

2DDA-1000
DENSITY GAMMA
PROBE



MOUNT SOPRIS
I N S T R U M E N T S

Mount Sopris Instrument Co., Inc.
Golden, CO U. S. A.
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Table of Contents

General Information	3
Overview	3
Controls, Connectors, and Layout	3
Theory of Operation	4
Specifications:*	5
Installing the 2DDA-1000.....	6
4 π & 2GGA Gamma density measurement	6
Operating Procedure	7
Operation	7
Performance Checks and Calibrations	7
Preventative Maintenance	9
Troubleshooting	9
Problems with the Tool	9
GAMMA Problems	9
Disassembly Instructions.....	10
Schematics	11
Appendix.....	12
Suggested QA Procedure.....	12

General Information

Overview

The 2DDA-1000 is a 1.125 inch diameter Gamma probe providing natural gamma measurement. The probe is equipped with an adjustable bow spring assembly which allows the user to run the probe and source carrier against the borehole wall. This configuration is typically used with a 2GGA assembly which has a radioactive source installed in the 2GGA to provide a basic Density Gamma measurement in the bore hole. The probe can be run without the bow spring assembly and or the 2GGA density source container and just a basic gamma log obtained.

Controls, Connectors, and Layout

Connectors for the tool are as follows. The probe top described below is a Mount Sopris standard single conductor probe top. Other variations of probe tops and wiring can be accommodated at the factory but will not be discussed in this document.

PROBE TOP CONNECTOR:

Pin	Signal	Origin
Probe top housing	Tool power ground	Armor
Center pin in probe top	Tool power positive	Center conductor

Layout for the tool in general is as follows starting at the bottom of the tool. The bottom of the probe and housing are the R & SP electrode. Just above the electrode inside the housing is the scintillation crystal and Photo multiplier. Next is the electronic section for the gamma and electric measurements, followed by the probe top.

Theory of Operation

GAMMA

The natural gamma measurement is made by the use of a Sodium Iodide crystal, which when struck by a gamma ray emits a pulse of light. This pulse of light is then amplified by a Photo multiplier tube, which outputs a current pulse. These pulses are then detected, shaped and transmitted up the cable line. The center of the Sodium Iodide crystal is referenced by a band of colored tape on the housing of the probe. The user must maintain this band of tape, or marker, as it may tend to degrade with use of the tool. The 2DDA Gamma tool must be powered with positive D.C. voltage with respect to the armor. Worthy of note is the crystal detector and the Photo multiplier tube. Both of these devices are fragile at best and are costly to replace. Mount Sopris has taken steps to afford these items as much protection as possible. These items are subject to damage by sudden shock or changes in temperature. When shipping or transporting the tool ensure it has proper protection from vibration and shock to reduce the chances of damage.

Specifications:*

Power Requirements

DC. voltage at probe top. MAX. 30 VDC @ 40mA nominal

Tool Output

Positive pulses, 3.0uS wide, Dead-time of 6.25uS

Gamma Detector

2DDA-1000 NaI (tl) .5" dia X 1.5" long 12.70mm dia. X 38.1mm long

Approximate K-Factor

1.2 +/- 0.2 X 10⁻⁶

Gamma Detector location

2DDA-1000; From probe top measure towards the bottom of the tool 755 mm.

Operating temperature range

-20 to 50 degrees C

Pressure rating

2000 PSI 13789 k PASCAL

Dimensions

2DDA-1000 Gamma

Length	48.77	inches	123	cm
Diameter	1.125	inches	2.85	cm
Weight	7.5	lbs	3.40	kg

Installation

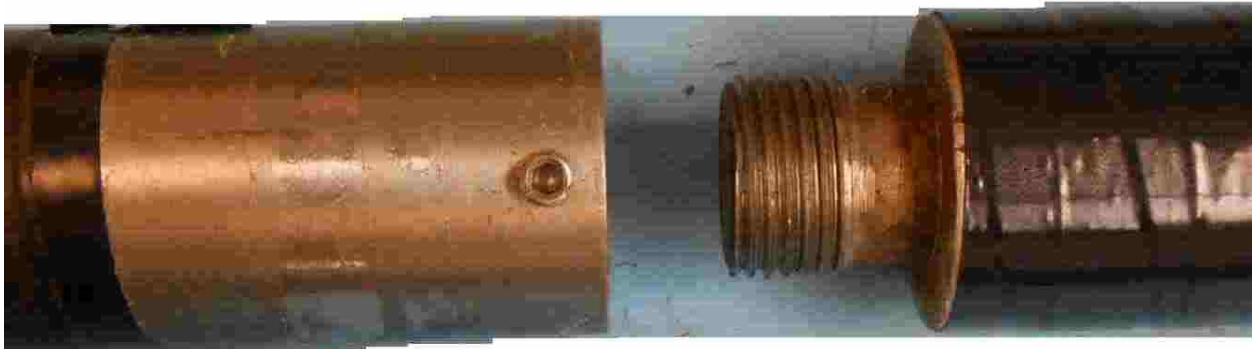
Installing the 2DDA-1000

Remove the thread protector from the probe top then thread the probe top onto the cable head of the winch assembly. Inspect the O-ring on the cable head for cuts or abrasions before each use to ensure an adequate seal. Use silicone lubricant on the O-ring when required and anti-galling compound on the threads as needed. Follow the operating instructions in this manual or in the logging software before logging in regards to this tool.

When operating SP, SPR mode attach the surface electrode to the logging system and plant the electrode in a mud pit or dug hole filled with water to insure good contact with earth.

4 π & 2GGA Gamma density measurement

Some versions of the HLP-2375 can be configured to have a GG-375 (p.n. 2GGA-1000) density source housing attached in place of the bottom electrode so that it can be used as a 4 π density measurement. Look for a joint between the housing and lower electrode section about 34 inches below the probe top. If there is a joint there will also be a set screw in the upper housing just above the joint used to lock the electrode section in place.



2DDA lower attachment point

When configured for density measurements at the factory the internal relay circuitry that connects the housing for SP, SPR measurements is disconnected and the probe top Delrin insulator is replaced by a solid stainless steel piece. This probe is available as a 2DDA-1000 bow spring 4 π density, or the HLP-G-2613 4 π density.

See the 2GGA-1000 operations manual (2GGA-Gamma-Gamma Sub.pdf) for more details.

Note: Use of the Cesium 137 source for this measurement requires a radioactive source handling license. Consult your licensing authority.

Operating Procedure

Operation

GAMMA MEASUREMENTS

Follow the instructions for the logger, and choose the correct tool driver file; turn the TOOL POWER to the ON position. Follow the logging instructions for the Matrix or MGXII logger to begin the logging process. When the logging process has ended, ensure that data recording and TOOL POWER is OFF before removing the probe from the cable head.

Warning: When lowering the probe do not let it free fall or touch bottom high rates of speed. Always slow the winch before reaching total depth. The probe housing joint uses fine pitch shallow threads necessary for the small housing material. Placing excessive force on the housing can drive the threads up over the attachment point causing the housing to bell out and possibly leading to a breach of the O-ring seal.

Performance Checks and Calibrations

Calibrations are performed at the factory and require a basic knowledge and understanding of the tool. In the event the user feels the tool needs to be calibrated it is advisable to speak with a representative of Mount Sopris. Performance checks for the gamma measurement can be made on the surface before logging. With the tool powered on and viewing data on the computer screen a small source of natural gamma radiation can be placed in close proximity to the detector area about 6 inches above the bottom of the probe. An increase in gamma counts will then be observed on the computer screen if the tool is working properly..

If a more in depth understanding of calibrations is required, below are some examples.

Gamma Calibration

There are presently two recognized facilities in the U.S.A. for primary calibration of gross count gamma ray logging systems:

1. The API Calibration Facility, Houston Texas.
2. The U.S. Dept. of Energy Facility, Grand Junction, Colorado.

API Calibration

The API gamma calibration model consists of (1) a very low activity zone and (2) a zone having approximately the same relative concentrations of uranium, thorium, and potassium as a typical shale bed and about twice the total activity. The API unit of activity is defined as 1/200 of the difference between the log response in the high activity zone and the low activity zone. According to this definition, the API unit is independent of tool type or other factors related to instrumentation.

U.S. Dept. of Energy Calibration Facility

The gross gamma ray calibration constant K which is used in the generally accepted formulae

$$GT = KA(\text{cps}\cdot\text{l})$$

(where G is the gross gamma ray equivalent uranium grade, T is the zone thickness, and A is the area under the log response curve) is determined from a log of Model N-3. The model consists of cylindrical zones having a diameter of 5 ft. The enriched zone is 4.19 ft thick and has an assigned grade of 0.24 percent equivalent U_3O_8 . System dead time is determined by logging one or more of the high grade U-1, U-2, and U-3 which have, respectively 2.48, 1.20, and 0.46 percent equivalent U_3O_8 assigned grades. Mount Sopris Instrument Company can provide K-factor calibrations on special request.

Quantitative interpretation of gamma ray logs require that the data first be corrected to standard conditions. The important corrections are:

- 1) Dead time
- 2) Borehole conditions

Dead time

The 2DDA probe has a fixed dead time of 5μ seconds and should be corrected for 6.25μ sec. using the formulae:

$$N_c = N_o / (1 - t * N_o)$$

where N_c = the corrected count rate

N_o = the observed count rate

t = the system dead time.

Borehole Corrections

The diameter of the well or drill hole as well as the nature of the borehole fluid affects the count rate measured in the hole. In an air filled hole, the caliper correction is small and usually neglected. However, for fluid-filled holes, the attenuation of the gamma ray intensity can be substantial.

In a similar manner, casing within a drill hole will attenuate the gamma ray flux from the formation and therefore a correction based on casing thickness and casing materials must be applied.

Field calibration

Field calibrators may be used to determine the stability of the gamma measurement using a low level radioactive source that can be held in a fixed position against the probe. The probe measurement can be affected by natural radiation in the ground or sources in the logging vehicle. For this reason, for calibrations to be repeatable, it may be necessary to hold the probe several feet above the ground and away from the vehicle.

Preventative Maintenance

The 2DDA Gamma Density requires little maintenance other than washing the probe off after each use. ***Never take the probe apart. This probe can be difficult to disassemble and requires special steps to be taken in order to gain access to the inside of the probe without damaging the electronics.***

Inspect O-rings occasionally and keep the threads on probe top clean to minimize future problems. If any of the probe top joints appear loose make sure you understand how they are attached before attempting to tighten them. Contact Mount Sopris if in doubt.

The heart of the gamma section is the Photo multiplier tube and the Sodium Iodide crystal. Both units are very fragile and can be damaged if the probe is dropped or sees very abrupt shock. Take great care while handling or packing the probe for transportation.

Troubleshooting

Problems with the Tool

In the event the tool develops a problem, follow the troubleshooting procedure listed below.

NEVER DIS-ASSEMBLE THE PROBE WITHOUT KNOWLEDGE OF PROCEDURE

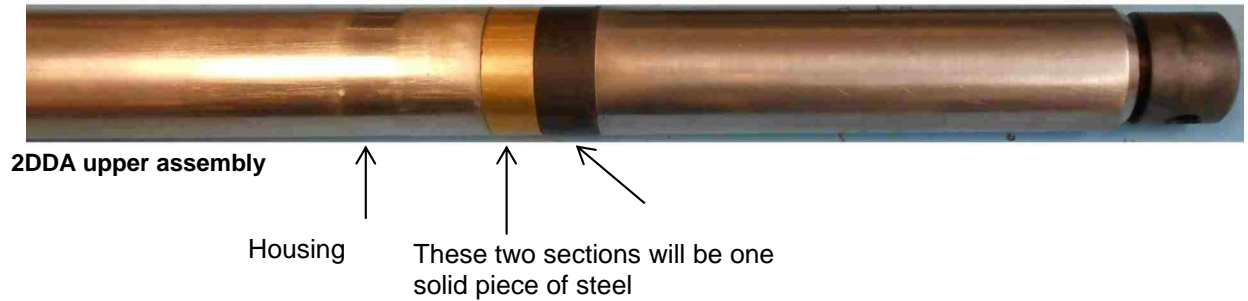
GAMMA Problems

1. No counts from the probe.
2. Is the correct tool configuration file selected?
3. When using Matrix or Logger software are the Tool Voltage and Current in the green area and correct?
4. Check cable for conductive leakage across the center conductor to ARMOR. (Readings should be greater than 20 million Ohms.)
5. Is the thread protector installed in the bottom of the probe in the stand-alone mode?
6. Is the logger supplying the correct voltage as specified in this document? Measure this on the end of the cable head with a voltmeter.
7. If above results are not correct or indeterminate consult Mount Sopris.

Disassembly Instructions

The 2DDA Gamma Probes should **never be disassembled** unless service is necessary. This is a difficult probe to disassemble, and is highly recommended that any service be performed by Mount Sopris or a qualified technician.

If probe must be entered first remove the PVC tape from the Delrin isolator section located just below the probe top. Unscrew the housing from the probe top and isolator section at the brass coupler taking care to not put too much force on the isolator section. The isolator can be damaged if too much force is applied across it. If a large amount of force is needed to break housing free from isolator ensure you anchor on the brass section right next to the top of the housing so isolator does not rotate.



Slide probe top with attached electronics out of housing. Use care with the fragile PMT and crystal inside. Reverse steps to re-assemble.

Schematics

Available upon request

HLP-2375/S

Drawing # 500S-0248

Title: SCH A1 - GAMMA

Drawing # 500S-0880

Title: MULTIVIBRATOR

Drawing # 500S-0876

Title: DYNODE MULTIPLIER BOARD

Appendix

Suggested QA Procedure

General notes for Quality Assurance are presented here for users who need to utilize these techniques when collecting data. These users will need to periodically calibrate their equipment using equipment whose calibration is traceable to an approved standard. Details of these calibrations must be recorded.

When an instrument is calibrated, records need to be kept regarding the calibration standard(s) used and what was changed on the instrument to calibrate it. Typically, the corrections made to the instrument involve changing constants that are used to scale the raw instrument reading so that the proper value is reported. The constants must be recorded during a calibration procedure. The Mt. Sopris family of Acquire programs records the calibration constants that were used to acquire the data. This aids the QA process, but does not replace the need for recording these constants at the time of calibration. The reason for this is that the length of time since the last calibration is unknown with only this information.

The device providing the standard must be traceable to an accepted standard. Examples of organizations providing standards for measuring instrumentation are: The U. S. National Bureau of Standards; The American Petroleum Institute; and the American Society for Testing Materials. For example, if the voltmeter or the density standard used for calibration is not traceable to an approved organization, such as those listed above, the calibration should not be considered valid. Records should be kept indicating the last time that standard being used for calibration was calibrated or checked against an approved standard. The QA procedure necessary for some programs mandate that the calibration standards be periodically checked against a standard approved by a proper agency.

A QA procedure may dictate that data taken from a given locale be associated with records indicating the exact time and location that the data was collected. The data itself may have to be collected in a certain format to meet requirements. Often, QA procedure specifies that surveys must be repeated and the data from the successive surveys compared. This technique is used to eliminate poor or invalid data.