

Gasunie Technical Standard

Material Specification
Instrumentation

MSM-05-E

Field gas chromatograph

External

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N.V. Nederlandse Gasunie

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Material Specification Instrumentation
MSM-05-E

Field gas chromatograph

This specification is drawn up by the Gasunie department
"Operations; Techniek - Elektro, Instrumentatie en Proces"
(Operations; Technology - Electrical, Instrumentation and Process).

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FOREWORD

This specification supersedes the sixth version of MSM-05-E and has been completely revised.

With respect to the former version:

- the specification regarding supply voltage has been adjusted;
- specifications regarding EX have been adjusted;
- maximum analysis range of Hydrogen is adjusted;
- introduction of renewables.

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1. SCOPE AND APPLICATION

1.1 Scope

This specification specifies the technical requirements that field gas chromatograph systems shall meet.

1.2 Application

This specification is applicable to all field gas chromatograph systems for gas service.

2. REFERENCES

This specification is subject to the requirements of the documents mentioned in this clause.

2.1 Standards

In this specification reference is made to the standards¹ mentioned in this subclause. Any supplements and errata notices are also applicable.

EN 60654-1	Industrial-process measurement and control equipment; operating conditions; part 1: climatic conditions.
NEN-EN-IEC 60529	Degrees of protection provided by enclosures (IP code).
NEN-EN-IEC 61000-4-2	Electromagnetic compatibility (EMC) - Part 4-2: Testing and measuring techniques - Electrostatic discharge immunity test.
NEN-EN-IEC 61000-4-3	Electromagnetic compatibility (EMC) - Part 4-3 : Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test
NEN-EN-IEC 61000-4-4	Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test.
NEN-EN-IEC 61000-4-5	Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test.
NEN-EN-IEC 61000-4-6	Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields.
NEN-EN-IEC 61000-4-7	Electromagnetic compatibility (EMC) - Part 4: testing and measurement techniques; section 7: general guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto.
NEN-EN-IEC 61000-4-8	Electromagnetic compatibility (EMC) - Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test.
NEN-EN-IEC 61000-4-9	Electromagnetic compatibility (EMC) - part 4: testing and measurement techniques; section 9: pulse magnetic field immunity test.
NEN-EN-IEC 61000-4-10	Electromagnetic compatibility (EMC) - part 4: testing and measurement techniques; section 10: damped oscillatory magnetic field immunity test.

¹ Applicable for all NEN-EN standards: Depending on the country where the standard will be applied, DIN-EN or BS EN, for example, shall be chosen.

NEN-EN-IEC 61000-4-11	Electromagnetic compatibility (EMC) - Part 4-11: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests for equipment with input current up to 16 A per phase
NEN-EN-IEC 61000-6-2	Electromagnetic compatibility (EMC); Part 6-2: Generic standards - Immunity standard for industrial environments.
NEN-EN-IEC 61000-6-4	Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments.
NEN-EN-ISO 10723	Natural gas - Performance evaluation for analytical systems.
NEN-EN-ISO/IEC 17025	General requirements for the competence of testing and calibration laboratories.
NEN-EN-ISO 6974-* (* all parts) ¹	Natural gas - Determination of composition and associated uncertainty by gas chromatography; Part 1: General guidelines and calculation of composition. Part 2: Uncertainty calculations. Part 3: Precision and bias. Part 4: Determination of nitrogen, carbon dioxide and C1 to C5 and C6+ hydrocarbons for a laboratory and on-line measuring system using two columns. Part 5: Isothermal method for nitrogen, carbon dioxide, C1 to C5 hydrocarbons and C6+ hydrocarbons. Part 6: Determination of hydrogen, helium, oxygen, nitrogen, carbon dioxide and C1 to C8 hydrocarbons using three capillary columns.
NEN-EN-ISO 6976	Natural gas - Calculation of calorific values, density, relative density and Wobbe index from composition.
NEN 1010	Elektrische installaties voor laagspanning - Nederlandse implementatie van de HD-IEC 60364-reeks (Electrical installations for low-voltage - Dutch implementation of the HD-IEC 60364-series).

2.2 Government rules

In this specification reference is made to the following Dutch government rules:

- [Meetcode gas LNB](#) published by ACM – Autoriteit Consument & Markt.

¹ For NEN-EN-ISO 6974 is the range for Hydrogen 0 % - 0,5 %.
This range will be extended to 20 % Hydrogen in this specification.

3. DEFINITIONS, ABBREVIATIONS AND SYMBOLS

3.1 Definitions

In this specification the following definitions will be applicable:

Client	The person or persons who is/are responsible, on behalf of Gasunie, for supervising the fulfilment of the contract in general and the execution of the work in particular.
Gas chromatograph	A system comprising an analyser and control unit, whether integrated or as separate units, used for the analysis of (natural) gas.
Prescribed validation	Validation prescribed by the Client in accordance with which the Service provider can only continue the work, on the relevant subject, following formal "acceptance" by the Client.
Service provider (Supplier)	The party with whom the contract is or will be concluded.
Validation ¹	The alignment of expectations demonstrating that the intended purpose will be achieved within the defined set of requirements with the process and/or product in question.
Verification ²	Demonstrating, by means of evidence, that the product or the action corresponds to the requirements set (has the product been made correctly/has the action been carried out correctly).

3.2 Abbreviations

In this specification the following abbreviations will be applicable:

EMC	Electromagnetic compatibility
GC	Gas chromatograph
GTS	Gasunie Transport Services
MLC	Multi-Level Calibration
FAT	Factory Acceptance Test
SAT	Site Acceptance Test
RED	Requirement for Documents

¹ A validation is, by definition, initiated by the Service provider, except for validation prescribed by the Client "prescribed validation".

² Verification is initiated and/or carried out by the Service provider.

3.3 Symbols

In this specification the following symbols will be applicable:

<u>Symbol</u>	<u>Description</u>	<u>Unit¹</u>
$b_0, \dots, b_3$	Coefficients of the multi-level polynomial of component i	1
d	Relative density	1
F_i	Relative response factor from component i relative to propane	1
H_I	Inferior calorific value ²	MJ/m ³ (n)
H_S	Superior calorific value	MJ/m ³ (n)
RW_i	Response factor component i	1
W	Wobbe index referred to superior calorific value	MJ/m ³ (n)
$X_{cal,i}$	Concentration of component i in the calibration gas	mol%
X_i	Unnormalised concentration of component i	mol%
$X_{i,norm}$	Normalised concentration of component i	mol%
X_p	Unnormalised concentration of propane	mol%
Y	Measured response	1
Y_i	Measured response of component i	1
Y_p	Measured response of propane	1
Z_n	Compressibility factor under normal conditions	1
ρ_n	Normal density	kg/m ³ (n)
$\Sigma_{\text{fixed components}}$	Sum of all fixed components	mol%
ΣX_i	Sum of all unnormalised direct and indirect components	mol%

¹ (n) conditions for a gas volume at 0 °C and 1,01325 bar.

² Calorific value is based on 25 °C.

4. REQUIREMENTS

4.1 Mechanical

4.1.1 Environmental

The temperature requirements that apply to electrical installations, equipment and materials are defined in [EN 60654-1](#). The following classes apply:

- indoor installation: class C2: -25 °C u/i +55 °C (ventilated);
- outdoor installation: class D1: -33 °C u/i +40 °C.

The solar radiation requirements that apply to electrical installations, equipment and materials are defined in [EN 60654-1](#). The following class applies:

- outdoor installation: class D1: 1 120 W/m².

The relative humidity (r.h.) requirements that apply to electrical installations, equipment and materials are defined in [EN 60654-1](#). The following classes apply:

- indoor installation: class C2: 10 % u/i 100 % r.h. (ventilated);
- outdoor installation: class D1: 15 % u/i 100 % r.h.

The enclosure of the analyser shall meet the requirements of at least IP54 in accordance with [NEN-EN-IEC 60529](#).

4.1.2 Gas connection

Gas connections on the GC are Gyrolok metric or NPT.

4.2 Electrical

The GC shall meet the requirements stated in [NEN 1010](#).

4.2.1 Power

The power to the GC will be supplied from the public mains supply:

- 220 V a.c. - 240 V a.c., 50 Hz;
- consumption: maximum of 3500 VA

After power failure the GC shall restart automatically.

4.2.2 Electromagnetic compatibility (EMC)

4.2.2.1 Emission

All electrical installations, systems and equipment applied at Gasunie shall comply with [NEN-EN-IEC 61000-6-4](#).

4.2.2.2 Immunity

Product standards:

If a product standard is available this product standard shall be applied.

Generic standards:

If no product standards are available installations, systems and equipment shall comply with [NEN-EN-IEC 61000-6-2](#). In this standard reference is made to the [NEN-EN-IEC 61000-4-2](#) up to and including [NEN-EN-IEC 61000-4-11](#) standards. The test levels are defined in the various sections of [NEN-EN-IEC 61000-4](#)-series. The environment in which all systems will be situated is defined as industrial (test level 3).

4.3 Fabrication

4.3.1 Labelling

Label all components used in the GC according to the manufacturer's drawings; including settings and process data.

Label the GC with the following data:

- labels obliged by law;
- manufacturer's name or mark;
- serial number;
- year of manufacture.

4.4 Explosion safety

The analyser is suitable for placement in a hazardous area (zone 1, zone 2) and safe area.

The following types of protection are allowed:

- intrinsic safety (Ex ia or Ex ib);
- increased safety (Ex e);
- combination of pressure-resistant housing (flameproof) and an increased safety (Ex de);
- pressure-resistant housing (flameproof) equipment (Ex d).

4.5 Functional

4.5.1 Gas stream selection system

The GC shall be provided with a gas stream selection system. The gas stream selection system shall be capable of selecting the following three separate streams:

- process gas;
- test gas (certified natural gas);
- calibration gas (Gravimetrically prepared with 7 components).

Note:

Above mentioned gasses will be provided with a maximum pressure of 1 bar (e).

The stream selection system shall be:

- a block and bleed valve system;
- mounted on or as close as possible to the GC;
- selected automatically or manually selectable by an operator.

Note:

A running calibration sequence shall not be interrupted by selecting a test or a process gas analysis.

4.5.2 Gas consumption

4.5.2.1 Carrier gas

The carrier gas shall be an inert gas (helium, hydrogen and/or argon).
The analyser shall not consume more than 25 ml/min per module.

4.5.2.2 Calibration gas and process gas

The GC shall not consume more than 50 ml/min of calibration or process gas (fast loop not included).

4.5.3 Control unit

The control unit shall provide the following functions:

- password protection;
- set-up and adjustment of parameters;
- control of the stream selection system (minimal 3 streams);
- control of the analyser;
- calculation of calibration lines;
- use of multi-level calibration ([NEN-EN-ISO 10723](#)) in combination with a single point calibration (see annex A);
- presentation of all data from the analyser;
- calculations on data from the analyser;
- generation of reports:
 - general configuration settings;
 - method;
 - calibration results;
 - analysis results.
- generation of chromatograms;
- saving analyses for a defined period, minimal 30 days;
- control of the analyser via direct interface;
- indication of the start and end of the calibration and the test gas procedures.

Present above mentioned data via a software package supplied with the GC.

4.5.3.1 Software package

The control unit shall be delivered with a software package.

This software package shall:

- be license free;
- be able to operate the control unit;
- be able to present data mentioned in subclause 4.5.3;
- be able to communicate via the intra company IT-network of Client.

Note:

Communication externally of the intra company IT-network of Client is not allowed.

4.5.3.2 Calculations of data from the analyser

The control unit shall provide the following calculations:

- component concentrations by using a calibration point or multi-level polynomial according to [NEN-EN-ISO 6974](#);
- calibration factors and/or response factors;
- superior (gross) calorific value (H_s);
- inferior (net) calorific value (H_i);
- relative density (d);
- normal density (ρ_n);
- superior (gross) Wobbe index referred to superior calorific value (W);
- component concentrations as listed in table 1;
- compressibility factor (Z_n).

Perform the calculation of the component concentrations in accordance with [NEN-EN-ISO 6974](#).

Perform in accordance with [NEN-EN-ISO 6976](#):

- calculation of superior and inferior calorific value;
- relative density;
- normal density;
- Wobbe index, and
- compressibility.

4.5.3.3 Input/output facilities

The GC shall have the following input/output facilities:

- two analogue outputs;
- one summary alarm output;
- one calibration active output;
- one Ethernet data communication port (see also 4.5.3.4);
- one communication port for maintenance/external calibration apparatus (common industrial standard, preferably Ethernet).

Note: Maintenance/external calibration and data communication port may be combined).

Analogue outputs

The analogue outputs shall be in the range of 4 mA - 20 mA. All analogue outputs shall be freely programmable.

Summary alarm output

The summary alarm output is a non-latching fail-safe contact.

4.5.3.4 *Communication protocol*

The communication protocol shall be a common industrial standard.

In the communication protocol the following components shall be available:

- all component concentrations (normalised) for the fixed and measured components (see table 1);
- all physical properties (H_s , H_I , d , ρ_n and W);
- compressibility factor (Z_n);
- unnormalised sum;
- response factors/concentrations per component per (calibration) analysis cycle;
- stream number;
- status information:
 - is calibrating;
 - is running test gas analysis;
 - is in operation.
- alarms indicating if the GC analysis is valid or not:
 - has an analyse fail;
 - has a calibration fail;
 - response factors are out of limit.
- method information: integration settings, peak settings, calibration lines and the like.

It shall be possible to synchronise the time and date information.

The use of maintenance software shall not disrupt the communication from/to other programs.

4.6 **Metrological**

4.6.1 **Analysis**

The analysis cycle time including calculations shall be less than fifteen minutes.

The GC shall be capable of measuring the components in agreement with [NEN-EN-ISO 6974](#) over the ranges according to the [Meetcode gas LNB](#) and future requirements given in table 1.

Table 1: Components and analysis ranges

Component	Analysis ranges	
	Minimum mol%	Maximum mol%
Methane	65,0	96,0
Ethane	0,20	11,0
Propane	0,10	4,00
2-methyl propane (isobutane)	0,01	0,90
Normal butane	0,01	0,90
2,2 dimethyl propane (neo-pentane)	0,001	0,50
2-methyl butane (isopentane)	0,001	0,60
Normal pentane	0,001	0,60
C6+ ¹⁾	0,001	0,50
Nitrogen	0,30	17,0
Carbon dioxide	0,20	11,00
Hydrogen	0,01	20,0
Helium	0,005	0,1
Carbon monoxide	0,01	0,3
Oxygen ²⁾	0,001	1,0
Argon ²⁾	0,001	5,0

¹⁾ C6+: pseudo component of the combined concentration of C6 to C8 components.

²⁾ If Oxygen and Argon are combined it shall be possible to implement the ratio.

Table 2: GC configurations

To be measured	Variant 1	Variant 2	Variant 3
Methane	x	x	x
Ethane	x	x	x
Propane	x	x	x
2-methyl propane (isobutane)	x	x	x
Normal butane	x	x	x
2,2 dimethyl propane (neo-pentane)	x	x	x
2-methyl butane (isopentane)	x	x	x
Normal pentane	x	x	x
C6+	x	x	x
Nitrogen	x	x	x
Carbon dioxide	x	x	x
Hydrogen		x	x
Helium ¹⁾		x	x
Carbon monoxide		x	x
Oxygen		x	x
Argon			x ²⁾

¹⁾ Depending on the configuration of the GC, helium will be a direct component or a fixed component.

²⁾ Can be combined with Oxygen. In that case it shall be possible to implement the ratio.

The direct components are the components which shall be calibrated with a calibration gas:

- methane;
- ethane;
- propane;
- 2-methylpropane (iso-butane);
- normal butane;
- nitrogen;
- carbon dioxide;
- hydrogen;
- carbon monoxide.

The indirect components are:

- 2,2 dimethyl propane (neo-pentane);
- 2-methyl butane (iso-pentane);
- normal pentane;
- oxygen;
- argon;
- C6+.

These components will be related to a bridge component (selectable) with relative response factors. For each variant (see table 2) of GC there shall be one uniform set of relative response factors for the complete range of concentrations.

4.6.2 Accuracy

The method for establishing the various systematic and random errors shall be in accordance with the performance evaluation described in [NEN-EN-ISO 10723](#). The outcome of the performance evaluation serves as advice to choose the way of calibrating the GC to match the stated uncertainty. The maximum allowable systematic and random errors in measuring the components and physical properties are defined in the following subclauses.

4.6.2.1 Physical properties

The maximum allowable relative systematic difference, the maximum allowable random error and the rounded overall maximum allowable error for the various physical properties are listed in table 3.

Table 3: Allowable error in various physical properties*

Calculation	Max. random error (see note 1)	Max. systematic error (see note 2)	Max. overall error (see note 3)
Superior calorific value	0,10 %	0,15 %	0,20 %
Wobbe index	0,14 %	0,20 %	0,25 %
Relative density	0,10 %	0,15 %	0,20 %

*) These errors are given for a confidence interval of 95 %

Notes:

- 1: maximum allowable random error.
- 2: maximum allowable relative systematic error.
- 3: rounded overall maximum allowable error.

Calculate the various physical properties according to the method described in [NEN-EN-ISO 6976](#).

4.6.2.2 Component concentrations

Define the maximum systematic difference with a test gas certified by an [NEN-EN-ISO/IEC 17025](#) accredited laboratory. Test gases are samples of natural gas which are analysed and certified according to [NEN-EN-ISO 6974](#) and [NEN-EN-ISO 6976](#).

Table 4: Maximum systematic difference

Concentration (mol%)	Maximum deviation (abs) (%)
50 - 100	0,2
10 - 50	1
1 - 10	2
0,05 - 1	10
0,01 - 0,05	40
< 0,01	100
Component	
C6+	50

4.6.2.3 Repeatability

The analyses shall result in a calorific value to be within 0,1 % of reading in a 24-hour period, over the ambient temperature range of -15 °C to 40 °C, *without* calibration.

The analyses shall result in a calorific value to be within 0,2 % of reading in a month, over the ambient temperature range of -15 °C to 40 °C, *with* calibration.

4.6.3 Calibration

Periodic calibration shall be according to [NEN-EN-ISO 6974](#) and [NEN-EN-ISO 10723](#).

4.6.3.1 Calibration type

Single Point Calibration:

The maximum duration of the periodic calibration shall be less than one hour and consists of minimal three calibration runs. The last two calibration runs shall be used for calculating the response factors. The results of each individual calibration run shall be provided/presented as a calibration result.

Multi-Level Calibration:

A multi-level calibration shall be in accordance with [NEN-EN-ISO 10723](#).

4.6.3.2 *Fixed (not measured) components*

A possibility for a fixed component correction shall be provided for helium, argon, hydrogen, carbon monoxide and oxygen.

It shall be possible to choose if these components are fixed or analysed by the GC.

4.6.3.3 *Normalisation of the concentrations*

The calculated concentrations shall be converted to 100 % minus the sum of the fixed components (see subclause 4.6.3.2):

$$X_{i,norm} = X_i \times \frac{100 - \sum \text{fixed component}}{\sum X_i}$$

Where:

$\sum X_i$ = sum of all unnormalised direct and indirect components (mol%)

$X_{i,norm}$ = normalised concentration of component i (mol%)

4.6.3.4 *C6+ components*

The C6+ concentration is measured as one peak or as separated peaks from hexanes to octanes or higher.

If only one peak of C6+ is measured it shall consist of hexanes, heptanes, octanes and benzene. For the calculations of the physical properties the ratio between those components is used and this shall be user defined or the corresponding physical properties of the combined C6+ shall be programmable in the controller.

5. MINIMUM VALIDATION AND VERIFICATION REQUIREMENTS

5.1 Validation

The Service provider communicates with the Client via which common industrial standard communication protocol the data will ultimately be sent and shall clarify how the required data will be made available (see subclause 4.5.3.4).

The Service provider provides the Client detailed information on how the following data from the GC will be made available:

- the communication protocol used;
- a description of available data;
- the format of the data;
- the order of the data points;
- possibilities for customisation.

5.2 Verification

5.2.1 Temperature test

The service provider shall demonstrate that the system has passed the temperature test, whereby the test has been carried out according to the following:

- The temperature test shall be lasted for 24 hours.
- The temperature shall be cycled back and forth between the required minimum and maximum temperature (see subclause 4.1.1) four times during the 24 hour period.
- All inputs and outputs shall be:
 - changed at a minimum of once an hour, and
 - registered.
- The test shall be passed error free.

5.2.2 Variations in power supply

Service provider shall demonstrate that the electrical installations, equipment and materials are tested for the effects of variations in power supply according to the methods described in [NEN-EN-IEC 61000-4-11](#).

5.2.3 Accuracy

Service provider shall demonstrate that the accuracies from table 3 can be obtained for the components from table 1 in accordance with [NEN-EN-ISO 10723](#) and based on at least one single point calibration.

5.2.4 Inspection and testing

The Service Provider shall demonstrate that the specific requirements stated by Client in the FAT and SAT have been met.

5.2.5 Control unit communication protocol

The Service provider shall demonstrate that the required data (see subclause 4.5.3.4) is available.

5.2.6 Documents

Upon delivery of the documents stated on the RED form, the Service provider shall demonstrate that the requirements set in this specification have been met.

6. MINIMUM QUALIFICATION REQUIREMENTS

(The stated requirements apply for the entire contract period)

Service provider has demonstrable knowledge of the materials to be delivered and can provide support in the event of malfunctions and/or defects via the usual communication channels and physically at the device within the period specified by the Client; all in accordance with the requirements set in this specification. Reporting and handling of malfunctions shall be in the Dutch language.

With regard to the instrument to be delivered, Service provider shall demonstrably have delivered at least 50 instruments to end users other than the Client. All this to the full satisfaction of the end users concerned and in accordance with the requirements set in this specification.

7. RATIONALE

(This clause is intended for the Client only)

7.1 Electrotechnical requirements

7.1.1 Power supply

The operation of the GC shall not be disturbed by fluctuations in the supply voltage; therefore the requirements mentioned in [OSA-18-E](#) (section "Variations in power supply") have been applied.

7.2 Functional requirements

7.2.1 Stream selection

To keep the dead time as short as possible, the gas flow selector should be mounted on the GC or as close to the GC as possible. The volume of the gas flow selector should be as low as possible to avoid dead time.

The calibration requirements as stated in this specification comply with the guidelines of the Measurement Code gas LNB and [OSS-20-E](#).

8. DOCUMENTATION

In this specification the following informational documentation applies:

- 1 [OSS-20-E](#) "Functional requirements for fiscal metering systems".
- 2 [OSA-18-E](#) "Requirements for electric/electronic equipment and installations regarding external influences".

ANNEX**A EXAMPLE FOR MULTI-LEVEL CALIBRATION INCLUDING RESPONSE FACTOR AND RELATIVE RESPONSE FACTORS (INFORMATIVE)**

When the performance evaluation indicates that the GC shall be calibrated with a multi-level calibration (MLC), this is an example how to use a response factor and relative response factors.

A.1 MLC and response factor

The multi-level calibration curve is multiplied with the response factor Rw_i according to:

$$X_i = Rw_i (b_0 + b_1 \cdot Y_i + b_2 \cdot Y_i^2 + b_3 \cdot Y_i^3)$$

Where:

- X_i = unnormalised concentration of component i in the sample (mol%);
- Rw_i = response factor for component i;
- $b_0...b_3$ = coefficients of the multi-level polynomial of component i;
- Y_i = measured response of component i in the sample (area counts).

The response factor is calculated as follows:

$$Rw_i = \frac{X_{cal,i}}{X_i}$$

Where:

- Rw_i = response factor component i;
- $X_{cal,i}$ = concentration of component i in the calibration gas;
- X_i = $b_0 + b_1 \cdot Y_i + b_2 \cdot Y_i^2 + b_3 \cdot Y_i^3$, where Y_i = measured average response of component i in the calibration gas (area counts) (= measured unnormalised concentration in the calibration gas);

The response factor is determined by periodic calibration. Its value should be near unity.

A.2 Calculation of the concentration of indirect components with relative response factors

The unnormalised concentration of each of the indirect components (neo-pentane, 2-methylbutane, n-pentane and C6+) is calculated via a direct component (propane) and a relative response factor. After each analysis run the concentrations of the indirect components are calculated according to:

$$X_i = F_i \times \frac{Y_i}{Y_p} \times X_p$$

Where:

X_i = unnormalised concentration of the indirect component i.

F_i = relative response factor from component i relative to propane.

Y_i = measured response of the indirect component i in the sample (area counts)

Y_p = measured response of propane in the sample (area counts)

X_p = unnormalised concentration of propane in the sample

The relative response factors for the pentanes and C6+ are related to the calibration curve of propane (see [NEN-EN-ISO 6974](#)). These shall be determined experimentally with reference gases and there shall be a possibility to enter these values in the controller. For one type of GC there shall be one uniform set of relative response factors for the complete range of concentrations.