



Exploration & Production

GENERAL SPECIFICATION

GEOLOGY

GS EP GLG 301

GWD: Gas While Drilling acquisition and interpretation

00	07/03	First issue
Rev.	Date	Notes

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1. General aspects

The following technical specifications and recommendations to Surface Logging CONTRACTORS are considered as a minimum requirement for a better Gas data acquisition and storage in order to improve gas data interpretation while drilling using the GWD methodology.

These technical specifications are based on the instrumentation currently used by the main CONTRACTORS. Different methods and evolution for gas detection systems could be take into account and utilised after an appropriate technical evaluation.

Each CONTRACTOR is required to indicate the name of a gas data acquisition specialist in order to have a direct technical correspondence.

2. Reference documents

The reference documents listed below form an integral part of this General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the EFFECTIVE DATE of the CONTRACT.

Standards

Reference	Title
Not applicable	

Professional Documents

Reference	Title
Not applicable	

Regulations

Reference	Title
Not applicable	

Codes

Reference	Title
Not applicable	

Other documents

Reference	Title
Not applicable	

Total General Specifications

Reference	Title
Not applicable	

3. Gas Trap

3.1 Technical Specification

- Type: constant Volume Trap or closest equivalent (QGM, Floating etc.).
- The gas trap should not be situated downstream of any major steps or turbulent zones in the flowline.
- The gas trap should be located near the bell-nipple, taking into account the safety (equipment) and its accessibility (maintenance).
- Mud outlet below the mud level.
- Position the gas trap so that the flow carries the discharge mud from the gas away from the mud entry port.
- Position the gas trap where the flow of drilling fluid is smooth (not turbulent) to avoid the degassing of aerated mud.

Reference gas trap (Microwave oven, VMS, SSR or equivalent) not requested as standard.

3.2 Recommendations for all CONTRACTORS

- Develop a constant volume and rate gas trap.
- Develop a heating system from gas trap to analyser (minimum 70°C) in order to keep constant temperature in the gas chain.

4. Gas Line

4.1 Technical Specification

- Two independent gas lines (one active and one spare) preferably with continuous purge capability.
- Kept to a minimum length; thus, no loops or twists at anytime.
- Condensation collector on each gas line.
- No polyethylene (to avoid segregation effects of the gas components) or steel allowed for gas lines. PVC gas line is recommended.
- Gas line should be available for extreme temperatures (i.e. 5 – 40°C).
- Use an insulation system.
- Air inlet far from any pollution sources (such as rig engines).
- “Gas mixture + Air vector”: pressure and suction flow should be constant, according to the specification of the equipment, with a visual control into ML unit.

- Suction flow must be checked daily and each change must be reported on the Master (Mud) Log.
- Gas line diameter as small as possible (i.e. ¼" when using a QGM gas trap).
- Transit time through gasline: maximum 2 min depending on gasline diameter & length.
- Desiccant product: silicagel not allowed. Calcium Chloride is recommended.
- Gas injection at gastrap location is only to check that the line is not blocked, but not used for checking gasline efficiency.
- T-valve with hypodermic needle for vacutainer samples.

4.2 Recommendations for all CONTRACTORS

4.2.1 Suction rate measurement

The suction rate can be measured using a simple and quick method.

The "tool" is a plastic bottle (1.5 litres) with open bottom and a "T" connection at the top. On the external part of the body it must be marked 1000 cc. While the suction pump is working, the gas line is connected to one of the "T" holes, then the bottom open end of the bottle is gently dipped in a can filled with water. At the same time the second "T" hole must be plugged simply using a finger and the water level will rise up to 1000 cc marker. The water transit time between the bottom and the marker must be carefully monitored using a chronograph.

The final result will be defined using the equations:

$$\text{Suction rate (litres/minute)} = 60 \text{ (sec)} / \text{water transit time (sec) up to 1000cc}$$

This can be considered as a satisfactory first approximation suction rate.

5. Analysers

5.1 Gas Detector

5.1.1 Technical Specification

- Type: FID for hydrocarbon gases.
- Eventually TCD type for acid gases (CO₂, H₂S), not yet proved for GWD analysis.
- Type of analysis: Total hydrocarbon Gas continuous/semi-continuous measurement (in equivalent methane in air).
- Sampling rate no more than 15 sec.
- Measurement unit: % or ppm. TG values stored in ppm unit into database but values should be displayed in percentage on detector front panel.
- Accuracy: +/- 5% (Relative error between observed values and true values) (see glossary).
- Resolution: 10 ppm. (Smallest variation in the gas composition which produces a detectable change in the signal) (see glossary).
- Transit Time from gas trap to TG detector to be checked routinely.

- Visual and audible alarms set on TG inside the unit (alarms threshold to be fixed according to COMPANY request).
- The systematic computation of NTG (Normalised Total Gas) uses the following formula:

$$\text{Normalised Gas (m}^3\text{/m}^3\text{)} = 14.71 \cdot (\text{TG} \cdot \text{Flow Rate} \cdot 0.2642) / ((\text{ROP} \cdot 3.281) \cdot (\text{Bit Size}^2))$$

Where:

- TG = Raw Total Gas (%)
- ROP = Rate of Penetration (m/h)
- Flow Rate = l/min
- Bit size = inch

5.1.2 Calibration

- Unit: compulsory in equivalent methane in air (EMA) using calibration bottles with only methane (do not use multicomponents mixtures).
- Type:
 - Master calibration using minimum of 3 points at different methane concentration (C1 = 1 000, 10 000 and 100 000 ppm).
 - Calibration check using 2 points at different methane concentration (C1 = 1 000 and 100 000 ppm).
- Frequency: master calibration must be performed before the Spud In (in the CONTRACTOR's base or laboratory or at wellsite). A master calibration chart has to be provided by the CONTRACTOR to the COMPANY representative at wellsite for unit acceptance.

Calibration check must be performed 1 per trip to surface or 1 per drilling phase. Minimum once a day. In case the calibration check gives bad results (exceeding the required accuracy range), a new master calibration must be performed at wellsite.

- Policy: no manual dilution allowed. Calibration gas bottles are compulsory.

Calibration bottles have to be provided by CONTRACTORS. Each new set of calibration bottles (new serial number and date) could be certified by COMPANY's laboratories (one bottle for each set).

Calibration bottles must be stored inside the unit.

Injection from front panel.

5.2 Recommendations for all CONTRACTORS

- Develop two active gas chains (with the same technical characteristics) for the measurement of Gas Out and Gas In.
- Develop new methods to improve lag time check (tracers) combining drilling constraints and safety.

6. Gas Chromatograph

6.1 Technical Specification

- Type: FID (Eventually TCD type, not yet proved for GWD analysis).
- Type of analysis: Chromatographic analysis from C1 to nC5.
- Use high resolution gas chromatograph with a cycle time maximum 90 sec (C1-nC5).
- Measurement unit: ppm.
- Component values computed using peak areas (do not use peak height).
- Accuracy: +/- 5% (Relative error between observed values and true values) (see glossary).
- Resolution: 1 ppm (Smallest variation in the gas composition which produces adetectable change in the signal) (see glossary).
- Threshold of quantifiable value: 10 ppm (see glossary).
- Saturation limit must be clearly defined.
- C1/C2 separation capacity: ratio minimum requested value = 200, recommended = 500.
- Each tool (main and/or backup) has to be identified by CONTRACTORS (serial number, technical specifications & characteristics including software version used) before well spuding.
- Displayed on front panel: oven Temperature, sample pressure and flow. It is recommended to insert these data on the database.
- Type and version have to be recorded on database and displayed on Master (Mud) Log document.
- No gas sample must be trapped into chromatograph for later analysis to avoid possible gas alteration/deterioration.
- It is required the possibility to display or print the chromatograms on request.

6.2 Calibration

- Type:
 - **master calibration:** minimum 3 points using gas mixture (C1-nC5) at known components concentration (with C1 = 100, 1 000, and 100 000 ppm).
 - **calibration check:** 1 point using gas mixture (C1-nC5) at known components concentration (with C1 = 10 000 ppm).
- Frequency: master calibration must be performed before spuding (in the CONTRACTOR's base or laboratory or at wellsite). A master calibration chart must be provided by the CONTRACTOR to the COMPANY representative at wellsite for unit acceptance.
- Calibration check must be performed 1 per trip to surface or 1 per drilling phase. Minimum once per day. In case the calibration check gives bad results (exceeding the required accuracy range), a new master calibration must be performed at wellsite.
- Policy: no manual dilution allowed. Calibration gas bottles are compulsory.

Calibration bottles must be provided by CONTRACTORS. Each new set of calibration bottles (new serial number and date) could be certified by COMPANY's laboratories (one bottle for each set). Calibration bottles must be stored inside the unit.

Injection from front panel.

6.3 Recommendations for all CONTRACTORS

- In order to increase the peak separation capability, it is recommended the use of hydrogen as carrier.
- Use small size calibration bottles (1 to 5 litres) stored horizontally in order to avoid gas segregation problems.
- Storage of all chromatograms in the Unit computer system data base.
- Analysis of gas sample from formation test (DST, RFT, MDT etc.):
 - Dilute the gas sample according to the gas chromatograph saturation specification.
 - Before analysis run a calibration check using a gas mixture (C1-nC5) with C1 = 100 000 ppm.

7. Data Management

7.1 Database

- Compulsory: both time and depth database.

7.2 Versus Depth

- Sampling rate: maximum every 50 cm, recommended every 20-25 cm.
- List of parameters compulsory to be recorded versus depth.

Label indicator	Standard units of measure	Description	Note
Depth	m (or ft)	Depth	
Depth TVD	m (or ft)	Depth TVD	
TG	ppm	Total Gas	TG & chromatographic data must be referred at the same sampling depth
C1	ppm		The highest C1 value recorded in the depth interval
C2	ppm		Value associated to the C1 value of the same chromatographic cycle
C3	ppm		As above
iC4	ppm		As above
nC4	ppm		As above
iC5	ppm		As above

Label indicator	Standard units of measure	Description	Note
nC5	ppm		As above
ROP	m/h (or ft/hr)	Rate of Penetration	
FLOW IN	l/min	Flow IN	From pump stroke or flowmeter
FLOW OUT	l/min	Flow OUT	From flowmeter
MW IN	g/l	Mud Weight IN	
BIT SIZE	inch	Bit size	
WOB	ton	Weight on bit	
Losses	mc/h	Mud Losses	Mud Losses Rate
SPP	Kg/cm ²	Stand Pipe Pressure	
TORQ	Kgm	Torque	
RPM	rpm	Revolution per minute	
TRPM	rpm	Revolution per minute	Motor + rotary/top drive

- Depth database without gas events as: Trip gas, PCG, calibration etc.
- Prepare a file containing these special gas events (Trip gas, PCG, calibration, etc.).

7.3 Versus Time

- Sampling rate optimised with Total Gas sampling rate requirement.
- List of parameters compulsory to be recorded versus time.

Label indicator	Standard units of measure	Description	Note
TIME	sec		
BITPOS	m (or ft)	Bit positions	
Depth	m (or ft)		
LDepth	m (or ft)	Lag depth	
ROP	m/h (or ft/hr)	Rate of Penetration	
WOB	ton	Weight on bit	
WOH	ton	Weight on hook	
RPM	rpm	Revolution per minute	
TRPM	rpm	Revolution per minute	Motor + rotary/top drive
TORQ	Kgm	Torque	
MW IN	g/l	Mud Weight IN	
MW OUT	g/l	Mud Weight OUT	

Label indicator	Standard units of measure	Description	Note
FLOW IN	l/min	Flow IN	From pump strokes or flowmeter
FLOW OUT	l/min	Flow OUT	From flowmeter
SMP1	nr	Pump strokes	
SMP2	nr	Pump strokes	
SMP3	nr	Pump strokes	
SPP	Kg/cm ²	Stand Pipe Pressure	
TV01	m ³	Active Volume Suction Pit	
TVO2	m ³	Active Volume Trip Tank	
TG	ppm	Total Gas	
C1	ppm		
C2	ppm		
C3	ppm		
iC4	ppm		
nC4	ppm		
iC5	ppm		
nC5	ppm		

7.4 Data Storage

- All acquired data (both versus depth and time) shall be stored systematically on CD-ROM in ASCII format. The CD-ROM shall be delivered to COMPANY at the end of the well activities or on COMPANY request.
- 2 copies requested (Subsidiary and HQ).



Appendix 1 Technical glossary

Accuracy

It is the difference between the measured value and the true or actual value of the gas (total or components) being measured.

It is represented as a percentage and can be expressed in % of reading.

Resolution

The smallest variation in the gas composition which produces a detectable change in the output signal. It can be also defined as the minimum difference between two discrete values that can be distinguished by a measuring device (Total gas detector and gas chromatograph).

It is expressed in absolute value.

Threshold value

The minimum detectable quantity but not quantifiable.

Threshold of quantifiable value

The lowest content on which accuracy and resolution can be applied.

Appendix 2 Gas vacutainer sampling

Sampling procedures

- Type: gas
- Sampling interval: constant sampling rate according to the operational program (i.e. each 10 meters) or when the quantity of gas is the double of the background gas.
- Type of container: Vials (20 ml) closed under vacuum (can be provided by the COMPANY).
- Provide T-valve with hypodermic needle for vacutainer samples.
- Sampling the gas on the gas line, located in the unit, before the analysers.
- The sampling pressure must be the normal pressure of analysers.
- Labelled, with permanent marker pen, on each vial: COMPANY name, Well name and number, depth of collection, date and hour.
- Repeat the sampling operation in order to obtain 3 different vacutainer vials.