloading Data



The SDG 200 saves two types of data files. One file contains information that is referred to as **diagnostic data**, the other file contains information that is referred to as **measurement data**. Data files can be downloaded from the SDG 200 via a USB flash drive.

Measurement Data

The measurement data is a record of all of the tests performed with the instrument (a test is made up of the 5 individual measurements taken in a cloverleaf pattern). It is a semi colon delimited text file containing the following information:

Internal: Software Version; Gauge Serial Number;

Results: Dry Density; Wet Density; Moisture Content (%); Volumetric Moisture; % Compaction;

Measurement Data

Special Features:	Soil Temperature; SDG Time; SDG Date; GPS Position; GPS Time; GPS Date;
Project Details:	Project Name; Project Locations; Project Contact; Description; Operator;
Material Details:	Material ID; Description; Max Dry Density; Optimum Moisture; %Greater than 3in; %Greater than ¾ in; %Gravel; %Sand; %Fines; PL; LL; Cu; Cc; A coefficient; B coefficient; Dry Density Offset; % Moisture Content Offset

When the measurement file is downloaded it is automatically named by the SDG 200.
The following naming format is used:

Project Name:month:month:day:day:hour:hour:minute:minute.mnt
Project 103061510.mnt for Project 1 of March 6, 3:10 PM

Diagnostic Data

The diagnostic data contains all of the measurement data as well as information that indicates how the SDG 200 is performing. This data is of little interest to gauge owners and operators but will be very helpful to TransTech in the event of an instrument malfunction. Similar to the measurement data, the diagnostic data is saved at the conclusion of a complete measurement. Data from partial measurements are not logged in memory.

When the diagnostic file is downloaded it is automatically named by the SDG 200.
The following naming format is used:

Project Name:month:month:day:day:hour:hour:minute:minute.dat
Project 103061510.dat for Project 1 of March 6, 3:10 PM

Storage Capacity






The SDG 200 has the capability to store up to twenty detailed projects and twenty detailed materials with an overall storage capacity of over 1000 MB for all data files. Upon completion of a set of five measurements, the complete details of the test will be written to a file and saved on the instrument **ONLY AFTER THE ACCEPT BUTTON HAS BEEN PRESSED**. This feature is new to the SDG 200 where the older 100 series saved automatically. With the 200 series, the gauge gives the operator the option to accept or reject a reading.

On occasions that operators do not complete the series of five readings that make up a complete measurement series and either exits out of the reading routine or turns off the instrument, that incomplete record will not be stored. If the operator tries to exit out of the reading as it is being taken a warning will display: **Attention! Measurement currently running; please allow measurement to complete**. Simply wait for the measurement to complete. If the operator decides to decline the completed set of readings, the gauge will not store that set.





Downloading Data

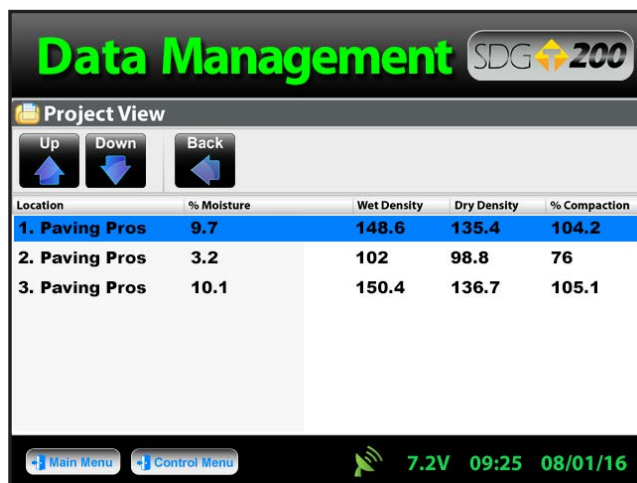
From the Control Menu, press **Data Management**.  This is where project files will be saved, viewed, printed and downloaded.






Scroll down to the project you would like to download using the arrows.   Insert the USB flash drive into the USB port located on the back of the gauge. Press **Download MNT**  if you wish to download the measurement data only. Press **Download DAT & MNT**  if you wish to download the measurement data as well as the diagnostic data. You will be prompted to insert the USB flash drive if you haven't already and then to press **Download**.  The gauge will return to the data management screen which now displays **BUSY** **BUSY** in the top right hand corner. When downloading is complete the gauge will display **READY**. **READY**

Viewing a Project File




Once you are in the **Data Management** screen you can view completed readings from your project files. Use the arrows   to scroll and highlight the desired project and press **View**.  All of your readings saved to this project will be listed in the order they were taken. Only the most pertinent information will be shown in this view including: Test Number, Location, % Moisture, Wet Density, Dry Density, % Compaction. Press the **Back** button  to exit the **Project View** screen.

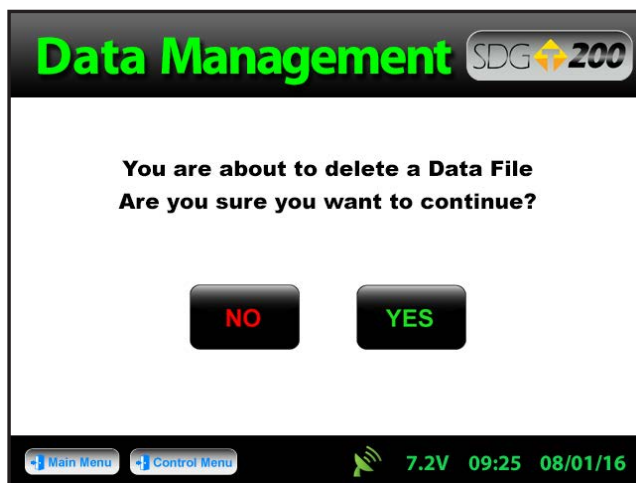


Printing a Project File

If you have purchased the TransTech portable printer for your SDG 200 you will be able to print test results on-site right from your gauge. Plug in your printer and from the **Data Management** screen, use the arrows   to scroll to your selected project and press the **Print** button. 

Deleting a Project File

When you wish to delete a project, select and highlight the correct project using the arrows   and press **Delete**.  You will be prompted with a warning asking if you are sure you wish to delete the file. Once confirmed and deleted, you will no longer be able to retrieve the measurement nor the diagnostics data.




Part 4: Maintenance and Troubleshooting



In the event that the SDG 200 were to malfunction, internal information about the gauge can be obtained and relayed to the factory. In the event that a repair is required, **we strongly recommend that authorized factory service be obtained.** Unauthorized repair or maintenance by the user will void the unit's warranty.




From the **Control Menu**, press **Diagnostics**  and the internal information needed for the factory to track your gauge will display. This information consists of the serial number, software version and the date the gauge was last calibrated.

Factory Calibration



Yearly recalibration of the gauge is recommended to maintain consistency and accuracy for the electronic components.



The diagnostic button  on the **Control Menu** will turn red as a reminder to calibrate the gauge. Only TransTech Systems or authorized distributors are able to perform this type of calibration.

Maintenance

The SDG 200 has been designed to require a minimum of maintenance or service. Normal care in use should insure long and trouble free operation.

Keep the SDG 200 bottom surface clean:

For accurate readings, the SDG 200 should have a smooth interface with the surface. Try not to place the SDG 200 on top of large rocks that would cause the gauge not to sit properly. Also, do not try to dig the gauge into the material.

Touchscreen:

Do not clean the touchscreen with abrasive products, solvents or other harsh cleaners. Apply window cleaner to a clean soft rag and wipe the surface clean.

Factory Calibration:


Yearly recalibration of the gauge is recommended to maintain consistency and accuracy for the electronic components.

Battery Care Tips:

- Whenever uncertain about the battery charge level or condition, recharge it.
- The battery will self-discharge and therefore should NOT be left uncharged for more than 30 days.
- An occasional complete discharge followed by a full recharge is recommended .
- NEVER drop the battery as this can damage the internals.
- DO NOT store in freezer or expose to extreme heat
- Battery should be fully charged before use

Troubleshooting

The chart below provides guidance to a few suspect conditions.

Problem	Remedy
Buttons Sticking / Frozen Software	Repress the frozen button firmly for three seconds. Be sure not to drag your finger from one button to the next. If this does not work, reset the gauge by turning it off and then back on.
Incorrect Density Reading	<p>Clean off sensor plate</p> <p>Check Current Material Details- be sure you have entered all details correctly (ex. Does the %Gravel, %Sand and %Fines add up to 100%?)</p> <p>Check Offsets- if you entered a Dry Density Offset or a %Moisture Offset be sure that the values selected make sense (see the Definitions and Calculations section of this manual)</p> <p>Check Units- be sure all of the values for the Density whether uploaded or entered, are in the same units</p> <p>Call Factory</p>
Battery Problems / Gauge Keeps Shutting Down / Gauge Will Not Come On	<p>Ensure battery pack is plugged in</p> <p>Check battery voltage- plug gauge into charger and wait for the green LED to illuminate to indicate a full charge</p> <p>Call Factory</p>
Data is not recording	Check Current Project Name- data readings will store on the Current Project only, be sure you have the correct Project name set on the gauge (Verify the name of the Project and Mix on each reading screen)
GPS Communication Errors	Call Factory
Touch screen is frozen	<p>A piece of sand or grit may be caught under the edge of the bezel creating a false touch. Using a business card or other flexible card, slide the card under the edge of the metal bezel to dislodge anything that may be caught.</p> 

Part 5: Definitions and Calculations - Measurement Results

The following values are reported at the end of a measurement:

Wet Density is total mass of material per unit volume in pcf or kg/m³

Volumetric Moisture is mass of water per unit volume in lb/ft³ or kg/m³, measured by the SDG 200.

% Moisture is water content as percent of dry density = $\left(\frac{\text{Volumetric Moisture}}{\text{Dry Density}} \right) \times 100$

Dry Density = Wet Density – Volumetric Moisture

% Compaction = $\frac{\text{Dry Density}}{\text{Max Dry Density}}$

Definitions of Material Properties

The following descriptions and material properties need to be entered in the gauge for measurement or data reporting purposes:

Material ID: Usually a numeric entry that will associate the soil being tested with the gradation and proctor test report. Examples of soil or material ID's may include **33.1099** or **776632**. Material ID's are limited to 13 characters.

Description: Typically a brief description of the soil that allows the operator to visually identify the material being tested. Examples may include **sand red**, or **brown silt**. Descriptions are limited to 13 characters.

Max Dry Density: This is the maximum dry density or target density or proctor number for the material being tested. It is input in lb/ft³ or kg/m³. **Be sure the units of the gauge are in the same units you wish to enter.** This value can be found in a proctor test report completed in accordance with **ASTM D 1557** or **ASTM D 698**. This is used by the SDG 200 as the value against which the measured dry density is compared to calculate percent compaction.

Optimum Moisture: This is the optimum moisture content for the material being tested. This value can be found in a compaction test report completed in accordance with **ASTM D 1557** or **ASTM D 698**.

PL: (Plastic Limit): This property describes soils with a high clay and silt content. It is defined as the moisture content in percent at which the sample begins to exhibit plastic behavior as it transitions from having semi-solid properties. This value is determined as outlined by **ASTM D 4318**.

Definitions of Material Properties

LL: (Liquid Limit): This property describes soils with a high clay and silt content. It is defined as the moisture content in percent at which a sample begins to exhibit liquid behavior as it transitions from having plastic properties. This value is determined as outlined by **ASTM D 4318**.

Cu: (Coefficient of Uniformity): Cu is defined as the ratio of D_{60} / D_{10} , where D_{60} is the particle diameter of which 60% of the sample is smaller, and D_{10} is the particle diameter of which 10% of the sample is smaller. Cu can be calculated from values taken from a particle size distribution plot defined by **ASTM D 422**.

Cc: (Coefficient of Curvature): Cc is defined as $D_{30}^2 / (D_{60} \times D_{10})$. Cc can be calculated from values taken from a particle size distribution plot defined by **ASTM D 422**.

% Gravel: The percentage of material by mass passing a 3 inch (75mm) sieve but retained on a #4 (4.75mm) sieve. % Gravel can be taken from a particle size distribution report defined by **ASTM D 422**.

% Sand: The percentage of material by mass passing a #4 (4.75mm) sieve but retained on a #200 (.075mm). % Sand can be taken from a particle size distribution report defined by **ASTM D 422**.

% Fines: The percentage of material by mass passing a #200 (.075mm) sieve. % Fines can be taken from a particle size distribution report defined by **ASTM D 422**.

Note: Be sure that the % Greater than 3", % Gravel, % Sand and the % Fines add up to 100%.

% Greater than ¾ inch: The percentage of material by mass retained on a ¾ inch (19.0mm) sieve. % Greater than ¾ inch can be taken from a particle size distribution report defined by **ASTM D 422**.

% Greater than 3 inch: The percentage of material by mass retained on a 3 inch (75mm) sieve. % Greater than 3 inch can be taken from a particle size distribution report defined by **ASTM D 422**.

Part 6: Standardization of the SDG 200



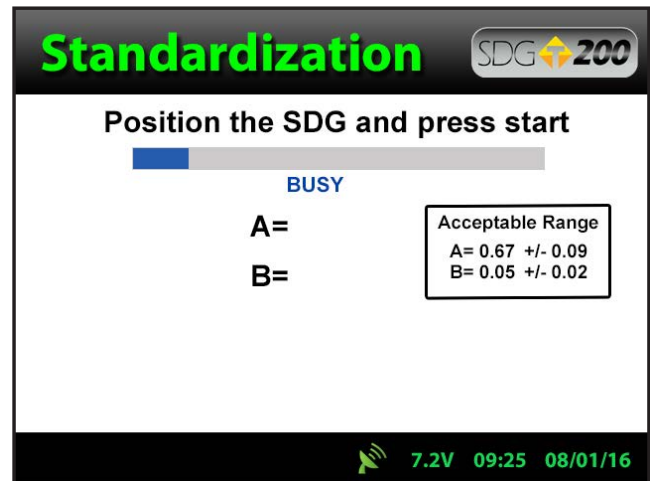
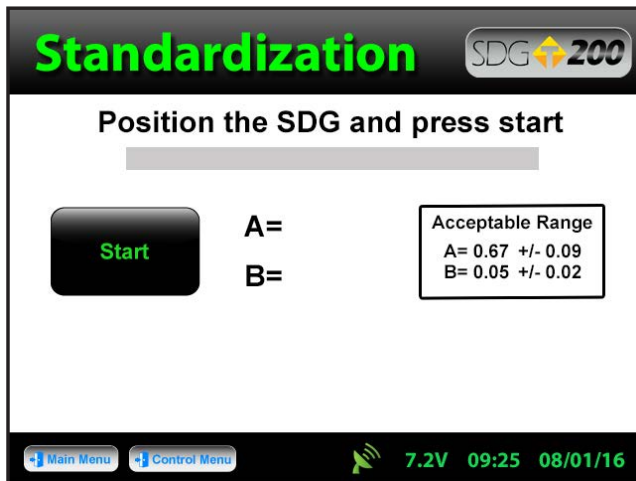
To assure that the SDG 200's ability to make consistent measurements has not been compromised, a daily measurement should be taken on a reference material and tracked day to day for any unacceptable variations. A metallic plate has been installed in the bottom of the SDG 200 carrying case that is suitable for this purpose.

Although this verification is referred to as a standardization of the gauge, the results of the standardization in no way influence the measurement of the gauge, they only serve to alert the user to a change in the way that the gauge is operating. Unexpected changes in the standardization values should be noted and discussed with product service at TransTech.

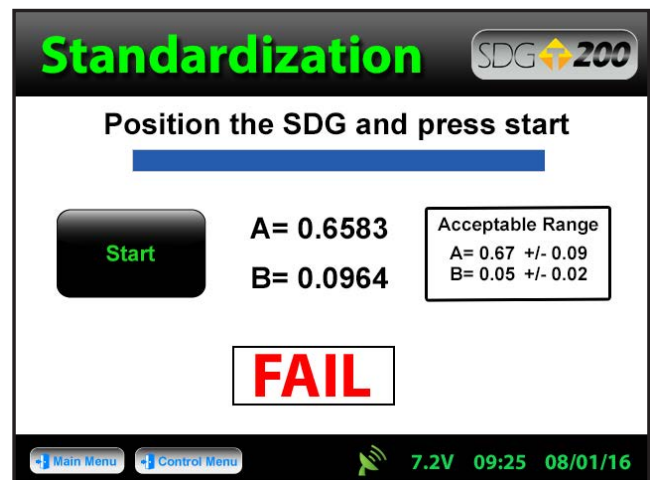
Standardization of the SDG 200



Standardizations are performed **inside the carry case**. Located at the bottom of the case is a steel plate. **Position the gauge on top of the plate inside the case. Be sure the gauge screen is facing you, if it is placed in the case backwards the handle will prevent proper seating you will get a false reading.** The case should not be on top of or around any large metal objects. From the **Control Menu**, press the **Standardize** button. Press **Start**, to begin the standardization. **Do not touch the gauge while it is busy.**



The acceptable range for the A and B values are displayed on the screen, however, the SDG 200 will respond with a **PASS** or **FAIL** based on these ranges automatically.



Standardization of the SDG 200



If you receive a **FAIL**, prior to calling TransTech Systems try the following:

1. Reposition the gauge / case to another location (outside preferably)
2. Be sure that you are testing the gauge inside the carry case that was provided with the SDG. The gauge and case are paired during production to determine the standardization.
3. Do not place the case on the back or near an automobile as well as any other large metal objects and / or wires
4. Be sure that no foreign objects have adhered to the bottom of the gauge or on the steel plate
5. Shut off all cell phones within 10ft of the gauge

WARNING: THE STANDARDIZATION OF THE SDG 200 WILL ONLY WORK WITH THE PLATE IT HAS BEEN ISSUED TO. IF YOU RECEIVE A FAIL RESULT, CHECK TO BE SURE THE SERIAL NUMBERS LOCATED ON THE GAUGE AND THE STANDARDIZATION PLATE ARE THE SAME.

WARNING: THE STANDARDIZATION OF THE SDG 200 MAY GIVE A FALSE “FAIL” IF TEST IS TAKEN TOO CLOSE TO METAL OBJECTS, POWER LINES OR OTHER ELECTRICAL DEVICES THAT MAY BE TOO CLOSE TO THE GAUGE. TURN THE GAUGE OFF AND MOVE THE GAUGE AT LEAST 10 FEET FROM THESE OBJECTS. IF AFTER THESE PRECAUTIONS ARE TAKEN THE GAUGE STILL DISPLAYS A “FAIL” CONTACT YOUR DISTRIBUTOR.

Part 7: Explanation of Gradation and Compaction Reports

All of the information needed to configure a SDG 200 to measure the density and moisture content of a material is available on the **Compaction Test Reports (Proctor Test)** and **Particle Size Distribution Reports (Gradation/Sieve Analysis)** completed as outlined by **ASTM D 422** and **ASTM D 1557**. In order to configure the SDG 200 to operate on materials that have high clay and silt contents, results from an **Atterberg limits test (ASTM D 4318)** will be needed as well.

The thirteen properties that will need to be entered through the SDG 200's user interface are shown on the material details screen and defined below. Further definitions of these properties can be found in **Part 5** of this handbook. Examples of a gradation report and compaction test are on the following pages.

The **Material ID** is any identifier that can associate the material being evaluated with its test report. A report number or sample number should be entered here. For the example shown, **08.0527** is the material ID. **Do not enter letters or characters as part of the material ID.**

The **Description** should be used to describe the material and help make a visual association with the material being tested. **Dark Brown Sand** is used for this example.

Explanation of Gradation and Compaction Reports

The **Max Dry Density** is the maximum practically achievable density a soil can have. This value is determined experimentally by performing a **Proctor Test (ASTM D 1557)**. **129.9 lb/ft³** is taken directly from the example compaction test report.

The **Optimum Moisture Content** is the water content (%) at which the material can be compacted to its maximum dry density. This is determined experimentally by performing a **Proctor Test (ASTM D 1557)**. **7.6%** is taken directly from the example compaction test report.

PL and **LL** are the plastic and liquid limits used to describe the plasticity of materials with a high silt and clay content. They are determined by following the test procedure outlined by **ASTM D 4318**. This example is a sandy material so PL and LL are input as **0.0**. If plasticity tests had been performed on this material, the results would be given on the gradation report.

Cu and **Cc** are the Coefficient of Uniformity and Coefficient of Curvature of the material. They are calculated values that are typically used to describe the particle size distribution a soil. In this example, **Cu = 4.4** and **Cc = 0.94**

% Gravel is the summation of the coarse and fine gravel in a sample of material. Some gradation test results will report this as a single value while others will break it down into the coarse and fine fractions. The SDG 200 only recognizes the total percentage of gravel so the coarse and fine fractions will need to be added together before entering them. The gradation report shown breaks the gravel content out into Fine and Coarse fractions so those will need to be added together.

$$1.3\% + 5.1\% = 6.4\%$$

% Sand is the summation of the coarse, medium and fine sand in a sample of material. Some gradation test results will report this as a single value while others will break it down into the coarse, medium and fine fractions. The SDG 200 only recognizes the total percentage of sand so the coarse, medium and fine fractions will need to be added together before entering them. The gradation report shown breaks the sand down into coarse, medium, and fine fractions, so the percent sand in the example shown is **8.1% + 31.3% + 48.2% = 87.6%**.

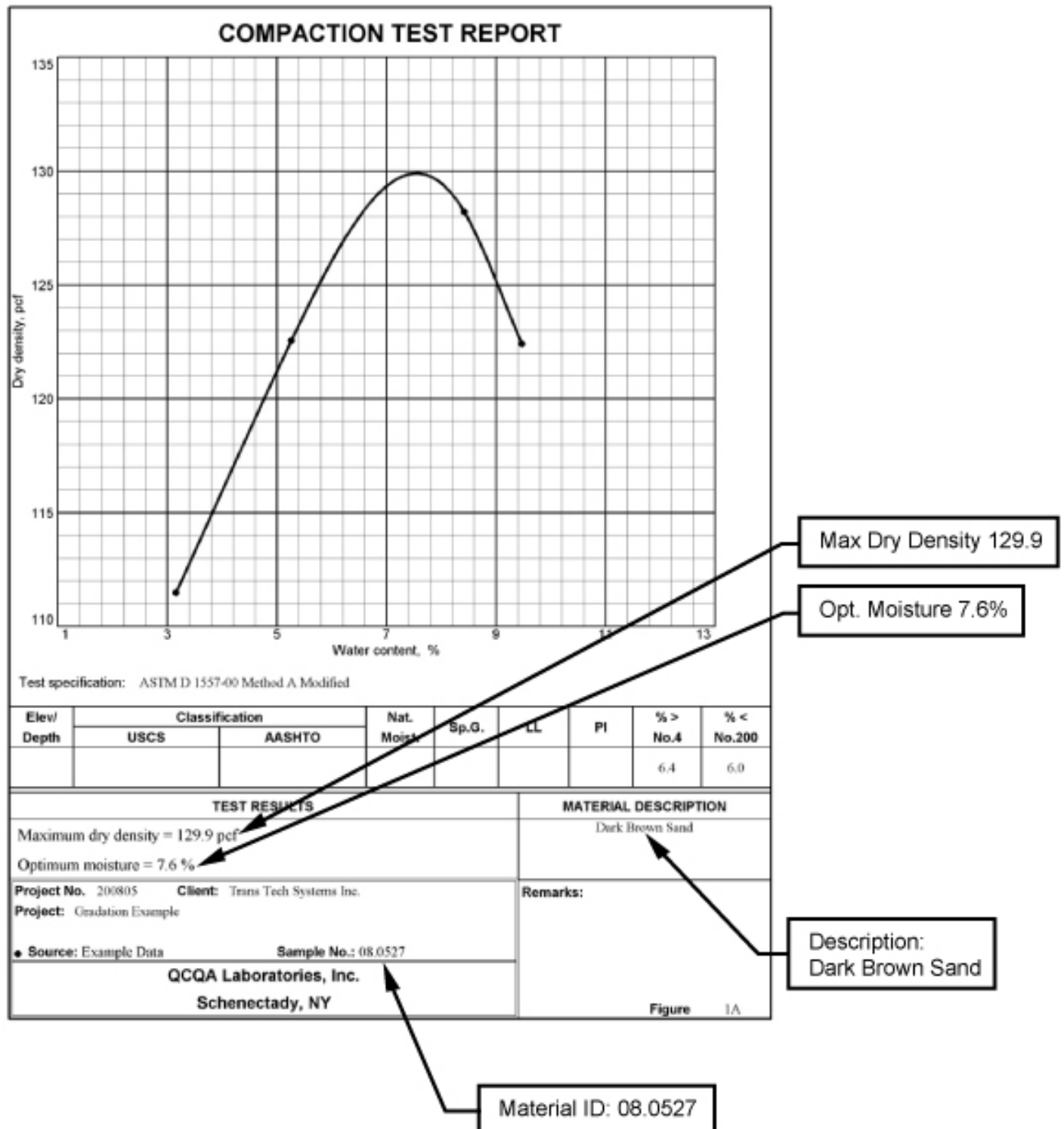
% Fines is the summation of the silt and clay in a sample of material. Some gradation test results will report this as a single value while others will break it down into the fractions of silt and clay. The SDG 200 only recognizes the total percentage of fines so the coarse, silt and clay fractions will need to be added together before entering them. In this example, the percent fines is **6.0%**.

% Greater than 3 inches is the percentage of the sample that is retained on the 3 inch sieve. Typical gradation tests report the “percent finer” or percentage that passes a particular sieve. In this example the percent finer for the 3 inch sieve is 100% so 0% of the sample is retained on the 3 inch sieve.

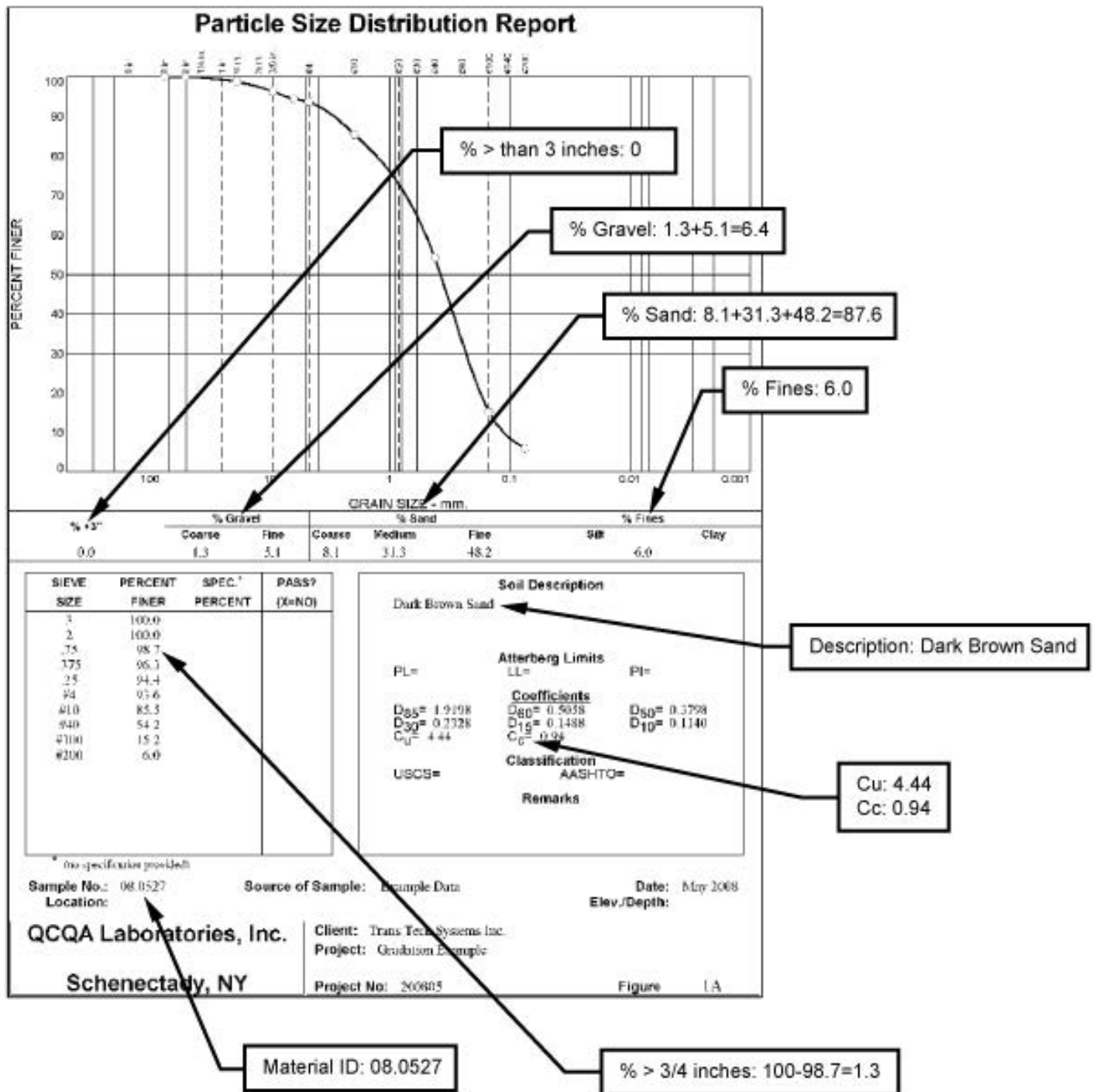
Explanation of Gradation and Compaction Reports

% Greater than 3/4 inch is the percentage of the sample that is retained on the 3/4 inch sieve.

Typical gradation tests report the “percent finer” or percentage that passes a particular sieve. In this example the percent finer for the 3/4 inch sieve is 98.7% so 1.3% of the sample is retained on the 3/4 inch sieve.



Explanation of Gradation and Compaction Reports



Note: The sum of **%Greater the 3 inches**, **%Gravel**, **%Sand**, and **%Fines** must add up to 100%. The default values programmed in the SDG 200 software add up to 100%. As soon as one of those values is edited, the sum will no longer add up to 100% and an error message will be displayed until all of those gradation values are entered such that the sum is 100% again!

Appendix A: Using the SDG MTL Generator

The SDG 200 MTL Generator is a spreadsheet based application developed to determine the gradation inputs that the SDG 200 needs to measure moisture and density of a soil in cases when the gradation performed was not done in accordance with **ASTM D 422**. The MTL Generator will allow users to input the gradation information that they have and will produce a particle size distribution curve from which the Cu, Cc, %Gravel, %Sand, %Fines, % larger than 3/4 inch, % larger than 3 inch values will be taken. Those values will be organized in a text file that can be uploaded onto the SDG 200 via a USB flash drive.

There are two MTL applications. One application allows users to input any sieve size, in millimeters, that was used in their gradation. The second application is useful when an **ASTM D 422** type gradation report is available and users simply want to type the report summary into their PC and generate a text file to upload into the SDG 200.

Getting Started:

The MTL applications are Microsoft Excel spreadsheets that contain macros. For the applications to operate properly, Excel will need to be configured to run macros on any computer you wish to use these on. To change the macro settings on your computer, follow these steps.

1. Open up Excel
2. Select the Tools menu
3. Select the Macro option
4. Select the Security option
5. Select the Security Level Medium and select OK

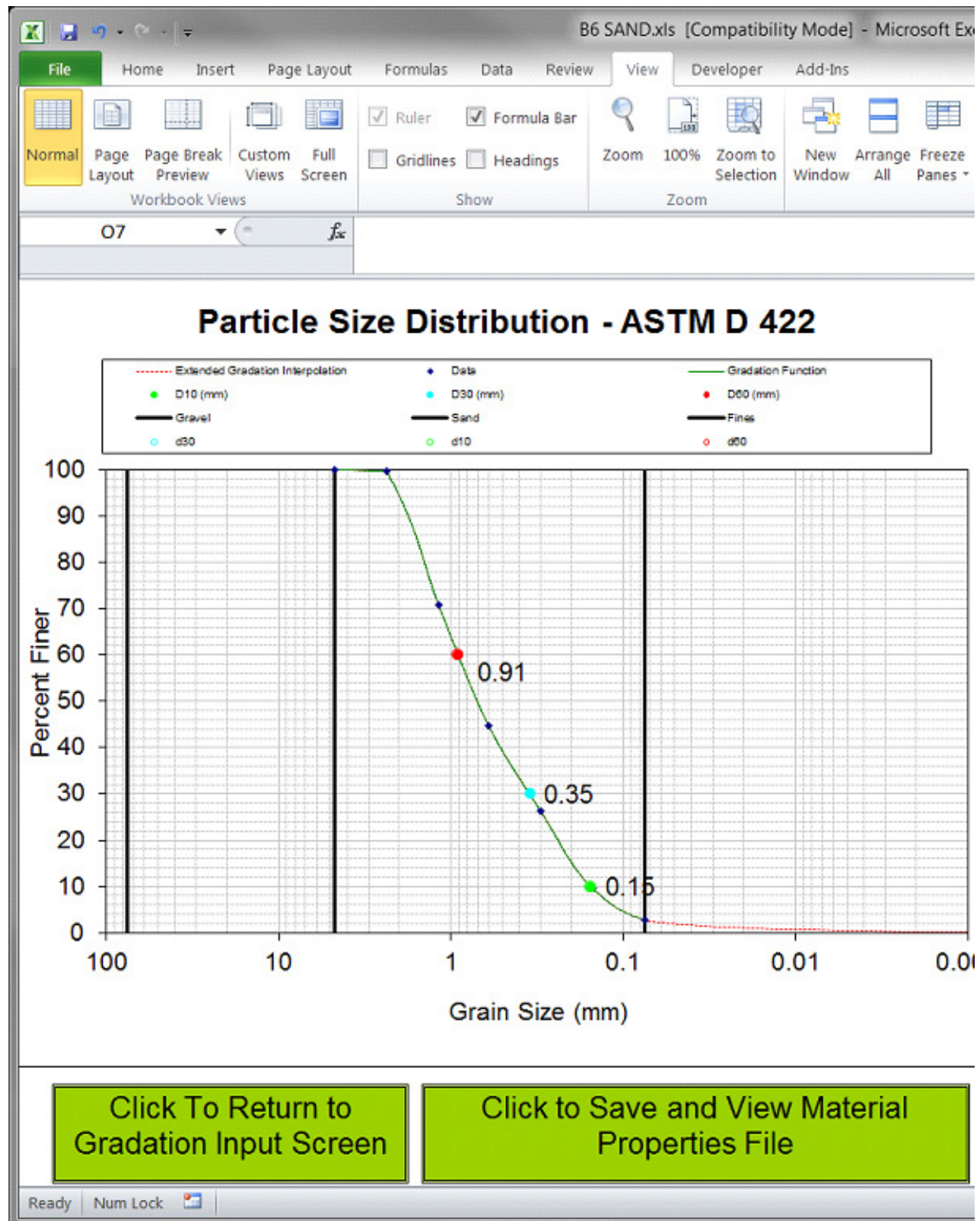
Once this setting is selected, Excel will ask you to confirm that you want to allow these applications to enable macros each time they are opened. Choose enable macros when prompted to do so.

The gradation calculator has two separate screens. Screen one explains the use of the calculator, contains conversion tables for US customary and metric sieve sizes, contains the inputs for the sieve sizes and percent passing those sieves and has inputs for the material descriptors that make up the material definition file.



Using the SDG MTL Generator - Screen Two

The second screen of the MTL generator displays the plot of the particle size distribution curve and displays a table of all of the material properties that will be converted into a text file to upload to the SDG 200.



Using the SDG MTL Generator

On Screen 1, input the sieves used in the gradation (in mm) and the percent of material passing each sieve in columns A and B. The data must be entered in order of decreasing sieve sizes, and the first sieve entered should be of a size such that 100% of the material passed that sieve.

Once the gradation data is entered, fill in the rest of the material definition information in the yellow cells on Screen 1. The explanations and limitations for those definitions are explained on Screen 1.

Clicking on the button to view the Particle size distribution curve displays Screen 2. The gradation curve will be visible, as well as a table of all of the properties that define the material. Clicking on the button to save and view the material properties file creates a text file with a .mtl extension of your PC's desktop. **(Note: the first time you open a .mtl file on your PC, you will need to manually open it from the desktop with WordPad or similar text file editor. After that, your PC will always open .mtl files automatically.)** The .mtl file can now be copied to a USB flash drive to be uploaded onto the SDG 200 as explained on page 18.

The SDG 200 will only recognize the first 20 .mtl files on the USB flash drive, and it will only recognize them if they are in the root directory of the flash drive. If .mtl files are in sub folders on your flash drive, the SDG 200 will not recognize them.

The MTL File Tool is designed to allow users to easily create .mtl files to upload into the SDG 200. If a gradation report completed in accordance with ASTM D 422 is available, all of the information on that report can be entered into the table on the Gradation file tool and a .mtl file will automatically be generated and saved to the Desktop of your PC. This file can then be transferred to a USB flash drive and installed directly into the SDG 200 as explained on page 18.

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TransTech Systems Product Warranty

The Company warrants to the Purchaser that the product delivered hereunder will be free from defects in material or workmanship and be the kind and quality designated or specified in the contract or purchase order. This warranty shall apply only to defects appearing within one (1) year from the date of shipment by the Company.

If the product delivered hereunder does not meet the above warranty and if the Purchaser promptly notifies the Company, the Company shall thereupon correct any defect, including nonconformance with the specifications, either (at the Company's option) by repairing any defective or damaged parts of the product, replacing the product, or by making available the necessary repaired or replacement parts.

The liability of the Company under this warranty, for any loss, whether the claim is based on contract or negligence, shall not in any case exceed the cost of correcting defects in the product as herein provided, and upon the expiration of the warranty period, all such liability shall terminate. The foregoing shall constitute the exclusive remedy of the Purchaser and the exclusive liability of the Company. The foregoing warranty is exclusive and in lieu of all other warranties, whether written, oral, implied or statutory.

No warranty of merchantability or of fitness for purpose shall apply. Unauthorized service shall void this warranty.

TransTech Systems Product Non-Warranty Return Policy

Non-warranty returns for TransTech Systems Inc. products must be made within twenty (20) days from the original date of shipment, unless otherwise indicated. Returned products must be in the original packaging, unused and in undamaged condition. Proof of purchase is required. Upon receipt of the product TransTech will inspect the product to the above mentioned criteria.

Unused products will be issued a credit to the Purchaser's account that was used to purchase the product. TransTech will not credit prepaid shipping cost. The original packing slip or invoice is required to be sent back with the product to be returned.

The Purchaser is responsible for shipping the product back to TransTech, carefully package the item(s) and include the packing slip and return manufacturing authorization number on the package. Prepay shipping is required – TransTech will not accept C.O.D.s.

Returns will be credited within 10 working days.

Proper Process of Warranty or Non-Warranty Shipments to TransTech Systems

For product returns (warranty or non-warranty), please follow the instructions below to assure prompt handling:

Call us for authorization (518-370-5558 or 800-724-6306), obtain a return manufacturing authorization number (RMA), and the return shipping address.

Indicate to our representative the reason for returning the product.

For Warranty Returns, Purchaser is responsible for shipping to TransTech's office. TransTech will pay ground shipping return to the Purchaser.

Trans Tech

TRANSTECH SYSTEMS, INC.

**900 Albany Shaker Road, Suite 2
Latham, NY 12110**

Phone: 518-370-5558

Toll Free: 1-800-724-6306

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Email: inquiries@transtechsys.com

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 **Toll Free: TransTech.Systems.Inc01**

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