AquaLocate™

Seismo-Electric Technology

GF6

Groundwater Assessment Technology for the 21st Century

(Optional 2D Automated Modeling Now Available)

Much of the information provided on the following pages can also be found at www.aqualocate.com

and www.findwellwater.com

AquaLocate, 5700 100th St SW Suite 330-194 Lakewood, WA 98499 800-251-2920

INTRODUCTION

There is a universal need for clean water. Only big cities and densely populated areas have piped water. Elsewhere aquifers often provide clean fresh water *via* boreholes. This water is nearly always derived from rainwater by downward percolation from the surface, from rivers, or by flow along rock layers from outcrop in adjacent hills or mountains. Sustainable groundwater supplies require a certain minimum annual rainfall, which varies depending upon many factors, especially runoff and evapotranspiration rates. Groundwater quality is also dependent upon aquifer geology, including the occurrence of soluble rocks. For example, limestone dissolves slowly and makes "hard" water. Gypsum and salt dissolve to give brines. Aquifers containing iron, such as many types of sandstone, may produce unacceptable water that causes brown staining.

In the past the only effective way to find groundwater supplies has been by drilling, often with a "dowser" providing an excuse to drill at a particular location. Drilling is an effective but costly exploration method. The modern oil industry grew in the early twentieth century when drilling was replaced by seismic as the principal exploration method. Seismic reduced exploration costs tenfold and oil exploration and development companies rapidly grew richer than the groundwater business, which is still locked into the use of magic, "dowsing", to fulfill an essential need. Dowsing is probably the only form of magic still believed in by a large proportion of the adult population. However, the only effective method for locating groundwater supplies in advance of the drill is based upon physics, rather than magic. Mostly Helmholtz and Clark Maxwell worked out the science in the nineteenth and early twentieth century. Seismoelectric signals were observed during experiments conducted during the fifties through the eighties and largely with oil industry support. These experiments were investigated by Dr. Clarke and Dr. Millar while still in the oil industry, causing them to decide to leave and set up Groundflow Ltd (in 1994) to promote seismoelectric technology.

GF developed the seismoelectric instrument the GF3500 which as in production until early 2012 and is an effective surface survey instrument (the GF6 is the newest update of the original GF3500) with its patented signal detection technology. GF's founders realized that even if the oil industry was not yet ready for seismoelectrics applications there should be a market for new groundwater exploration equipment. The GF6 is the result of a ten-year development program and fifteen-years of operation (headed up by Ervin Kraemer AquaLocate Founder) around the world. The seismoelectric system has been recently updated by AquaLocate to develop a even more effective, robust and affordable system. The system has been tested at thousands of locations in more than fifteen countries including the USA, Europe, Australia, New Zealand, the Middle East and India to name a few.

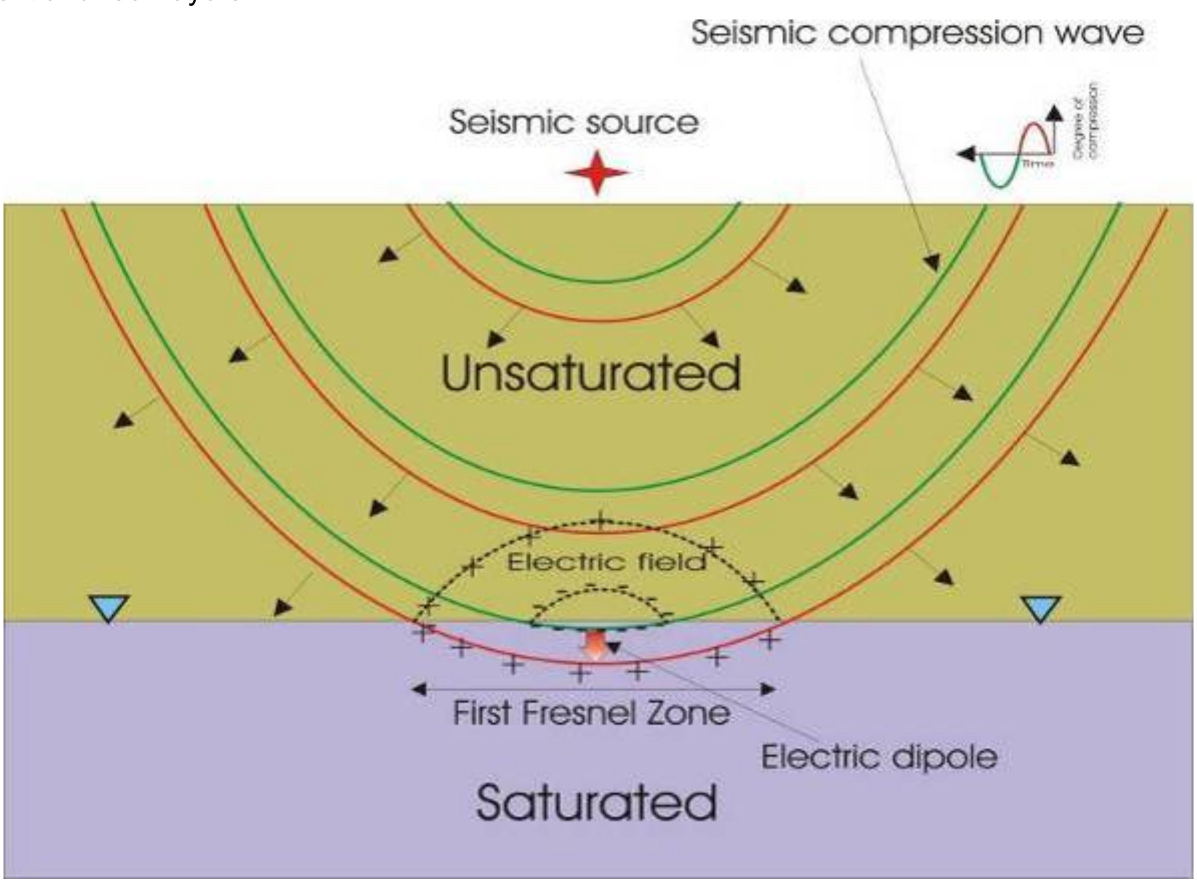
Seismoelectrics resembles seismic reflection surveying (seismic) but is a fundamentally simpler technique than seismic and uses simpler equipment.

To operate the GF6 you should know how to use a personal computer. However, you do not need to be a Geophysicist, Geologist, or Hydro Geologist to operate the equipment successfully. The processing is mostly automatic and unlike nearly all other geophysical techniques, if the target (groundwater or oil) is absent, there will be no signal. No freshwater filled permeable layers equal no reproducible signal; it's as simple as that, provided that the data has been collected properly. The equipment can only find aquifers it cannot create them. There are many places without producible potable water just as there are many places without oil wells.

OPERATING PRINCIPLE

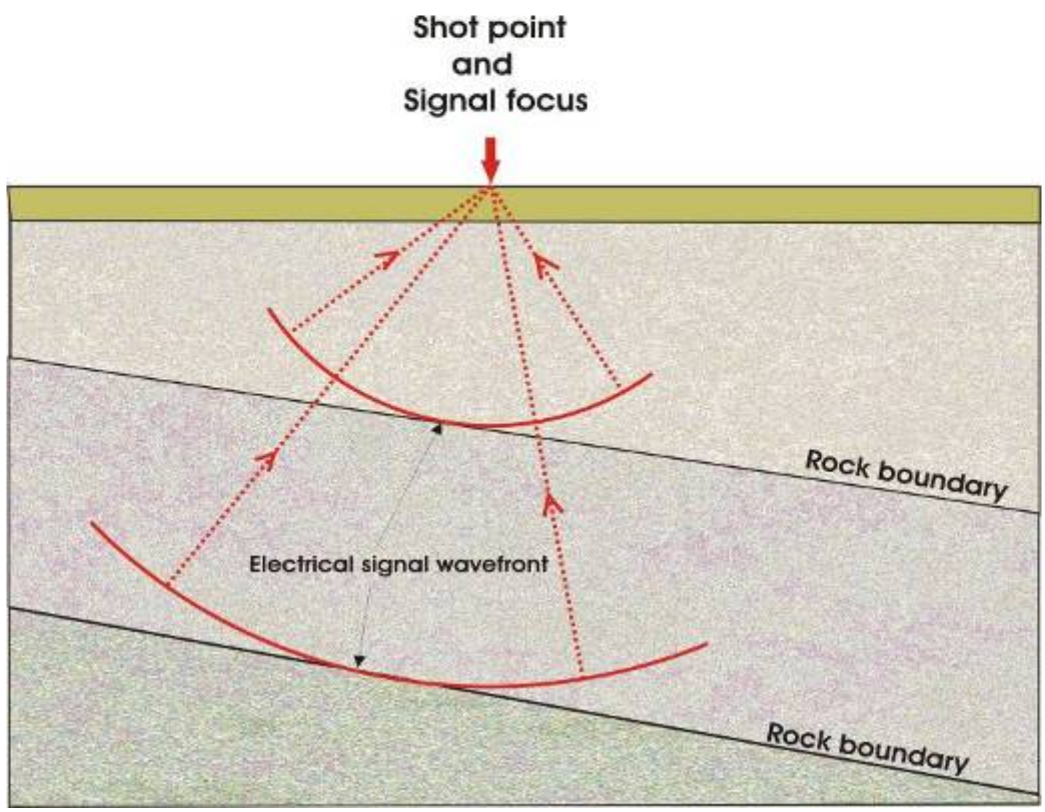
The GF6 receiver is designed to map aquifers by measuring the seismoelectric signals produced by them. Seismoelectric (or "electrokinetic") signals are produced whenever water is forced to move by the pressure changes associated with a seismic shot. As the sound wave from the shot moves through the ground it squashes the rock matrix rather like a sponge. The less-compressible water is forced to move relative to the rock matrix. Although the distance moved is very small, typically much less than a millimeter, the water carries free ionic charges away from their partners bound to pore surfaces. The resulting charge separation disturbs the electromagnetic field. The disturbance propagates to the surface at the speed of light and is detected by the antenna array, whenever the pressure pulse wave front crosses an interface separating rocks of differing properties; usually at bedding planes. There is extensive literature describing the formation and propagation of seismoelectric signals. Contact AquaLocate for details.

Signals are surprisingly strong. This is because of the geometry of the signal generating process, which *focuses* the signal back to the shot point. When a seismic shot is fired a sound impulse travels outwards in all downward directions. The hemispherical wave front (see diagram below) passes through different sediment and rock layers.

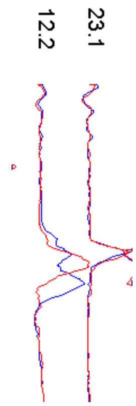


The sketch shows, at the lower left, the approximate shape of the sound pressure pulse. The initial part is strongly compressional, causing a positive pressure change. This is followed by a negative excursion.

The circular area encompassed by the leading edge of the pulse when the negative part is just intersecting the same layer is called the first Fresnel zone. This zone resembles the inner part of the "Fresnel lens" used in the rear window of many camper vans. The electrical response to the passing pressure wave adds up to zero when the sound passes through uniform rock but when it crosses boundaries, as between aquifer and non-aquifer rocks, or the water table, large changes in the response across the boundary give rise to a net signal that perturbs the static electromagnetic field. This perturbation propagates to the surface at the speed of light and is detected by the antenna array. The curvature of the wave front and the Fresnel geometry ensures that the signal is tightly focused back to the shot point. This is true whether the rocks are horizontal or inclined (see below).



When the rock layers are inclined they will appear shallower than they are. This effect is mostly small. It is possible to distinguish flat from inclined beds by examining the symmetry of the signals. Flat layers produce radially symmetrical signals, while they are radially anti-symmetrical from inclined layers. Here are signals from two adjacent shots illustrating anti-symmetrical (left) and symmetrical responses.



SIGNAL SYMMETRY

Characteristics of seismoelectric signals from aquifers are determined by:

1. *Rock permeability*. The ease with which the water can move in the rock - the better the aquifer, the greater the permeability and the faster the rise-time of the signal.
2. *Water salinity***.** Salty water is more conductive than fresh and tends to “short circuit” the seismoelectric signal generating process. Therefore the saltier the water the weaker the signals.
3. *The degree of layering of the aquifer*. Generally, in clastics aquifers (gravel, sand and mud), the coarser, more permeable aquifers often give stronger but less reproducible signals than the finer, less permeable but more bedded units. Limestone aquifers behave similarly. Bedded and relatively unaltered limestones generate reproducible signals. Limestones altered by weathering, karst formation, collapse and fracture enlargement give signals that are less easy to interpret.
4. *The velocity of sound in the rock layers down to and including the aquifer*. A simple velocity model is used to estimate both the depth and thickness of aquifer layers.
5. *Fluid composition*. If immiscible pollutants have entered the aquifer they may give rise to "bright spots” on the records. Natural oil and gas pools do the same.

EQUIPMENT OPERATION SPECIFICATION

The GF6 is designed for field operations from within a vehicle. The following specifications define the limits within which the equipment should be operated.

Operating Temperature	**0 to 50 degrees C in shade (direct sunlight should be avoided)**
Storage	**-20 to 50 degrees C**
Shock	**10G**
Vibration	**2G**
Power	**Dual USB from standard laptop**

The GF6 is powered by connecting it to a laptop or tablet computer using a one USB port. The GF6 can be synced with any Windows 7 or Windows 8 based laptop or tablet computer. If a laptop is not purchased from AquaLocate, we recommend the purchase of at least a semi-rugged laptop.

(AquaLocate provides a configured laptop as a purchase option)

EQUIPMENT LIST AND IMAGES

The following items are **not** provided by AquaLocate but are required for typical GF6 operation.

Electrode Template (Can use a reel type measuring tape)

Bosch 11245EVS or MAKITA HR5210C Roto Hammer (or equivalent)

Bosch SDS-Max ¾ inch Groundrod driver (Other manufacturers are available)

1.5" x 42" Relton SDS-Max Masonry Drill Bit (Other manufacturers are available)

Copper Clad Steel or Stainless Steel Electrodes (8 – 1.0m X ¾ in. diameter)

(0.75m and 1.25m have also been used successfully but are not commonly needed)

Stake puller system (One option is www.stakepuller.com (ask for the 7/8 inch puller)).

8 lb Sledge Hammer and 3 lb steel mallet

Small Generator (>2750Watts)

Garden Shovel & Flat Shovel

GPS (Garmin Etrex is commonly used)

Weather proof Cargo containers to keep supplies clean & safe

Survey Flags & Permanent markers to mark survey flags

10 and 12 gauge black powder blank shot gun ammo (Winchester Black Powder **Blank** Load, 6 Dram Eq. Powder, XBP12 and XBP10)

Round mouth vice grip pliers

Packing tape (For hammer & plate use)

Auto ranging multi-meter (ranges from $50-$75.00)

50 foot extension cord

Laptop for GF6 operation (If GF6 Option 2 is not selected)

(Minimum laptop requirements: Windows 7 Pro, 4GB Ram (recommend 8GB), 320GB Hard Drive, 12.1" LCD, 2.2GHz Intel Core Duo (recommend Intel Core i5), recommend Toughbook type laptop)

(Most of the above items can be found online or at major hardware or tool outlets)

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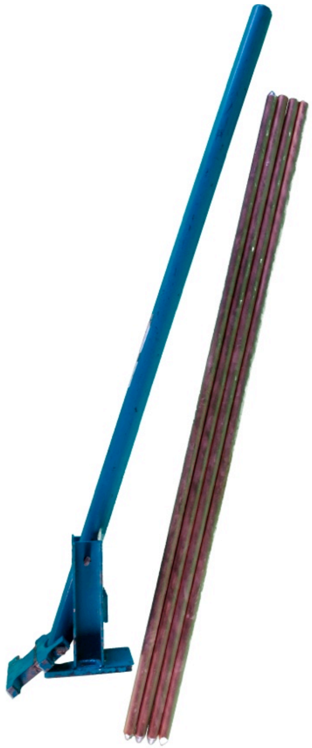

Electrode puller and electrodes.
(Copper clad or stainless steel electrodes recommended)

1.5” x 42” SDS-Max Drill bit.

3KW Generator.

Makita HR5210C Roto-hammer and SDS-Max groundrod driver.

Garden shovel and flat shovel.

Shallow Seismic Source and Trigger Cable.

6lb sledgehammer and 3lb steel mallet.

Round mouth vise grips and box tape.

Garmin Etrex and auto ranging multimeter.

100’ reel type measuring tape.

XBP10 and XBP12 black powder blanks.

Flags and permanent marker.

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FREQUENTLY ASKED QUESTIONS

Q: Who is responsible for manufacturing, distributing and training on the GF Seismoelectric (GF6) unit?

A: Ervin Kraemer of AquaLocate USA has been contracted to perform worldwide manufacturing, distribution, and R&D of the GF6 (and associated equipment) and training for new system operators - www.aqualocate.com

Q: Do I need training or can I just learn how to use the equipment with the operator's manual?

A: Using our equipment is not difficult but it's not intuitive. We consider it very important that at least one person per unit is trained on proper use and operation of the GF6.

Q: Does successfully operating the equipment require special knowledge or can anyone learn how to use the equipment?

A: We have successfully trained people from all walks of life; from a homemaker to a Geophysicist. Every individual who's taken our training program and followed recommended operating standards has gone on to become a successful operator of our Seismo-electric equipment. The only knowledge that is required is basic computer skills. Additionally, due to some of the physical requirements certain people with disabilities or physical limitations may need assistance operating the equipment.

Q: Are there any surface conditions where the system cannot be used?

A: The system works best when surface conditions are made up of native unobstructed surface material. For our purposes, "native unobstructed surface material" means and combination of undisturbed sand, clay, and/or silt combined generally with less than 30% rock material. The equipment has been used to successfully locate groundwater in conditions that don't meet these standards however; quality data collection can be much more difficult.

Q: Why do I need a generator?

A: The generator is used to provide power to the large roto hammer we use to install the electrodes and drill the hole in preparation for the buffalo source. The electrodes can be installed with a sledge hammer but we do not recommend that method due to the inconsistency of installation. Additionally a small diameter hand auger or shovel can be used to prepare for use of the buffalo source but these methods are time consuming and are not recommended.

Q: How successfully is this system at locating groundwater?

A: Success depends largely on proper use of the equipment and proper well construction techniques. Most operators of our systems don't get hired where groundwater is easy to locate and in many cases operators do work with their system after one or more dry wells have been drilled. We have had reports from operators around the world who have had success rates better than of 8 out of 10 new boreholes. At least one operator has indicated an overall success rate of better than 9 out of 10 new boreholes. Some of these operators indicated that the success rate of new boreholes before the use of our equipment was in some cases less than 4 out of 10.

Q: What is the life expectancy of the GF6 unit?

A: The life expectancy of the GF6 unit depends on proper care and use. We have operators who have been providing groundwater assessment with our systems since 2002 and are still using their original system. (Excludes cable repair or replacement.)

Q: Once I purchase a complete system with cables and seismic sources, can I build my own cables?

A: The only cable that cannot be reproduced is the antenna cable as it is part of the patented system.

Q: Is the GF6 system affected by electrical interference?

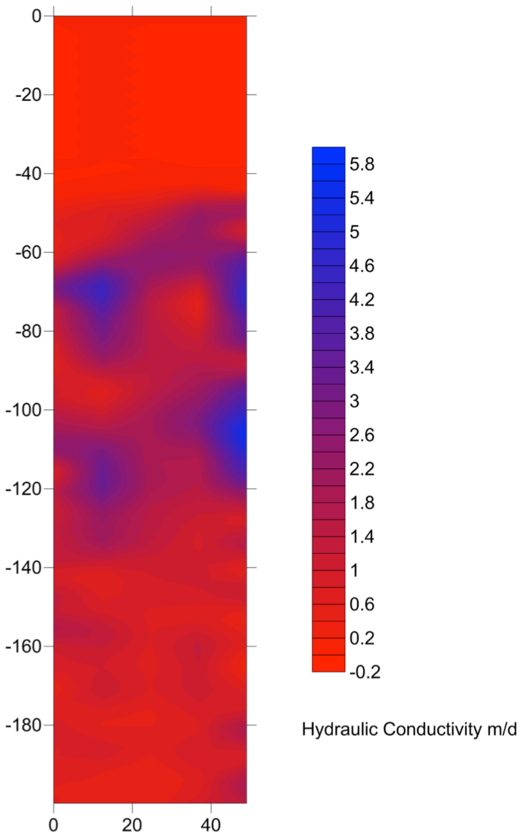
A: The GF6 system is sometimes affected by high levels of electrical interference if very close to the test sites but is rarely affected by residential electrical sources even if nearby or high voltage electrical sources as long as they are at least 20 to 35m (sometimes more) away from the test site. False positives will not occur even if high levels of electrical interference is encountered as long as the operator has been properly trained how to interpret the Seismoelectric data.

Q: How deep can the GF6 locate groundwater?

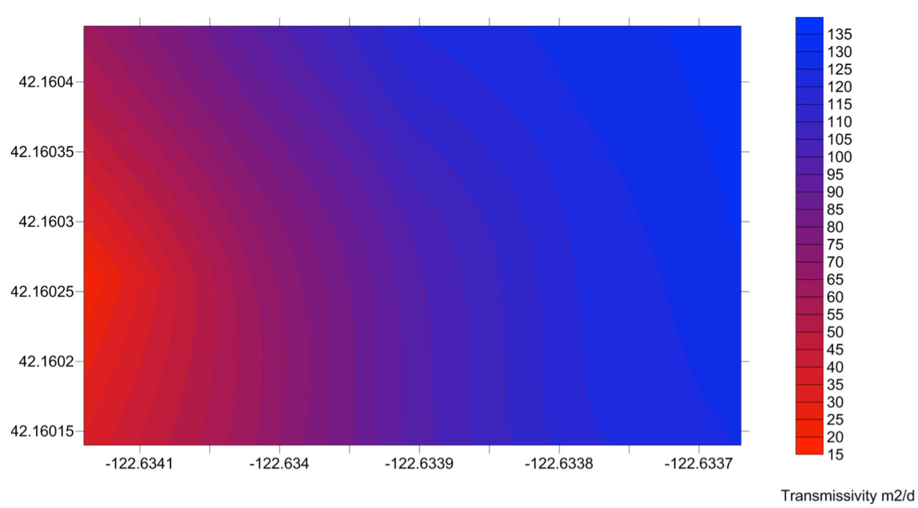
A: Using the Deep SFG (Seismic Frequency Generator) system, groundwater can be detected as deep as 500m (or more in ideal testing conditions). Operators have reported successful water wells drilled to as deep as 700m and have indicated detecting groundwater at existing boreholes to over 1000m. Limited testing with the GF6 has been accomplished on aquifers and/or oil reserves deeper than 1000m.

Optional Automated 2D Modeling

The GF6 is now available with optional automated 2D modeling of "Hydraulic Conductivity", "Transmissivity", and "Yield" calculations.



Sample of Hydraulic Conductivity 2D Map



Sample of Transmissivity 2D Map

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GF6 Seismo-Electric Equipment and Services

Excluding shipping, insurance, bank charges and Taxes due	USD $
Geophysical Systems:	
GF6 Seismo-Electric System Option 1 (Laptop Not Included)	$15,750
With 2D Mapping Option	$18,000
GF6 Seismo-Electric System Option 2 (Semi-Rugged Laptop Included)	$18,250
With 2D Mapping Option	$20,500

(Includes 1 Antenna Cable set, 1 Hammer trigger/cable set, 1 Magnetic Trigger/Cable and 1 Shallow SS (Seismic Source))

Optional Extras, Spares and Replacement Parts:

Deep SS (Seismic Source)	$2,500
Spare Hammer Trigger and Cable (recommended)	$400
Spare Antenna Cable Set (recommended)	$425
Spare Magnetic Trigger/Cable (recommended)	$250
Spare Shallow SS	$400
Base Plate for Shallow SS	$130
Deep SS Safety/Stabilizer	$225
2D Mapping Option	$2,250

Training (Travel costs for training away from Washington State will vary)

Basic GF6 Operation Training (2 Days) Per Person	$2,000
Advanced GF6 Operation Training (4 Days) Per Person	$3,000
Data Review/Interpretation Assistance (Per Hour) (0.5 hour minimum.)	$150

After Sales Servicing: (Shipping not included)

60 Day Back-to-base Limited Warranty	Free
2 Year Replacement Warranty (Covers the GF6 only)	$2,000
Onsite support (Covers 8 hour day, excludes travel costs)	$1,200 per day
Post warranty repair (parts not included)	$150 per hour
Data interpretation assistance (0.5 hour minimum. Not more than 16 sites per hour)	$150 per hour

(AquaLocate is the manufacturer and distributor of the GF6 and does not provide consultation, opinion or legal advice on or about the potential commercial/business use of the GF6 and associated equipment)

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