VERIFICATION REPORT OF HNG-SCRUBBER PROCESS

Procedure:
A test of burning diesel fuel with HydroNano Gas (HNG)

Purpose:
To demonstrate HNG's ability to significantly reduce and transform toxic emissions from the burning process of fossil fuels into a climate neutral state.

Place:
The HydroInfra laboratory

Address:
HydroInfra technologies AB/ HydroAtomic Institute
Stockholm, Sweden

Date:
May 30, 2013

Publishers

HydroInfra
Technologies
stc AB
www.HydroInfra.com

HNG®
HydroAtomic
Nano Gas©

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GRAPHICAL SUMMARY OF THE TEST RESULTS

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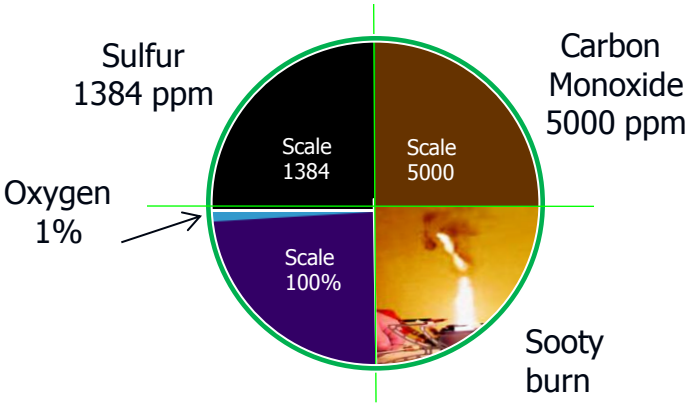
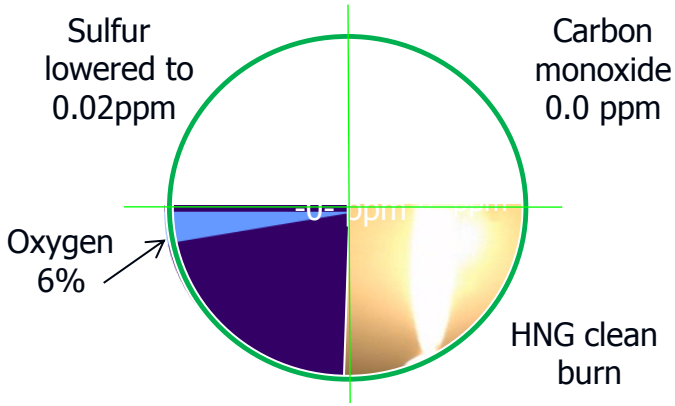
Burning diesel only - no HNG



Burning diesel with HNG



"According to our professional experience we have never seen results like this before" – joint comment by Lars Månsson and Olof Sten

Lars Månsson
CEO-MetLab AB
www.metlab.se

Test and results are witnessed and verified by Lars Månsson, CEO at the accredited laboratory Metlab AB and Olof Sten, CEO Palgo AB.

The company Metlab AB-
One of Sweden's leading air consultant laboratories with accreditation for the most frequently measured parameters.

The company Palgo AB-
Specializes in smoke gas air analysis and combustion monitoring

Olof Sten
CEO-Palgo AB
www.palgo.se

ppm = parts per million

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The HNG - scrubber system consist of three phases: 1) Hot scrubber = HNG injected in the burner. 2) Dry scrubber = HNG injected in the chimney. 3) Wet scrubber = HNG injected in a water chamber

SUMMARY OF THE HNG TEST RESULTS:

The test values shown in the column below, are reduced in the dry and wet phase of the HNG scrubber system. These reduced values are measured with an electronic water instrument.

SO2 – Sulfur
Burning only with Diesel.....1384.0 ppm
Burning with HNG and Diesel.....0.2 ppm
Difference (close to eliminated) -1383.8 ppm

CO – Carbon monoxide
Burning only with Diesel - over measure limit 5000.0 ppm
Burning with HNG and Diesel.....0,0 ppm
Difference (eliminated) -5000.0 ppm

Oxygen – O2
Burning only with Diesel.....0.6 %
Burning with HNG and Diesel.....6.0 %
Difference (oxygen regained) +5.4 %

CO2 – Carbon Dioxide
Burning only with Diesel.....6,0 %
Burning with HNG and Diesel..... .8,0 %
Difference (reduced in dry and wet phases) 2,0 %

Nitric Oxide NO
Burning only with Diesel.....61,0 ppm
Burning with HNG and Diesel.....80,0 ppm
Difference (reduced in dry and wet phases) 19,0 ppm

Energy efficiency
The measuring of the temperature for energy efficiency shows an increase by nearly 100%

Cost of HNG production
The fuel used to generate the needed HNG gas is within 10% of totally used fuel in the burner.

ppm = parts per million

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Answers to two highly important questions that will arise when reading this Verification Report

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NEUTRALIZATION OF SULFUR (SO_2)

The result of this report shows such remarkable data that it creates a first line of questions

Question: According to the measurement the sulfur (SO_2) disappears. Where does it go?

Answer: The initial report by the Stockholm University infrared spectrometer shows no sulfur, but presence of ethylene which can be used as a fuel component. The conclusion is that sulfur breaks up and binds to a molecular structure related to ethylene. No harmful acid appears. No significant decrease of Ph-value.

POSITIVE ENERGY BALANCE

Question: Is the energy needed to produce HNG gas reasonable in relation to its emission and energy performance?

Answer: The HNG gas is a reactive gas, not intended to be used as an energy carrier. When the HNG gas is injected in the diesel fuel (hydro carbon), it quickly frees the hydrogen bond in the fuel. Only a very small amount of the HNG gas is needed to gain a very efficient burning process. This results in a net gain in energy efficiency between 10-30%. This means a positive energy balance between the cost of HNG gas production and the total energy efficiency gain.

CONCLUSION

The answer to the questions above gives the reader of this report the possibility to imagine the great consequences for the global climate, when the HNG technology will be implemented. A rapid transformation to a clean energy use for a sustainable future that can start now.

An upcoming report on science and research will in more detail explain the future of this technology.

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The verification of the HNG hot scrubber process

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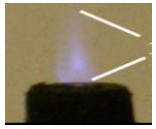
Picture from the HNG hot scrubber burner verification process

The diesel oil flame with no gas:

Result: Sooty toxic emissions

Diesel

HNG gas



1 cm

HNG with Diesel

The results from the insertion of a thin 1 cm HNG gas flame

Result: Bright clean hot flame

Conclusion: these pictures show that the hot scrubber function cleans up the burnings and creates a hot, bright flame with no visible emissions. It also shows that the use of fossil fuel can be climate neutral.

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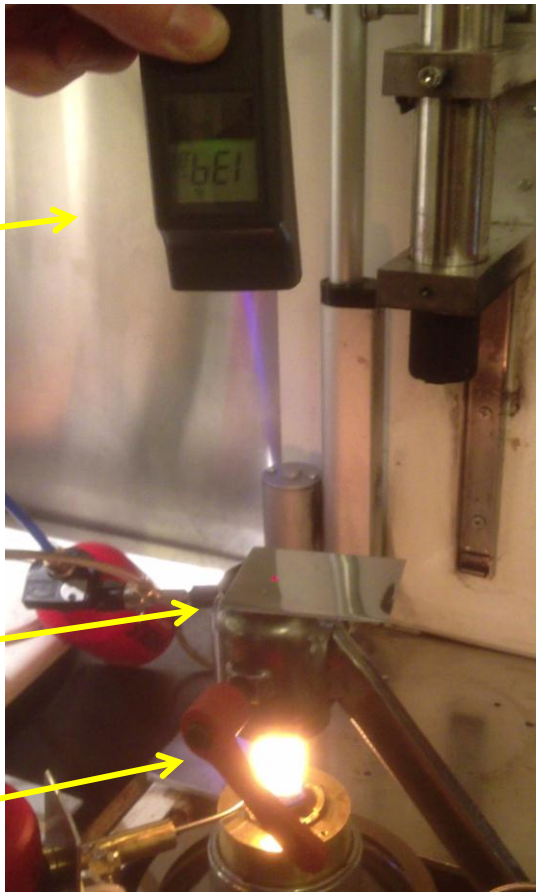
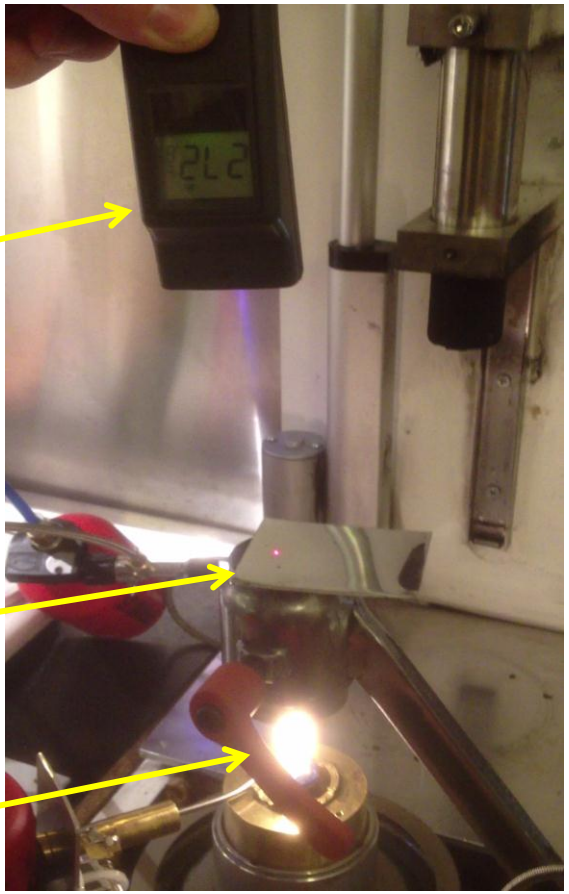
Maximum temperature from diesel flame on a metal plate 139 C



The temperature increases by 100% from burning a mixture of diesel and HNG flame. 272 C



The HNG gas is a reactive gas, not intended to be used as an energy carrier. When the HNG gas is injected in the diesel fuel (hydro carbon), it quickly frees the hydrogen bond in the fuel. Only a very small amount of the HNG gas is needed to gain a very efficient burning process. This results in a net gain in energy efficiency between 10-30%. This means a positive energy balance between the cost of HNG gas production and the total energy efficiency gain.

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HNG HOT SCRUBBER

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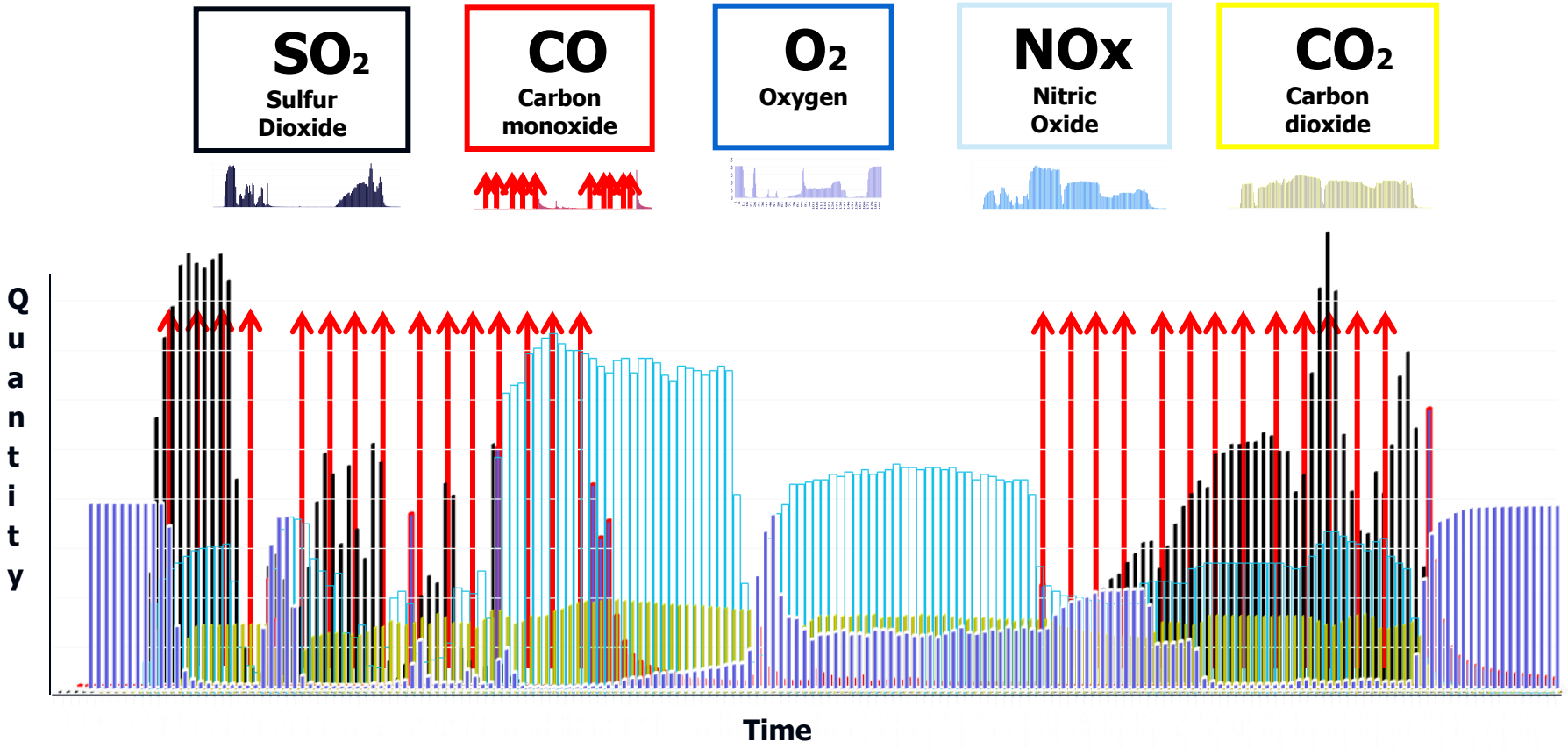
The graph below shows which gases we are measuring and the results

(Click on each gas for a definition)



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HNG HOT SCRUBBER –

These graphs give an overview of all gases measured

(click each gas to go directly to the analysis page specific to that gas)

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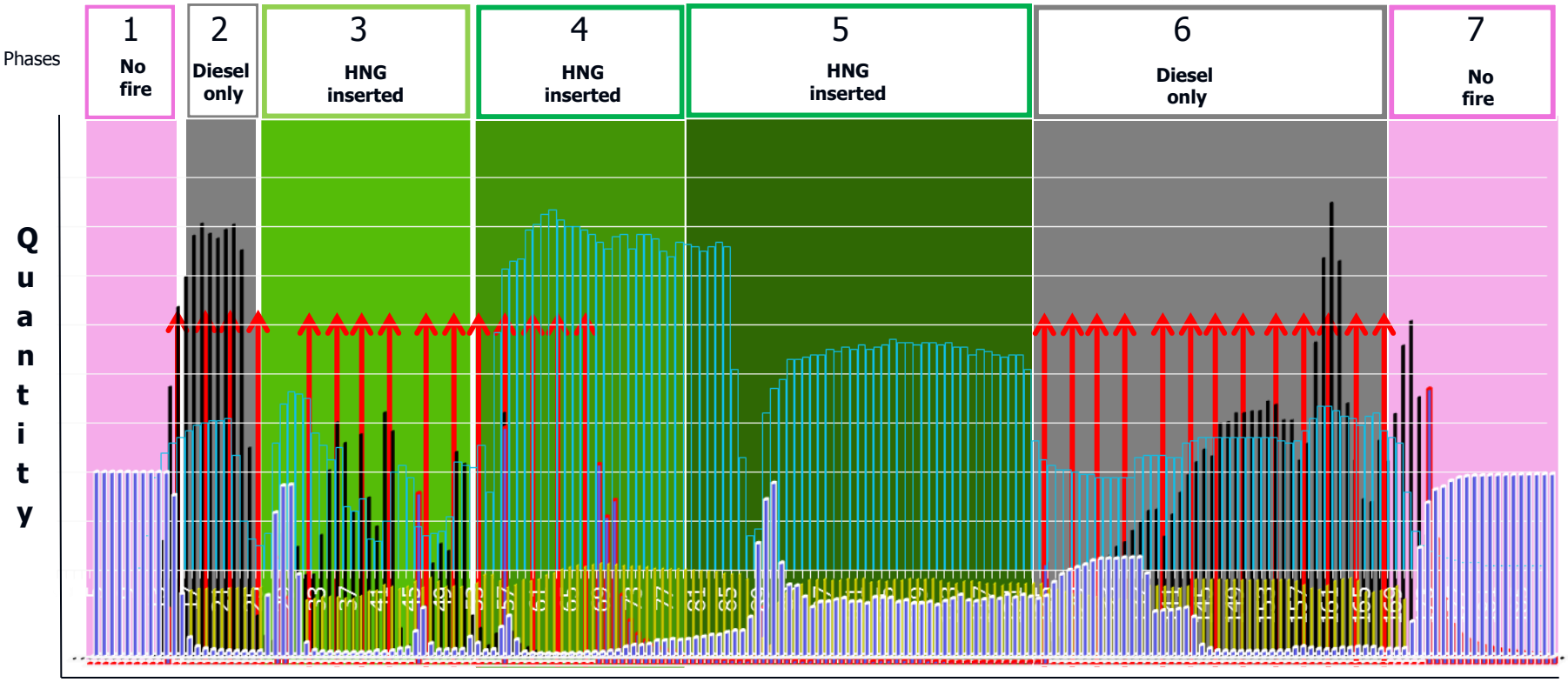
SO_2 Sulfur Dioxide ppm	CO Carbon Monoxide ppm	O2 Oxygen %	NOx Nitric Oxide ppm	CO_2 Carbon dioxide %

ppm = parts per million



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HNG HOT SCRUBBER

This graph shows the maximum value that the instrument can measure is 5000 ppm. When the values of carbon monoxide (CO) exceeds 5000 ppm, this graph can only show 5000 ppm, even though the measured values exceeds this level. With the insertion of the HNG gas in phase three this harmful carbon monoxide gas (CO) is totally eliminated.

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CO Carbon Monoxide ppm

Arrows indicate the ppm were over the 5000 ppm capacity of the measurement equipment to measure

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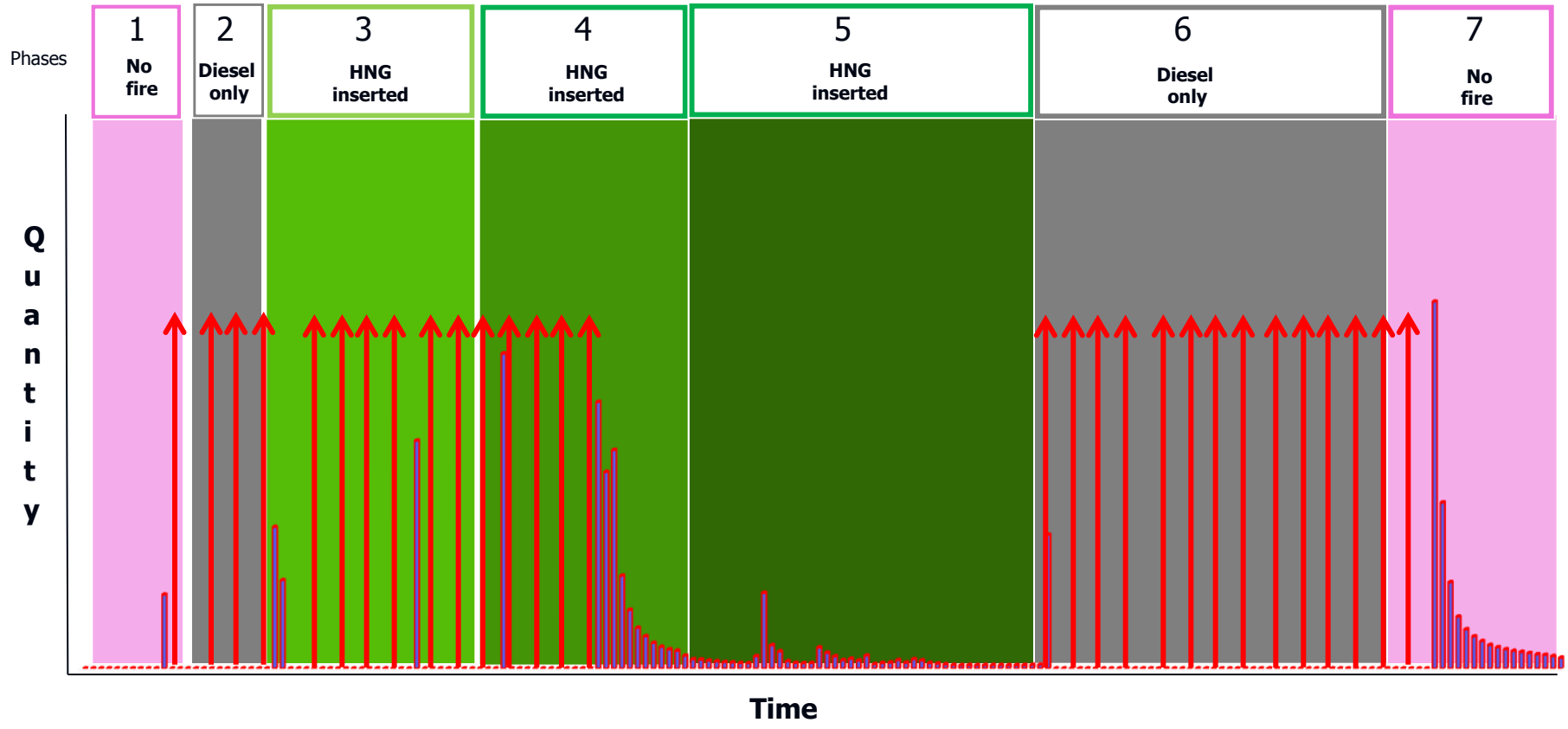

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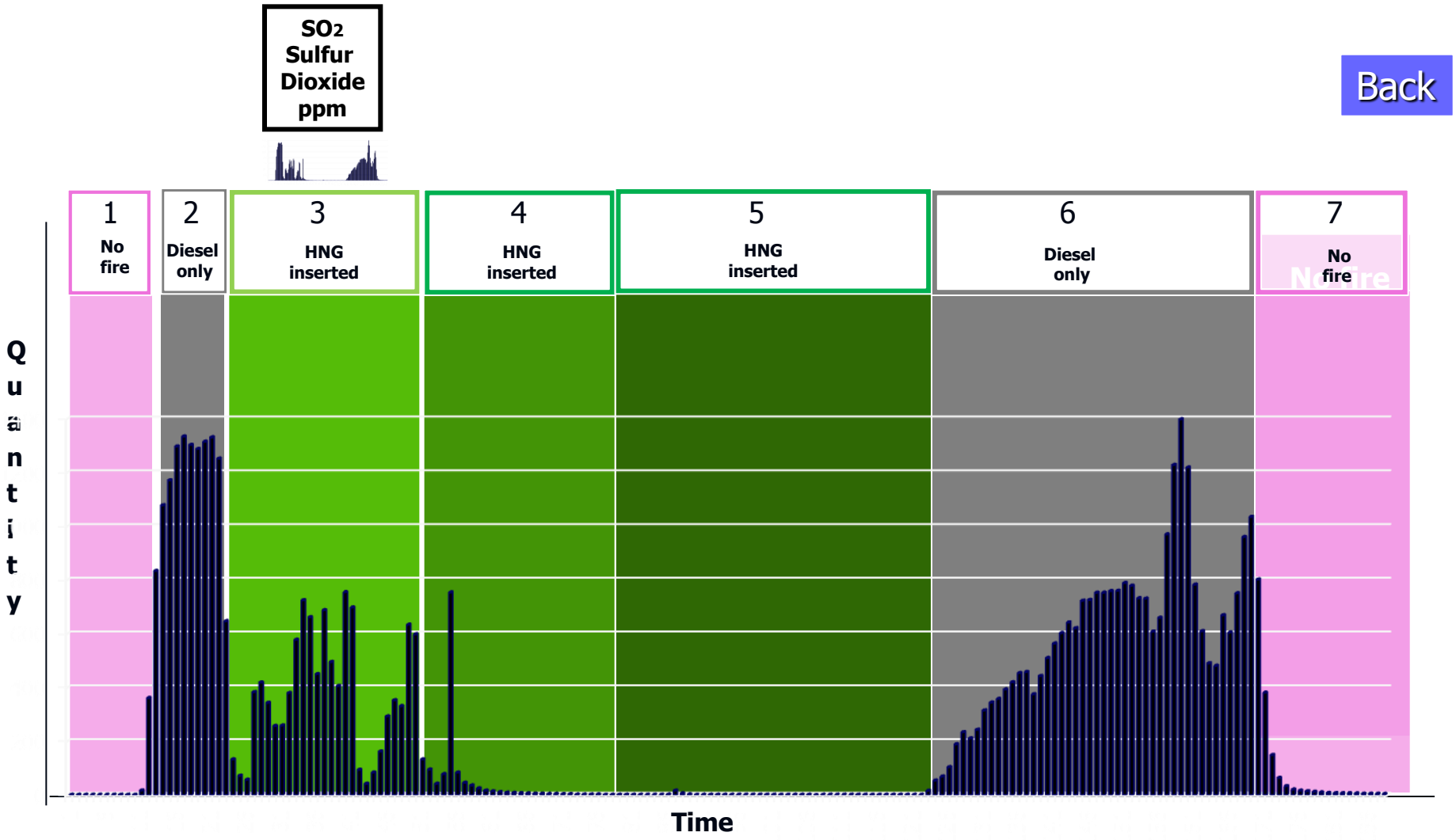
HNG HOT SCRUBBER

The sulfur dioxide (SO2) is totally eliminated. This is achieved in the hot phase of the HNG scrubber process. The result also, thanks to the highly reactive properties of HNG, produces greater energy efficiency of the fuel.



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HNG HOT SCRUBBER –

This graph shows oxygen values actually increased at phase 3 of the test. It shows that HNG gas has its own oxygen and therefore requires less oxygen from external air, while at the same time increasing the heat of the flame.

O2 Oxygen %

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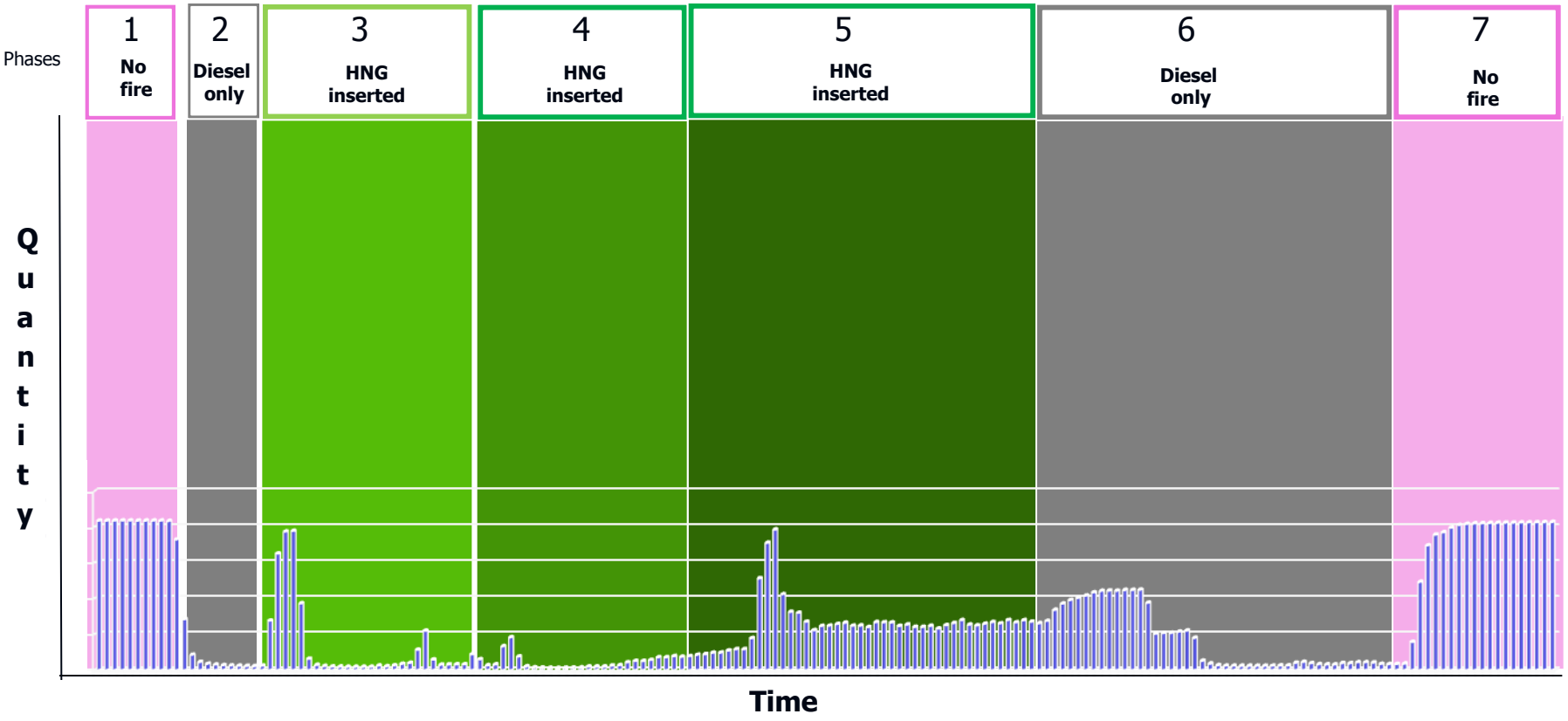

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HNG HOT SCRUBBER

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This graph shows nitric oxide (NOx) at the point of stabilization in phase 3 an increase of between 20 and 30 ppm. The NOx will be neutralized in the 2nd and 3rd phases in the dry and wet scrubber process.

NOx Nitric Oxide ppm

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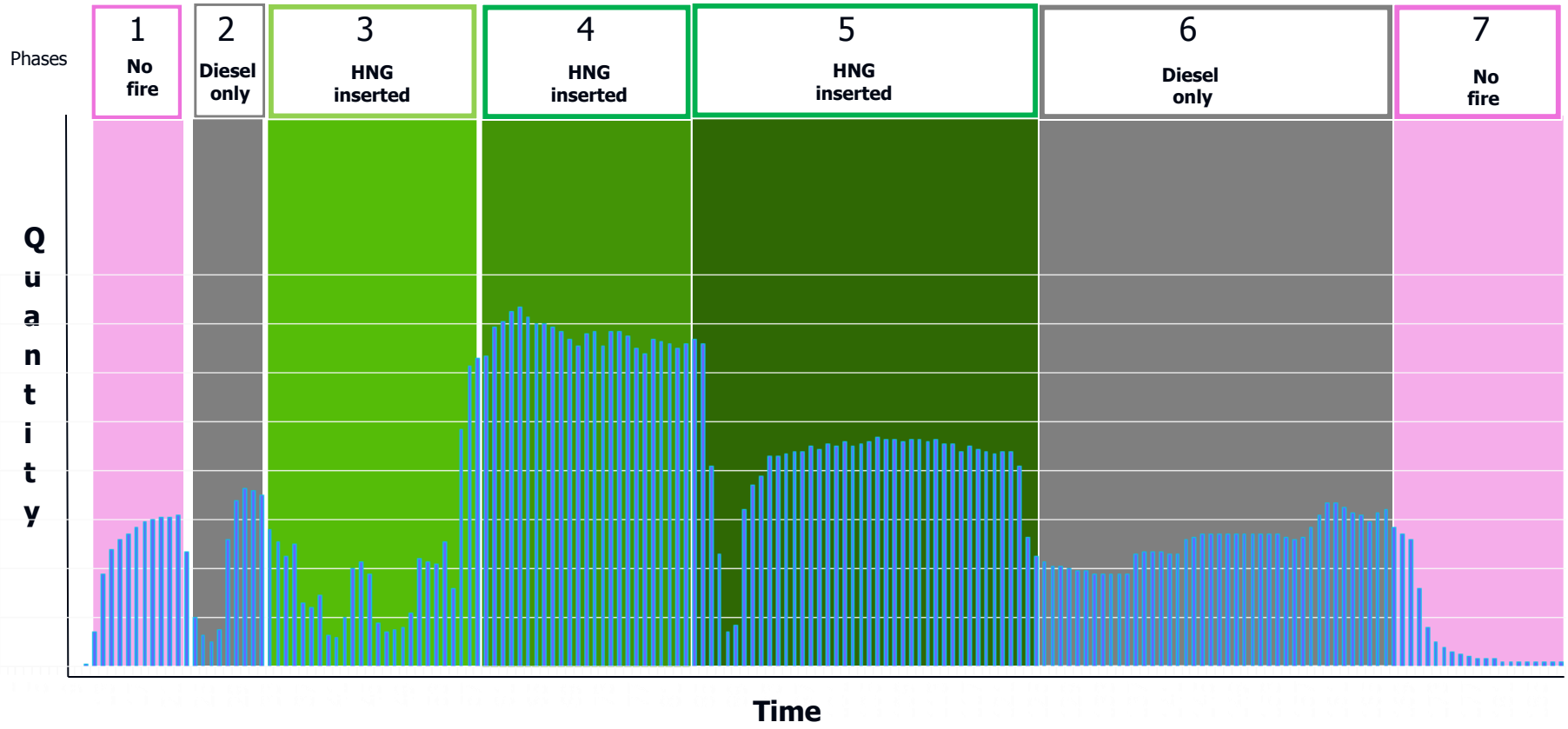

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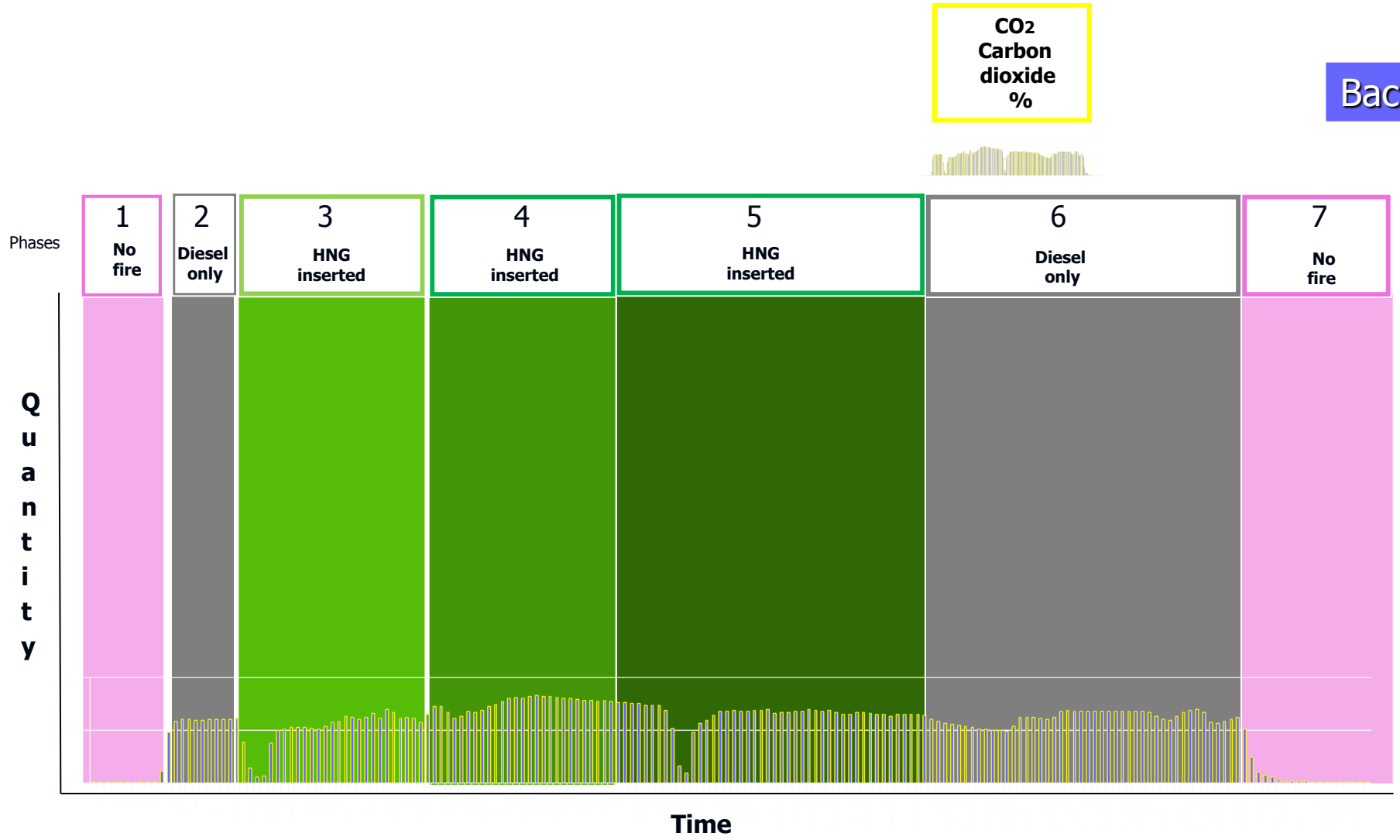
HNG HOT SCRUBBER

Carbon dioxide (CO_2) shows a slight increase of 3 % once the HNG gas is introduced and the burning is stabilized in phase 3. These HNG scrubber dry and wet processes makes it possible for an easy and harmless assimilation of the catalyzed CO_2 in nature.



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Horiba gas analyzers

Horiba analyzers are state of the art standard equipment used by accredited inspectors to check that the emissions are within legal standard value from power plants and other emission outlets.

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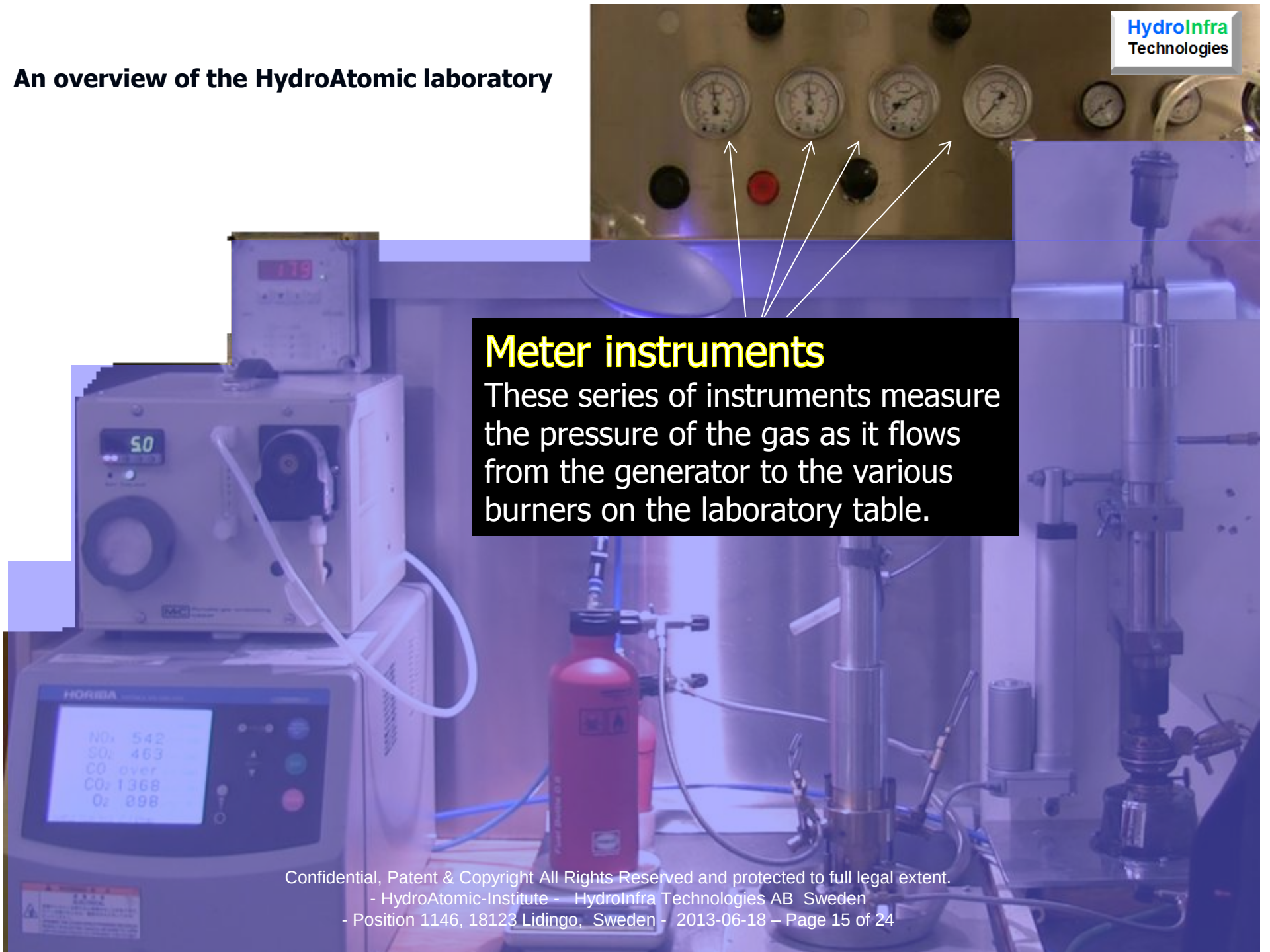
An overview of the HydroAtomic laboratory



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An overview of the HydroAtomic laboratory

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The HNG scrubber systems

The analyzer input

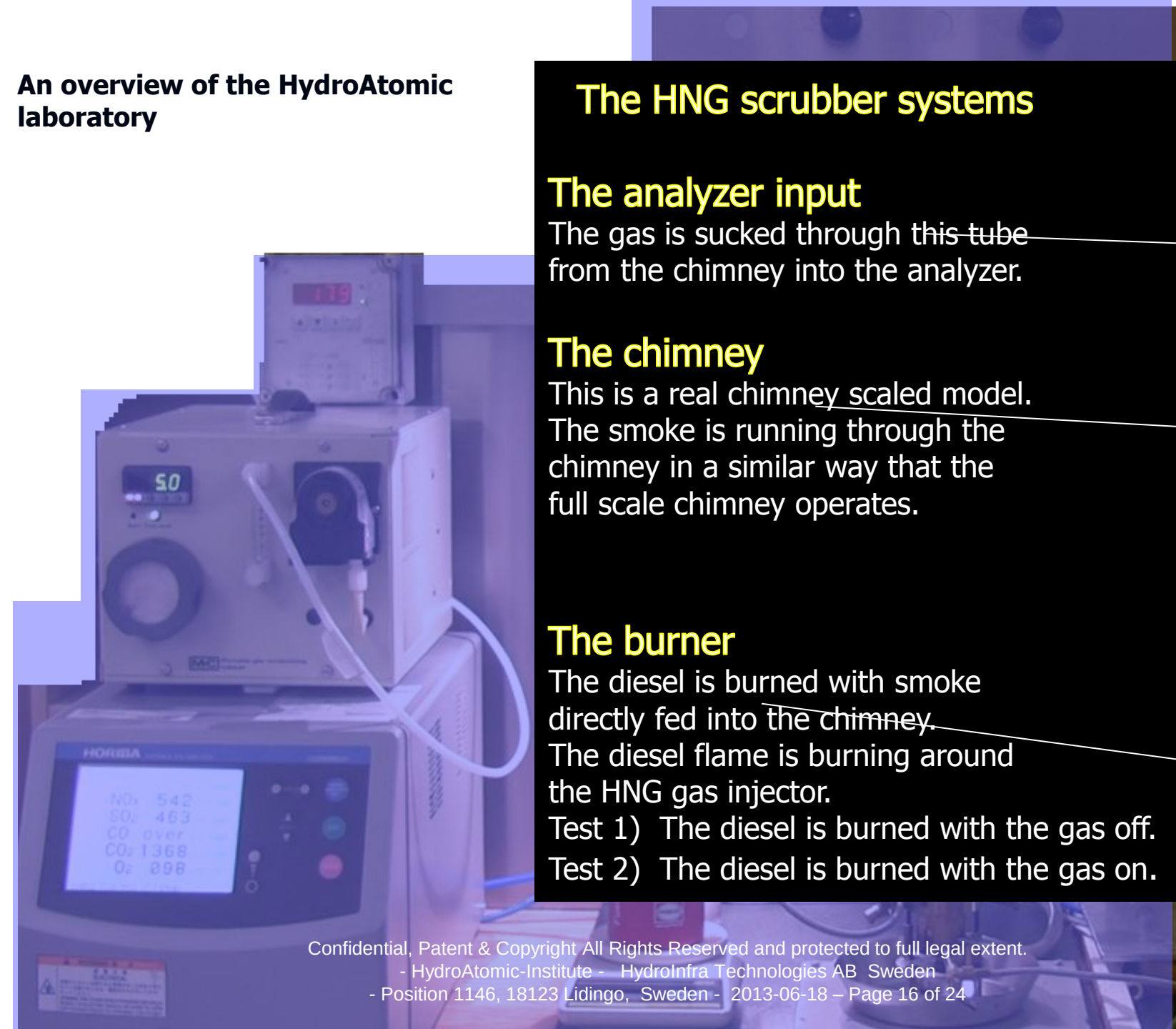
The gas is sucked through this tube from the chimney into the analyzer.

The chimney

This is a real chimney scaled model. The smoke is running through the chimney in a similar way that the full scale chimney operates.

The burner

The diesel is burned with smoke directly fed into the chimney.
The diesel flame is burning around the HNG gas injector.
Test 1) The diesel is burned with the gas off.
Test 2) The diesel is burned with the gas on.



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THE VERIFICATION PROCEDURE

A. The burner for the diesel is started to run constantly throughout the verification process.

B. The access of the burner flame to the chimney was adjusted during the process to achieve a continually stable measurement.

C. The measurement system is continually activated to sense the smoke flowing through the system.

D. The measurement processing system is delivering data to the screen and the electronic log systems and recorded by the computer every ten seconds.

E. The verification procedure is continually active within the two periods. A) When diesel only is burning. B) When diesel and HNG gas is burning together. All data is also recorded continually.

F. During the verification test procedures some sight inspections of the flame in the chimney is done by opening and closing of the chimney access. This effect will be seen on the data diagram.

G. As indicated by the data diagram, the verification process was done in two subsequent periods. One without and one with injected HNG gas. The data from these verification periods is presented in two diagrams.

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PICTURE FROM THE VERIFICATION PROCESS

The verification procedure took place in the HydroInfra/HydroAtomic Institute laboratory on May 30, 2013 in the presence of:

- Olof Sten, CEO of Palgo AB, specialized in smoke gas air analysis and combusting monitoring.

- Lars Månsson, CEO of Metlab AB, one of Sweden's leading air consultant laboratories with accreditation for most frequent measurement parameters.

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The accredited test instruments

Picture of the accredited Horiba measurement instrument with Olof Sten CEO of Palgo AB This particular equipment was used during the verification process.

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The measurement company presentations

Palgo AB

PALGO AB – Company Profile

PALGO is an engineering and marketing company specialised in Stack Gas Analysis and Occupational Health and Environmental Monitoring. The company was formed in 1983 and is operating from it's headquarter in
Arlöv (4 km north of Malmö) in south Sweden. Today the company has 5 employees including technically highly educated and skilled sales, service, engineering/production staff and administrative personnel.

PALGO represent several world leading companies with outstanding products for Advanced Analysing Technique. We are one of the leading Scandinavian suppliers of Monitoring Systems including measurement of HCl, NH3, CO, CO2, NO, NO2, N2O, SO2, Hg, VOC, O2, H2O , sampling pumps, gas detectors, airborne particulate monitoring, heat stress monitors, automatic weather stations, etc. PALGO has application knowledge and knowledge of local legislation and procedures with reference to emission and we have long and deep experience in System Integration, Sample Handling and conditioning. PALGO handles commissioning, installation, training and service of all equipment. Maintenance and supply of spare parts to a lot of advanced analysers supplied by PALGO during many years, is included in our daily routine.
(Continued…)

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Among the suppliers we represent are:

Environnement SA , DURAG Group, HORIBA , CASELLA Limited, Detector OY, M&C Products, Enotec GmbH, Rbr Messtechnik GmbH, Fresenius Umwelttechnik GmbH

PALGO has customers in a large part of the Swedish and Danish Power Industry. These are some of the larger customers:

- Power Plant builders (Alstom Power AB, Babcock and Wilcox Völund, KMV Energi etc)
- Power Plant operators (Fortum, Sydkraft, Vattenfall, Elsam etc)
- Chemical Waste Incinerators (SAKAB, Kommunekemi, EKOKEM etc)
- Waste Incinerators (SYSAV, Hässleholm, Ljungby, Sundsvall, Linköping, I/S Vestforbrandning, Fynsverket etc)
- Industry (Volvo, SSAB, AstraZeneca etc)

The relationship with all our suppliers and customers is excellent and based upon:
Long-lasting mutual trust, respect and understanding
.
Intensive and continuous exchange of knowledge and information
.
Joint Product promotion and Marketing Development

The deep and specialised knowledge of instrumentation and advanced analysers makes PALGO a reliable and qualified partner also in the future.

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The measurement company presentations

Metlab AB

METLAB was founded by Bo Månsson in 1965 as the very first consultant company specialised in the field of emission measurements and is today one of Sweden´s leading air consultant laboratories with accreditation for most frequent measurement parameters, such as stack sampling of dust, micro-organic pollutants (dioxins etc), metals (mercury etc), vapour of HCl, HF, SO2, SO3, NH3 etc, gas analysis (O2, CO2, CO, SO2, NOx, VOC), gas flow and temperature. Besides emission measurements METLAB offers a number of other consultant services in the environmental field.

METLAB is also the leading manufacturer of Stack Sampling Equipment in Scandinavia including pitot tubes and suction pyrometers. (continued…)

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The measurement company presentations

Metlab AB

METLAB offers enviromental consultant services from three locations in Sweden: Enköping, Falun and Skelleftehamn. The main business is emission measurements by the accredited test laboratories. A variety of other environmental consultant services is also offered (see examples below)

Emission Measurements

•Emission measurements with reference methods (CEN/TC 264)
•Emission limit value compliance assessment
•Acceptance tests measurements (proof of guarantee) on energy plants and gas cleaning equipment
•Process optimization measurements
•Permit measurements
•QAL2 calibration measurements of CEMS
•AST calibration control measurements
•Measurements for checking CEMS
•Comparable measurements according to Swedish NFS 2004:6 (NOx)
•O2, CO2, CO, SO2, NO, NO2, NOx, N2O, TOC
•HCl, HF, SO2, NH3
•Hg, Cd+Tl and Sb+As+Pb+Cr+Co+Cu+Mn+Ni+V
•Dioxins (PCDD/PCDF), PAH, PCB-WHO
•Dust/Particulate matter
•Particle size distribution PM1/PM2,5/PM10
•Gas velocity, gas flow, water content, temperature
•Fire room temperature, residence time determination
•Continuous Hg flue gas analysis (Semtech gas analyzer)
•List of accredited measurement methods
•Residence time measurements on waste incineration plants

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The definition of the various gases analyzed.

Oxygen (O_2)

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Oxygen is the third most abundant element in the universe and makes up nearly 21% of the earth's atmosphere. Oxygen accounts for nearly half of the mass of the earth's crust, two thirds of the mass of the human body and nine tenths of the mass of water. Large amounts of oxygen can be extracted from liquefied air through a process known as fractional distillation. Oxygen can also be produced through the electrolysis of water or by heating potassium chlorate ($KClO_3$).

Oxygen is a highly reactive element and is capable of combining with most other elements. It is required by most living organisms and for most forms of combustion. Impurities in molten pig iron are burned away with streams of high pressure oxygen to produce steel. Oxygen can also be combined with acetylene (C_2H_2) to produce an extremely hot flame used for welding. Liquid oxygen, when combined with liquid hydrogen, makes an excellent rocket fuel. Ozone (O_3) forms a thin, protective layer around the earth that shields the surface from the sun's ultraviolet radiation. Oxygen is also a component of hundreds of thousands of organic compounds.

Estimated Crustal Abundance: 4.61×10^5 milligrams per kilogram
Estimated Oceanic Abundance: 8.57×10^5 milligrams per liter
Number of Stable Isotopes: 3 (ccView all isotope data)
Ionization Energy: 13.618 eV
Oxidation States: -2
Electron Shell Configuration:
$1s^2$
$2s^2 \quad 2p^4$
Reference : http://education.jlab.org/itselemental/ele008.html

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Carbon Monoxide (CO)

Carbon Monoxide (also known as CO) is a colourless, odourless poisonous gas and is a common yet preventable cause of death from poisoning worldwide. Approximately half of the deaths from unintentional CO poisonings result from the inhalation of smoke from fires. Other significant causes are vehicle exhausts and deaths in industrial / commercial settings. On average between 1 and 2 people die each year in Ireland from unintentional CO poisoning in the home in incidents related to domestic heating or other fossil fuel installations in the home (i.e. excluding the inhalation of smoke from fires).

The incomplete combustion of organic fossil fuels such as oil, gas or coal is a common environmental source of CO and is responsible for many cases of non-fatal unintentional CO poisoning.

In normal conditions the combustion process (the addition of oxygen) will result in carbon in the fossil fuel, combining with oxygen, in the air, to produce Carbon Dioxide (CO2), the same substance we exhale when we breathe.

However, if there is a lack of air for the combustion process or the heating appliance is faulty, Carbon Monoxide can be produced.

When CO is inhaled into the body it combines with the blood, preventing it from absorbing oxygen. If a person is exposed to CO over a period, it can cause illness and even death. Carbon Monoxide has no smell, taste or colour. This is why it is sometimes called the "Silent Killer".

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Reference: http://www.carbonmonoxide.ie/htm/whatis.htm

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Sulfur Dioxide (SO_2)

Sulfur dioxide (SO_2) is one of a group of highly reactive gasses known as "oxides of sulfur." The largest sources of SO_2 emissions are from fossil fuel combustion at power plants (73%) and other industrial facilities (20%). Smaller sources of SO_2emissions include industrial processes such as extracting metal from ore, and the burning of high sulfur containing fuels by locomotives, large ships, and non-road equipment. SO_2 is linked with a number of adverse effects on the respiratory system.

Sulfur dioxide can cause acid rain that seriously affects ecosystems. Acid rain is a major problem in the northern hemisphere, where trees and whole forests have been affected. Sulfur dioxide deposition can affect vegetation around industrial discharges and in cities. Lichens are good bio-indicators of pollution and do not like to grow where there is sulphur dioxide in the air.

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Reference: http://www.mfe.govt.nz/issues/air/breathe/sulphur-dioxide.html

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Carbon dioxide (CO_2)

Carbon dioxide, (CO_2), a colourless gas having a faint, sharp odour and a sour taste; it is a minor component of Earth's atmosphere (about 3 volumes in 10,000), formed in combustion of carbon-containing materials, in fermentation, and in respiration of animals and employed by plants in the photosynthesis of carbohydrates. The presence of the gas in the atmosphere keeps some of the radiant energy received by Earth from being returned to space, thus producing the so-called greenhouse effect. Industrially, it is recovered for numerous diverse applications from flue gases, as a by-product of the preparation of hydrogen for synthesis of ammonia

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Reference: http://global.britannica.com/EBchecked/topic/94900/carbon-dioxide

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NO_x

NO_x is a generic term for mono-nitrogen oxides NO and NO_2 (nitric oxide and nitrogen dioxide). They are produced from the reaction of nitrogen and oxygen gases in the air during combustion, especially at high temperatures. In areas of high motor vehicle traffic, such as in large cities, the amount of nitrogen oxides emitted into the atmosphere as air pollution can be significant.

No_x gases are formed everywhere where there is combustion – like in an engine. In atmospheric chemistry, the term means the total concentration of NO and NO_2. NO_x react to form smog and acid rain. NO_x are also central to the formation of tropospheric ozone.

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Reference: http://en.wikipedia.org/wiki/NOx

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