PEAK SCIENTIFIC

Your local **gas generation** partner

Peak Scientific Gas Solutions

Choosing the right set-up for GC

A PEAK gas generation brand

Gas generators provide a number of benefits

Convenience
Gas on-demand, no cylinders to change or maintain supply stocks

Consistency
Consistent gas quality and supply, no impurities or running out of gas

Economy
Eliminate on-going costs of cylinders, manage lifetime running costs

Safety
No pressurized compressed gas cylinders in your lab

Green
No repeated gas deliveries, energy efficient

PEAK SCIENTIFIC

Gas Safety

Compressed gases can be dangerous

- Nitrogen, helium, argon – Risk of asphyxiation
- Hydrogen, acetylene – Risk of fire/explosion
- Cylinders contain up to 9000L compressed gas
- 1L LN2 produces 696L N2 gas

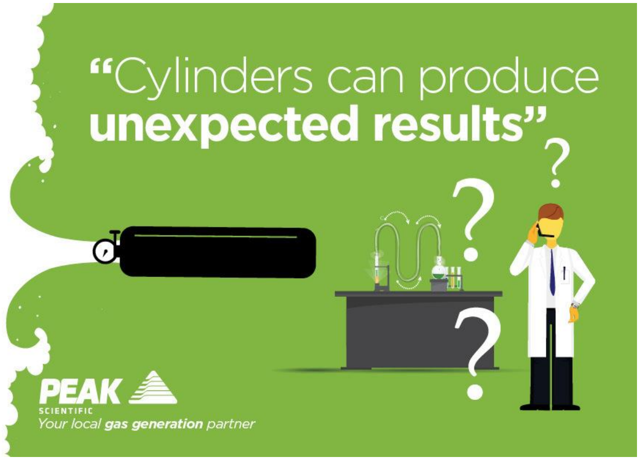
Effect of release of inert gas into the lab – O_2 displacement

O_2 (Vol %)	Effects and Symptoms
18-21	**No discernible symptoms** can be detected by the individual. A risk assessment must be undertaken to understand the causes and determine whether it is safe to continue working.
11-18	Reduction of physical and intellectual performance **without the sufferer being aware**.
8-11	Possibility of fainting within a few minutes without prior warning. **Risk of death below 11%.**
6-8	Fainting occurs after a short time. **Resuscitation possible** if carried out immediately.
0-6	Fainting almost immediate. **Brain damage**, even if rescued.

PEAK SCIENTIFIC

H2 Cylinders

- H2 cylinders are potentially dangerous
  - 9000L of stored gas at 200barg in a cylinder
  - 150cc and 7barg in Precision SL
- Hydrogen and cylinder storage are increasingly regulated
  - The cost of installation can be high as H2 cylinders need to be moved further away from the lab
- Be aware of the hidden costs of cylinders
  - Delivery
  - Rental
  - Regulator replacement
  - Line maintenance
  - Frequent in-line trap replacement
- Generators can be factored in to new lab installations to save cost
- Resources on cylinders and H2 safety



Safeguard your hydrogen supply by using a generator

"A key benefit for us has been the elimination of the safety hazards associated with compressed gas cylinder handling."

Kerri Heckrow, NPD Lab Manager, Evergreen Packaging, NC, USA

PEAK SCIENTIFIC

H2 generator safety

- Low stored volume
- Low pressure
- Continuous monitoring of pressure
  - Over-pressure
  - Under-pressure
- Auto-shutdown
  - External leak
  - Internal leak
- Diagnostics at start-up
- Cell shut-down in case of problem

PEAK SCIENTIFIC

Calculating gas requirements for GC

Main detector gas requirements

		FID	FPD	NPD	ECD	TCD	SCD	MSD
Combustion gases	H2	● 30-50	● 50-75	● 2-5			● 40-100	
	Zero Air	● 300-500	● 60-100	● 60			● 40-100	
Makeup gas	N2	● 10-40	● 60	● 5-10	Trace ● 60			
Reference gas	H2					● 10 - 75		
	N2					●		

- FID, FPD, NPD & SCD – Same basic function – burn a flame
- ECD – Make-up must be N2 Trace (hydrocarbon-free)
- TCD – reference gas is same as Carrier gas

Calculating the requirement

If no information is available, use worst-case flow rates to calculate

Eg. 3x FID = 150cc/min H_2, 120cc/min N_2, 1500cc/min Zero Air.

Eg. 2x FID + 1x ECD = 100cc/min H_2, 140cc/min N_2 Trace, 1000cc/min Zero Air

If method data is available:

Extract the information from the method information provided

At first sight this can look confusing

Look for key information

PEAK SCIENTIFIC

Acquisition methods

Page 2 of 10

15.02.2016 8:23:11 Method: Method embedded in C:\Clarus GC 2\DATA\VDK\February2016\12-008.rst

Detector Parameters

	Detector A	Detector B
Detector	FID	ECD
Range	1	1
Time Constant	200	200
Autozero	ON	OFF
Polarity		

Heated Zones

Injector A:
Setpoint : 110 °C

Injector B:
Setpoint : OFF

Detector A : 250°C
Detector B : 150°C
Auxiliary (NONE) : 0°C

Oven Program

Cryogenics : Off
Initial Temp : 80°C
Initial Hold : 17.00 min

Total Run Time : 17.00 min
Maximum Temp : 240°C
Equilibration Time : 0.5 min

Timed Events

There are no timed events in the method

Real Time Plot Parameters

	Pages	Offset (mV)	Scale (mV)
Channel B	1	0.000	1000.000

```
 method: C:\CHEM32\1\METHODS\ALC .M
Modified on: 10/17/2014 at 8:46:57 AM
    ====================================================================
                                Agilent 7890 GC
    ====================================================================

    Oven
    Equilibration Time                              0.2 min
    Oven Program                                    On
        50 °C for 1 min
        then 5 °C/min to 80 °C for 0 min
        then 20 °C/min to 300 °C for 5 min
    Run Time                                        23 min


    No Injectors


    Front SS Inlet H2
    Mode                                            Split
    Heater                                          On    285 °C
    Pressure                                        On    10 psi
    Total Flow                                      On    287.34 mL/min
    Septum Purge Flow                               On    3 mL/min
    Gas Saver                                       Off
    Split Ratio                                     50 :1
    Split Flow                                      278.77 mL/min

    Column #1
    Ultra 1 Methyl Siloxane: 2655.76598
    Ultra 1 Methyl Siloxane
    325 °C: 25 m x 320 um x 0.52 um
    In: Front SS Inlet H2
    Out: Front Detector FID

    (Initial)                                       50 °C
    Pressure                                        10 psi
    Flow                                            5.5753 mL/min
    Average Velocity                                92.07 cm/sec
    Holdup Time                                     0.45256 min
    Pressure Program                                On
        10 psi for 0 min
    Run Time                                        23 min


    Front Detector FID
    Heater                                          On    300 °C
    H2 Flow                                         On    35 mL/min
    Air Flow                                        On    350 mL/min
    Makeup Flow                                     On    30 mL/min
    Const Col + Makeup                              Off
    Flame                                           On
    Electrometer                                    On
```

Acquisition methods

15.02.2016 8:23:11 Method: Method embedded in C:\Clarus GC 2\DATA\VDK\February2016\12-008.rst

Detector Parameters

	Detector A	Detector B
Detector	FID	ECD
Range	1	1
Time Constant	200	200
Autozero	ON	OFF
Polarity		

Heated Zones

Injector A:
Setpoint : 110 °C

Injector B:
Setpoint : OFF

Detector A : 250°C
Detector B : 150°C
Auxiliary (NONE) : 0°C

Oven Program

Cryogenics : Off
Initial Temp : 80°C
Initial Hold : 17.00 min

Total Run Time : 17.00 min
Maximum Temp : 240°C
Equilibration Time : 0.5 min

Timed Events

There are no timed events in the method

Real Time Plot Parameters

	Pages	Offset (mV)	Scale (mV)
Channel B	1	0.000	1000.000

No flow information given – use maximum flows for calculations

```
method: C:\CHEM32\1\METHODS\ALC .M
Modified on: 10/17/2014 at 8:46:57 AM
    ====================================================================
                             Agilent 7890 GC
    ====================================================================

    Oven
    Equilibration Time                            0.2 min
    Oven Program                                  On
        50 °C for 1 min
        then 5 °C/min to 80 °C for 0 min
        then 20 °C/min to 300 °C for 5 min
    Run Time                                      23 min


    No Injectors


    Front SS Inlet H2
    Mode                                          Split
    Heater                                        On    285 °C
    Pressure                                      On    10 psi
    Total Flow                                    On    287.34 mL/min
    Septum Purge Flow                             On    3 mL/min
    Gas Saver                                     Off
    Split Ratio                                   50 :1
    Split Flow                                    278.77 mL/min

    Column #1
    Ultra 1 Methyl Siloxane: 2655.76598
    Ultra 1 Methyl Siloxane
    325 °C: 25 m x 320 um x 0.52 um
    In: Front SS Inlet H2
    Out: Front Detector FID

    (Initial)                                     50 °C
    Pressure                                      10 psi
    Flow                                          5.5753 mL/min
    Average Velocity                              92.07 cm/sec
    Holdup Time                                   0.45256 min
    Pressure Program                              On
        10 psi for 0 min
    Run Time                                      23 min


    Front Detector FID
    Heater                                        On    300 °C
    H2 Flow                                       On    35 mL/min
    Air Flow                                      On    350 mL/min
    Makeup Flow                                   On    30 mL/min
    Const Col + Makeup                            Off
    Flame                                         On
    Electrometer                                  On
```

Flow information given – use indicated flows for calculations

PEAK SCIENTIFIC

Calculations - Recap

1. Count the number of each detector type (remember some GCs may have 2 detectors) and add together the required flows of H_2, N_2 and Zero Air.
2. If specific flow details are not available, use ‘worst case’ flow rates.
3. Use the GC Gas Calculator to document the information and confirm with the customer

Carrier gas

Carrier gas flow rates

The aim of calculating the carrier gas flow rate is to find the **‘total flow’** of the carrier gas.

The **‘total flow’** is the flow of carrier gas through the GC inlet

Knowing the **‘total flow’** allows us to recommend the correct generator(s) to support the GC

Most GCs use a split/splitless injector

The calculation of flow rates differs depending on whether the method uses ***split*** injection or ***splitless*** injection

PEAK SCIENTIFIC

Carrier Gas

Peak would always recommend either N2 Trace or H2 Trace

Zero air cannot be used for carrier gas

Can be more difficult to calculate if you try to go into too much detail…

Keep it simple…

Getting relevant flow information

Find the **total carrier gas** flow for each GC

- If multiple methods used on 1 GC, calculate using the method with the highest total flow
- Don't try to calculate the Total flow – this should be easily available from the method

If helium carrier gas is used and being converted to hydrogen, the total flow must be increased by 25%

- For total flow of 100cc/min helium, the customer will require 125cc/min hydrogen

If the customer is using helium carrier gas and is converting to Nitrogen the flow will stay the same

Acquisition methods

Acquisition methods

```
 method: C:\CHEM32\1\METHODS\ALC .M
Modified on: 10/17/2014 at 8:46:57 AM
    ==================================================================
                            Agilent 7890 GC
    ==================================================================

    Oven
    Equilibration Time                          0.2 min
    Oven Program                                On
        50 °C for 1 min
        then 5 °C/min to 80 °C for 0 min
        then 20 °C/min to 300 °C for 5 min
    Run Time                                    23 min


    No Injectors


    Front SS Inlet H2
    Mode                                        Split
    Heater                                      On     285 °C
    Pressure                                    On     10 psi
    Total Flow                                  On     287.34 mL/min
    Septum Purge Flow                           On     3 mL/min
    Gas Saver                                   Off
    Split Ratio                                 50 :1
    Split Flow                                  278.77 mL/min
```

```
Column #1
Ultra 1 Methyl Siloxane: 2655.76598
Ultra 1 Methyl Siloxane
325 °C: 25 m x 320 µm x 0.52 µm
In: Front SS Inlet H2
Out: Front Detector FID

(Initial)                                 50 °C
Pressure                                  10 psi
Flow                                      5.5753 mL/min
Average Velocity                          92.07 cm/sec
Holdup Time                               0.45256 min
Pressure Program                          On
    10 psi for 0 min
Run Time                                  23 min


Front Detector FID
Heater                                    On     300 °C
H2 Flow                                   On     35 mL/min
Air Flow                                  On     350 mL/min
Makeup Flow                               On     30 mL/min
Const Col + Makeup                        Off
Flame                                     On
Electrometer                              On
```

Acquisition methods

H2 Total flow = 287 cc/min

H2 detector flow = 35 cc/min

Total H2 requirement = 322 cc/min

N2 requirement = 30 cc/min

Zero Air requirement = 350 cc/min

```
method: C:\CHEM32\1\METHODS\ALC .M
Modified on: 10/17/2014 at 8:46:57 AM
=====================================================================
                            Agilent 7890 GC
=====================================================================

Oven
Equilibration Time                               0.2 min
Oven Program                                     On
    50 °C for 1 min
    then 5 °C/min to 80 °C for 0 min
    then 20 °C/min to 300 °C for 5 min
Run Time                                         23 min


No Injectors


Front SS Inlet H2
Mode                                             Split
Heater                                           On    285 °C
Pressure                                         On    10 psi
Total Flow                                       On    287.34 mL/min
Septum Purge Flow                                On    3 mL/min
Gas Saver                                        Off
Split Ratio                                      50 :1
Split Flow                                       278.77 mL/min

Column #1
Ultra 1 Methyl Siloxane: 2655.76598
Ultra 1 Methyl Siloxane
325 °C: 25 m x 320 µm x 0.52 µm
In: Front SS Inlet H2
Out: Front Detector FID

(Initial)                                        50 °C
Pressure                                         10 psi
Flow                                             5.5753 mL/min
Average Velocity                                 92.07 cm/sec
Holdup Time                                      0.45256 min
Pressure Program                                 On
    10 psi for 0 min
Run Time                                         23 min


Front Detector FID
Heater                                           On    300 °C
H2 Flow                                          On    35 mL/min
Air Flow                                         On    350 mL/min
Makeup Flow                                      On    30 mL/min
Const Col + Makeup                               Off
Flame                                            On
Electrometer                                     On
```

Calculations - recap

1. Get the highest **total flow** for each GC or GC-MS

2. Count the number of each detector type (remember some GCs can have 2 detectors) and add together the required flows of H2, N2 and Zero Air.

    If no info provided re. specific detector flow details, use ‘worst case’ flow rates.

    If you do not know the total carrier gas flow rate try to find other methods online to get an indication of approximate flow requirements

    Add **total flow** and **detector flow** together

3. Use the GC Gas Calculator to document the information and confirm the total gas requirement

PEAK SCIENTIFIC

Helium conversion to H_2 & resources available

There’s no need for us to have helium cylinders on site and no need to change air or helium cylinders at all, so that reduces instrument down time and cylinder manual handling risks.

Ian Bennington, Senior Analyst, Nerudia, UK

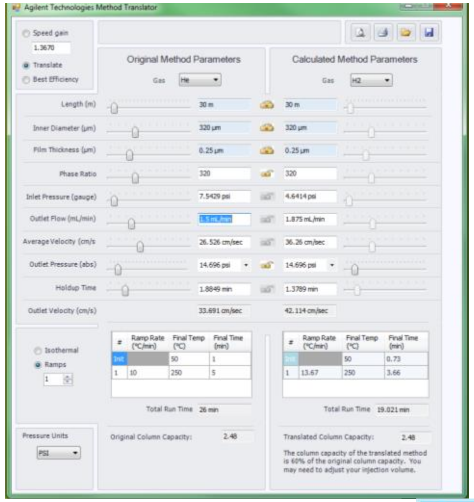
PEAK SCIENTIFIC

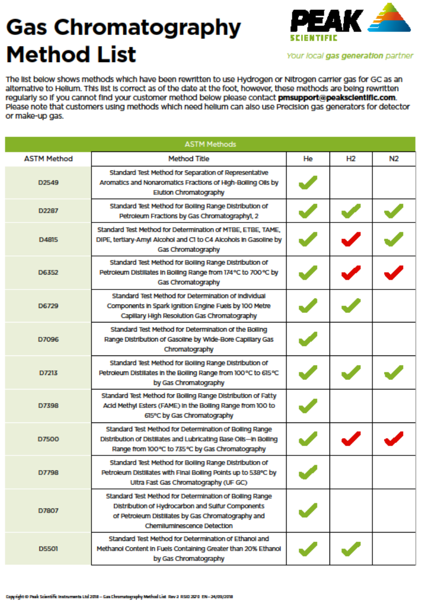
Assumptions

1. You/your customer wants to change carrier gas
2. You/your customer can change carrier gas
3. You/your customer understands that conversion might take some time
4. You/your customer understands the process of conversion

Online Resources

- Agilent Method Translation software
- Restek EZGC method calculator
- Peak GC method list





Gas Chromatography Method List

PEAK SCIENTIFIC
Your local gas generation partner

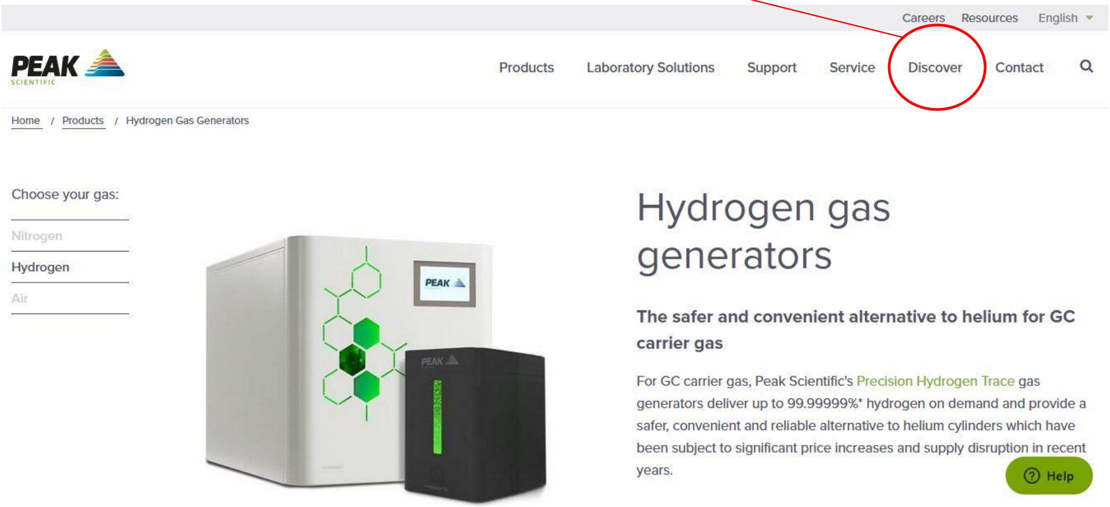
The list below shows methods which have been rewritten to use Hydrogen or Nitrogen carrier gas for GC as an alternative to Helium. This list is correct as of the date at the foot, however, these methods are being rewritten regularly so if you cannot find your customer method below please contact **pmsupport@peakscientific.com**. Please note that customers using methods which need helium can also use Precision gas generators for detector or make-up gas.

ASTM Methods				
ASTM Method	Method Title	He	H2	N2
D2549	Standard Test Method for Separation of Representative Aromatics and Nonaromatics Fractions of High-Boiling Oils by Elution Chromatography	✓		
D2287	Standard Test Method for Boiling Range Distribution of Petroleum Fractions by Gas Chromatography1, 2	✓	✓	✓
D4815	Standard Test Method for Determination of MTBE, ETBE, TAME, DIPE, tertiary-Amyl Alcohol and C1 to C4 Alcohols in Gasoline by Gas Chromatography	✓	✓	✓
D6352	Standard Test Method for Boiling Range Distribution of Petroleum Distillates in Boiling Range from 174°C to 700°C by Gas Chromatography	✓	✓	✓
D6729	Standard Test Method for Determination of Individual Components in Spark Ignition Engine Fuels by 100 Metre Capillary High Resolution Gas Chromatography	✓	✓	
D7096	Standard Test Method for Determination of the Boiling Range Distribution of Gasoline by Wide-Bore Capillary Gas Chromatography	✓		
D7213	Standard Test Method for Boiling Range Distribution of Petroleum Distillates in the Boiling Range from 100°C to 615°C by Gas Chromatography	✓	✓	✓
D7398	Standard Test Method for Boiling Range Distribution of Fatty Acid Methyl Esters (FAME) in the Boiling Range from 100 to 615°C by Gas Chromatography	✓		
D7500	Standard Test Method for Determination of Boiling Range Distribution of Distillates and Lubricating Base Oils—in Boiling Range from 100°C to 735°C by Gas Chromatography	✓	✓	✓
D7798	Standard Test Method for Boiling Range Distribution of Petroleum Distillates with Final Boiling Points up to 538°C by Ultra Fast Gas Chromatography (UF GC)	✓		
D7807	Standard Test Method for Determination of Boiling Range Distribution of Hydrocarbon and Sulfur Components of Petroleum Distillates by Gas Chromatography and Chemiluminescence Detection	✓		
D5501	Standard Test Method for Determination of Ethanol and Methanol Content in Fuels Containing Greater than 20% Ethanol by Gas Chromatography	✓	✓	

Online Resources from Peak

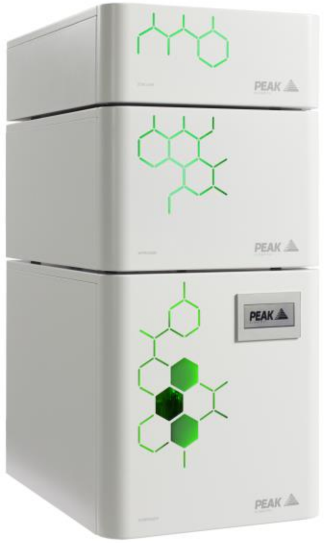
- Step by step guide to changing carrier gas
- Application notes highlighting change of carrier gas for GC & GC-MS

www.peakscientific.com



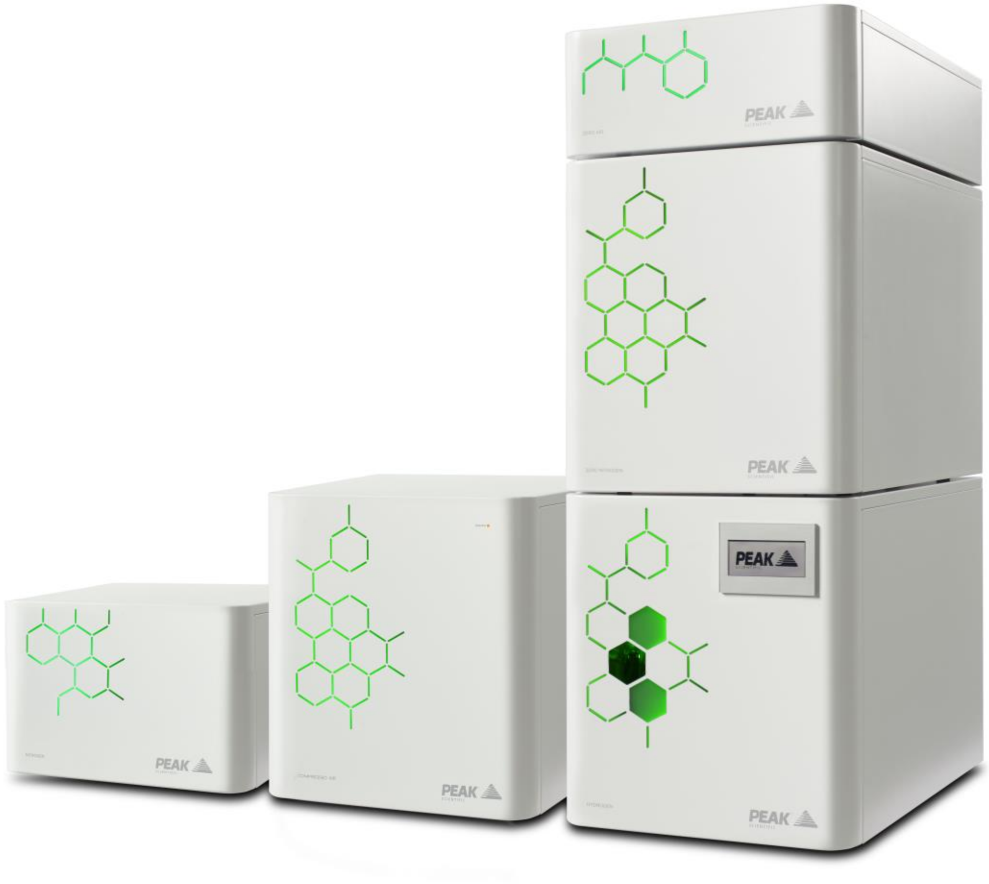
Precision range

- H2, N2 and ZA for carrier gas and detector gas
- Stackable, modular
- Low maintenance
- Low cost of ownership
- Easy to use – plug and play
- Can be configured to meet your laboratory’s gas requirements



Questions?

Q&A Session



Template Rev: 2.1

Thank you
www.peakscientific.com

Our Vision:
To exceed the expectation of our Customers, Colleagues and Suppliers

Our Values:
- **Respect** customer, supplier, colleague
- **Restless** constantly striving to improve
- **Freedom with responsibility**
- **Fun & passion** in everything we do

PEAK SCIENTIFIC