Test Results For Physical Separation Of Tritium From Noble Gases And It's Implications For Sensitivity And Accuracy In Air And Stack Monitoring

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WE FACE A CHALLENGE

At many nuclear facilities,
Air and Stack monitors are required to measure:
Multiple radio-active materials
Separately and simultaneously
With great accuracy and high sensitivity

EVEN WHEN

High concentrations of one material are likely to mask the signals from the low concentration of other materials being measured.

WE NOTE THAT

Most ionizing radiation detector types exhibit significant cross talk when presented with multiple sources of ionizing radiation.

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Solution…..

Overhoff Technology sees a need for a family of air and stack monitors to simultaneously measure

Tritium

Organic C-14

Inorganic C-14 ($^{14}CO_2$)

Noble Gases

Specifically

- New - Tritium–Carbon-14 **Survey Meter**
- New - Tritium–Carbon-14–Noble Gas **Stack Monitor**
- Upgraded - Tritium–Carbon-14 **Air Sampler**

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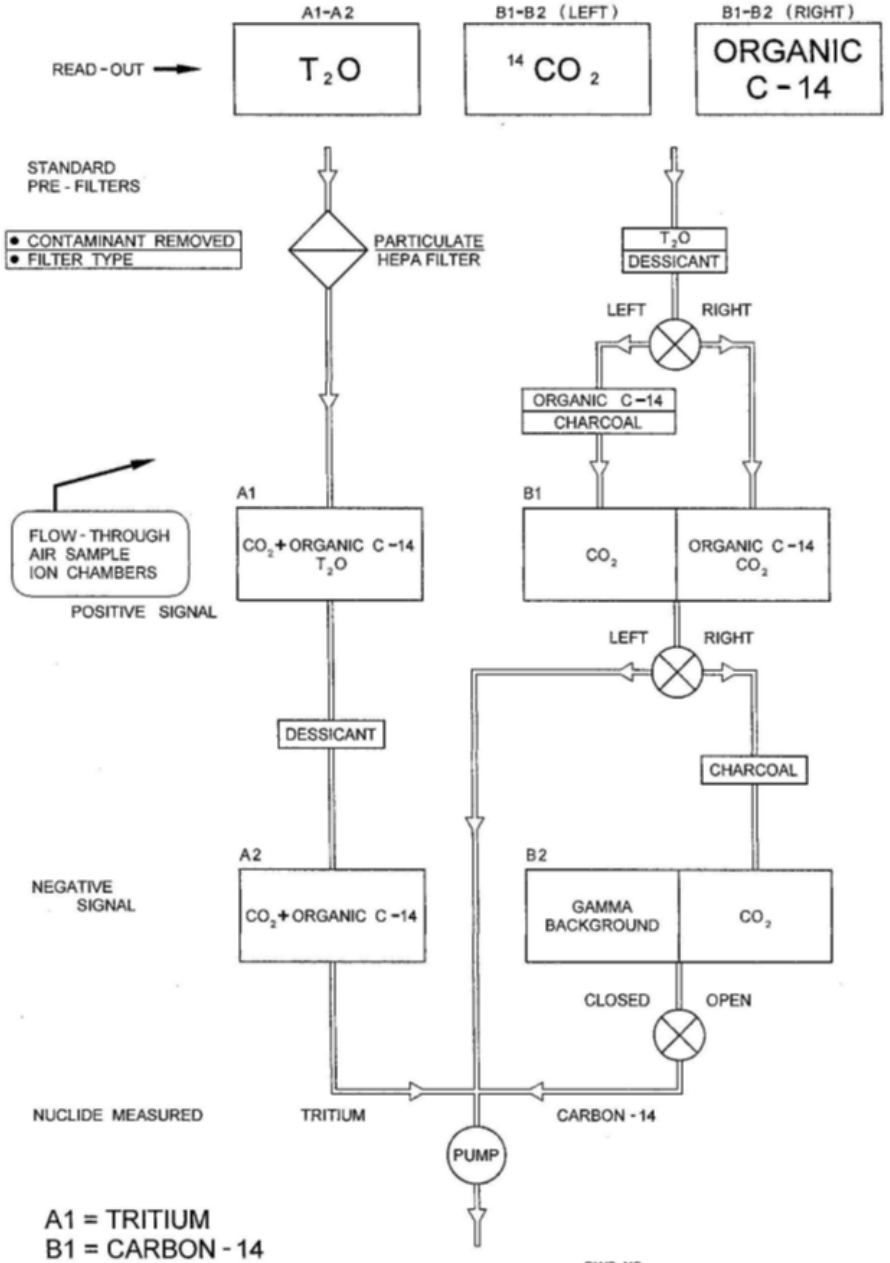

NEW SURVEY METER

Good Results thru
Physical Separation

TriCair

Tritium and C-14
SURVEY METER

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Good Results thru Physical Separation

NEW FAMILY OF STACK MONITORS

Triathalon

Tritium, C-14,
Noble Gas
STACK MONITORS

NEWLY UP-GRADED AIR SAMPLERS

TASC

Tritium, C-14 SAMPLER
With Mass Flow Meter
More efficient Re-Combiner

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Separation of Tritium Oxide from Noble Gases Via Nafion Membrane

TEST PROCEDURE

VALIDATION TEST OF A DISCRIMINATING TRITIUM MONITOR FOR MEASURING TRITIUM OXIDE IN THE PRESENCE OF NOBLE GASES

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- REV. 1

August 25, 2011

- APPLICABLE TO:

MODELS 421-HTO AND 93-DR-T-HTO

TEST CONDUCTED AT:
OVERHOFF TECHNOLOGY CORPORATION
1160 US ROUTE 50, MILFORD, OHIO, USA

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Background

Model 421-HTO

- The Model 421-HTO is designed to measure Tritium concentration in the oxide form (HTO).

- The collected sample is “processed” in order that only tritium (HTO) is measured from a sample which may contain noble gases.

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Model 421-HTO Uses A Dual Ionization Chamber Detector

- Dual chambers share the same axis mounted to a common electrometer.
- Model 421-HTO is designed for a low level detection limit of

  $0.005\ MBq/m^3$

  or

  $0.1\mu Ci/m^3$
- Requiring large chambers with nominal volume of 8 liters each.

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- The “measurement” side chamber, has sample flowing through it and the other chamber the “compensation” chamber is sealed.

- Both chambers are approximately equal in effective volume and respond to external gamma radiation equally.

- The two chambers have bias voltages of opposite polarity, thus cancelling the effects from background gamma radiation.

The technique of using a semi permeable membrane for the separation of tritium in oxide form (HTO) from noble gases in an air sample has been known for over 30 years.

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Test objective:

What is the Nafion Tube Dryer Efficiency over the operating temperature range of 5°C to 40°C?

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Nafion Dryer Process

- HTO is stripped out of the wet sample that flows through the dryer.

- The purge gas is combined with the sample of HTO only and is measured in the detector of the monitor.

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- This protocol dictates the importance of knowing the efficiency for a given Nafion tube dryer within the operating conditions for this particular monitor.

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Use of permeation (Nafion) tube dryer to REMOVE the Noble Gases from the Sample Flow Stream

- The dryer consists of two concentric flow tubes
- The outer tube is stainless steel
- The inner tube is the permeation membrane
- Sample gases flow in thru the center tube(s)
- Clean dry PURGE air flows in opposite direction thru the outer tube
- Any H_2O or T_2O moves thru the membrane into the purge flow
- The Noble Gas goes straight to exhaust or to separate detector
- The clean purge air carries only Tritium into the Ion Chamber.
- Purge flow rate 2X main flow rate, results in a Tritium sample concentration 0.5 times the original sample
- The corrected value is shown on the display

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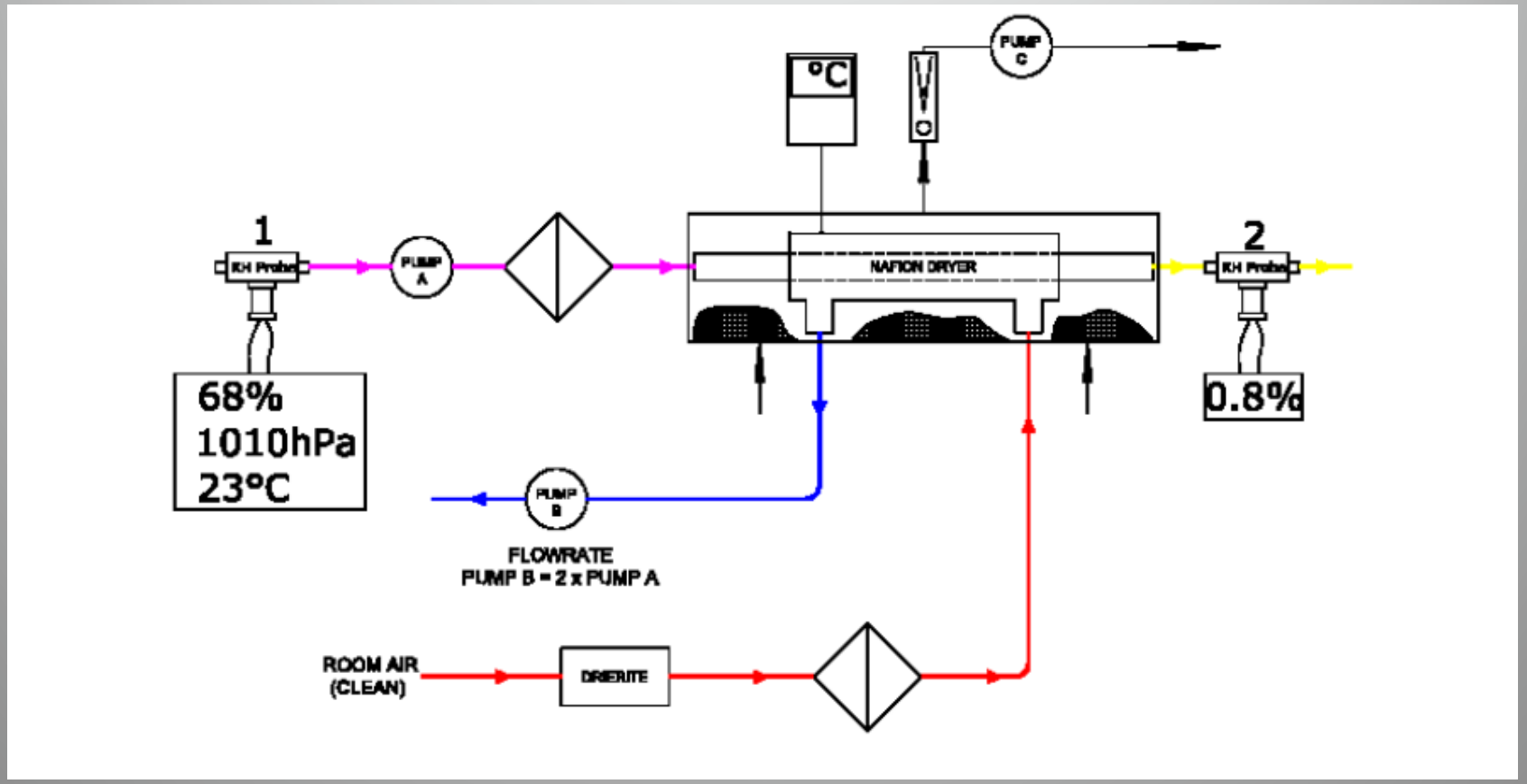
Set-up for Testing Efficiency of a Nafion Tube Dryer



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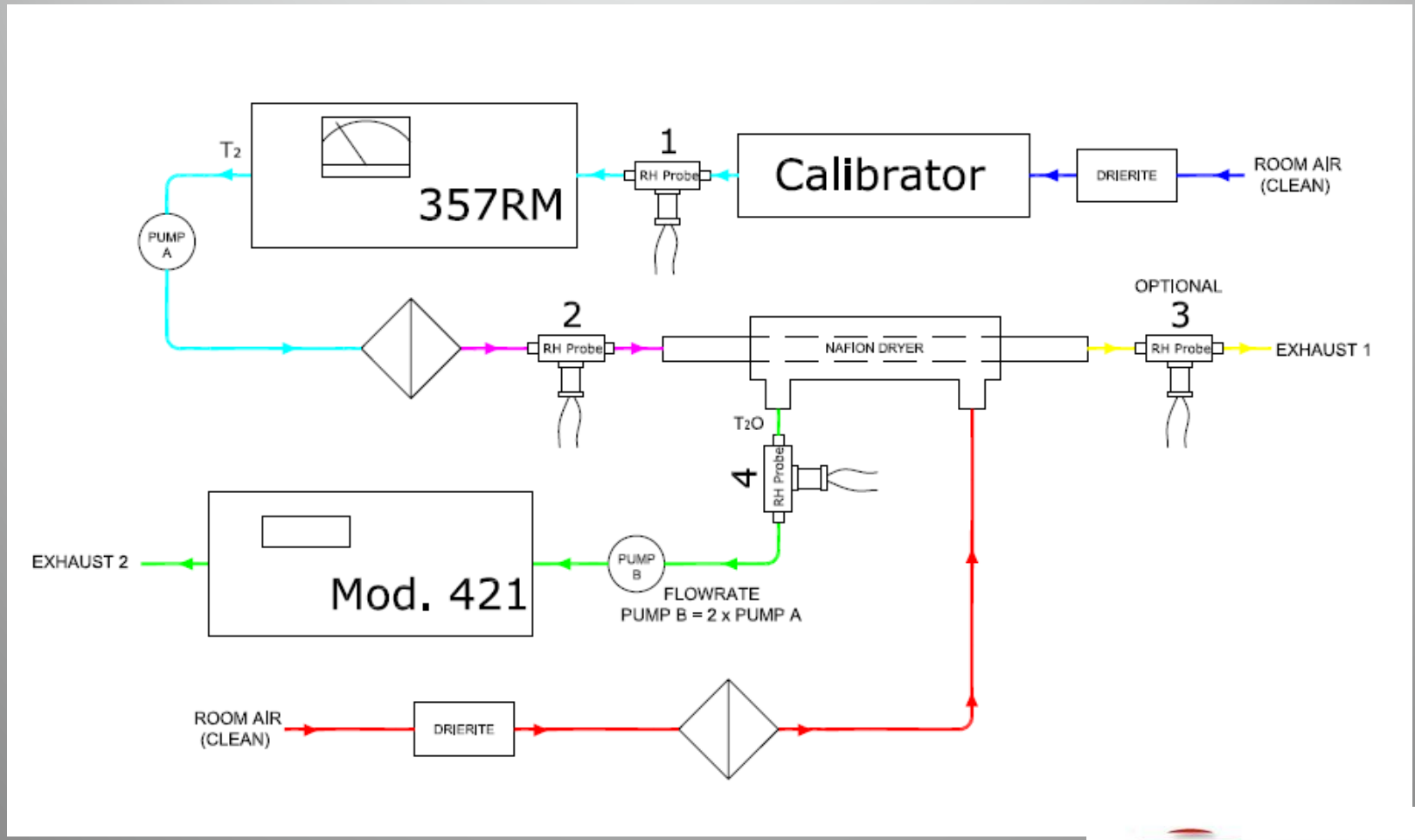
Set-up for Calibrated Injection of Tritium into Test Apparatus



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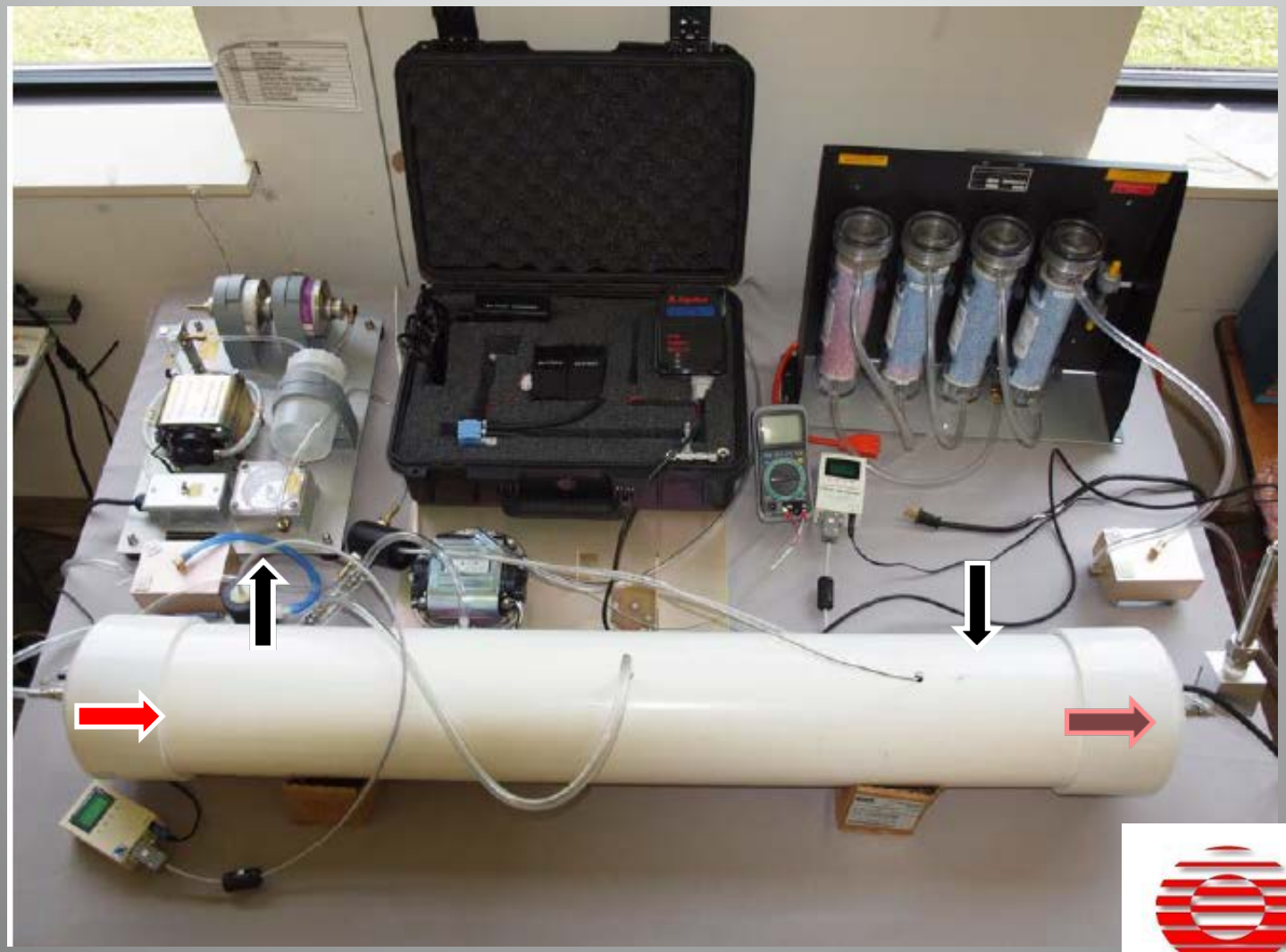
Set-up for Test

2 pumps, the inlet RH sensors, the outlet dew point sensor with sampling cell at the right end of the PVC chamber



Purge Flow In

Main Flow In

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Nafion Tube Dryer
Test Results

Naf. t°[°C]	*In* RH [%]$_{min}$	*In* RH [%]$_{max}$	*Out* RH [%]$_{min}$	*Out* RH [%]$_{max}$	ε_{min} [%]	ε_{max} [%]	Condition
5	75	78	0	2	97.33	100.00	COOLING
10	75.5	78.5	0.4	2.4	96.82	99.49	COOLING
12	71.8	74.8	0.4	2.4	96.66	99.47	COOLING
15	68.6	71.4	0.6	2.6	96.21	99.16	COOLING
20	81	84.5	1.6	3.6	95.56	98.11	COOLING
26	71.5	74.5	1.7	3.7	94.83	97.72	AMBIENT
30	70.2	73	2.1	4.1	94.16	97.12	WARMING
35	69.6	72.4	2.6	4.6	93.39	96.41	WARMING
40	83	86	6.5	8.5	89.76	92.44	WARMING

The input results are based on the accuracy of the temperature and humidity meter iTHX-SD.
The output results are based on the accuracy of the temperature and humidity analyzer EdgeTech HTM.

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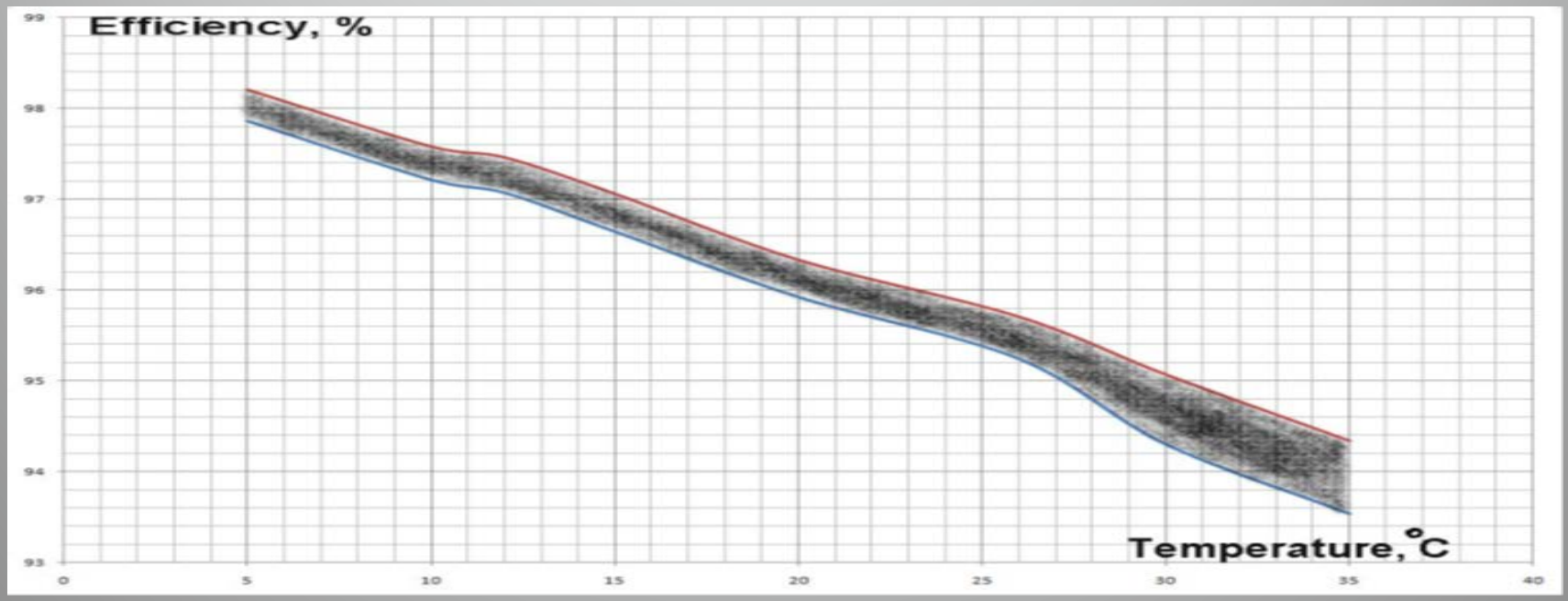
Efficiency change with Temperature: 90% at 40° C to 99% at 5° C.



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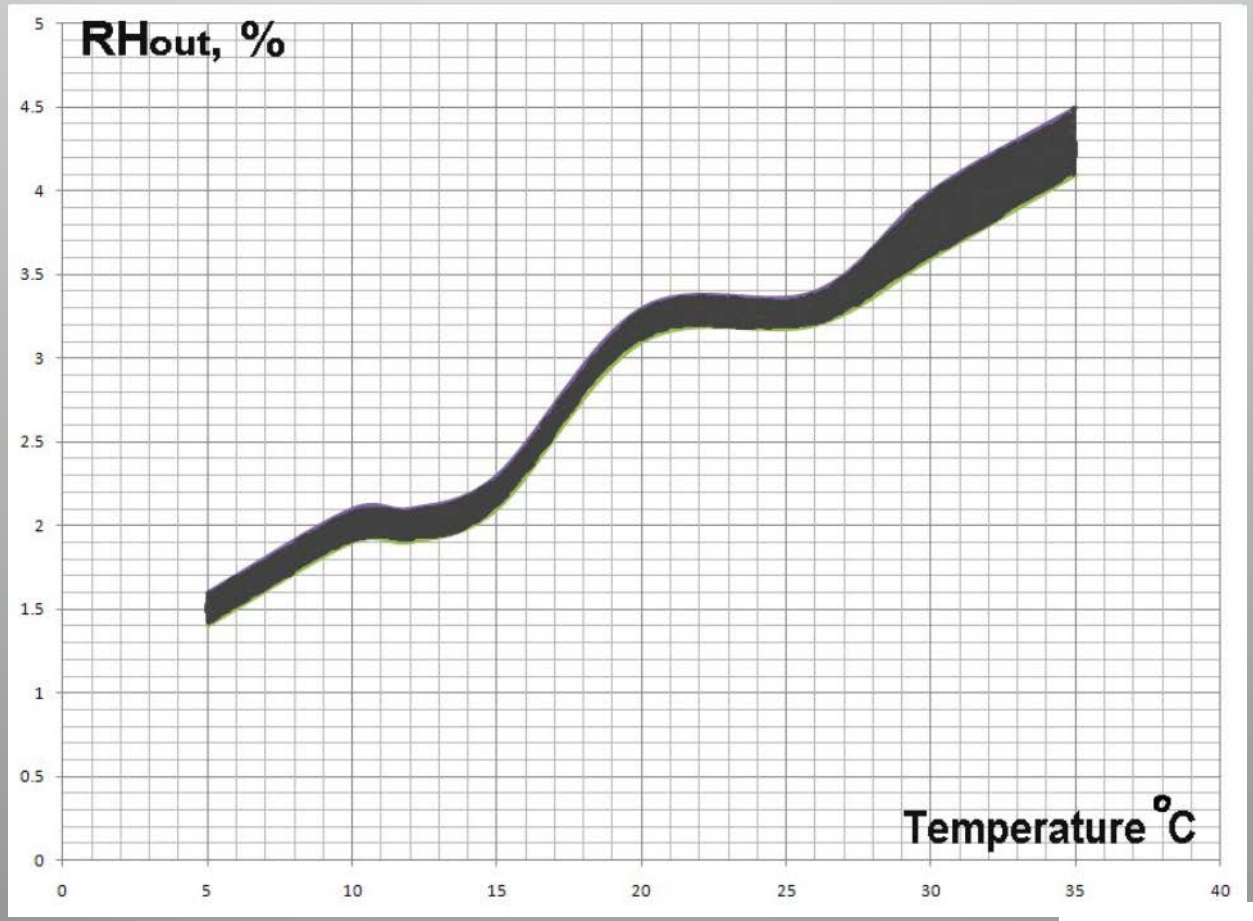
Relative Humidity of Exit Gas vs Temperature: 1.5% at 5° C to 4.3% at 35° C



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Preparation of Clean Dry Purge Gas

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Results and Conclusions

- ***RESULTS:*** This test provides data on how efficiency varies over the temperature range 5°C to 40°C. The test was conducted at Overhoff Technology Corporation during July 2011.
- ***TEST CONCLUSIONS***: The drying efficiency ranged from a minimum of 90% at 40^{o} C to a maximum of 99% at 5^{o} C.
- ***BATTERY OF TESTS CONCLUSIONS***: Detection Limit **0.005 MBq/m^3 achieved even in presence of high Nobel Gas Levels**

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Thank you for your attention,

Your Questions, Comments and Discussion are very welcome

Robert Goldstein, Ivan Mitev, Dell Williamson