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To FLAMMABLE GAS TANK SAFETY	From WASTE TANKS PROCESS ENGINEERING	Page 1 of 1 Date 1/19/95
Project Title/Work Order Results of Gas Monitoring of Double-Shell Flammable Gas Watch List Tanks		EDT No. 610149 ECN No.

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1		Cog. Mgr. N. W. Kirch	<i>NWK</i>	1-23-95/R2-1			
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7. Abstract Tanks 103-SY; 101-AW; 103-, 104-, and 105-AN are on the Flammable Gas Watch List. Recently, standard hydrogen monitoring system (SHMS) cabinets have been installed in the vent header of each of these tanks. Grab samples have been taken once per week, and a gas chromatograph was installed on tank 104-AN as a field test. The data that have been collected since gas monitoring began on these tanks are summarized in this document.		
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1.0 INTRODUCTION

Tanks 241-SY-103, 241-AW-101, 241-AN-103, 241-AN-104, and 241-AN-105 are on the Flammable Gas Watch List. Standard hydrogen monitoring system (SHMS) cabinets have recently been installed in the vent header of each of these tanks. Grab samples have been taken and analyzed using mass spectroscopy as a means of baselining the SHMS cabinets. A gas chromatograph was installed on tank 241-AN-104 as a field test for the instrument. The data that have been collected since gas monitoring began on these tanks are summarized in this document.

2.0 TANK CONTENTS

Tank 241-SY-103 contains about 466 m³ (123,000 gallons) of concentrated complexant (CC) waste, 1590 m³ (420,000 gallons) of double-shell slurry (DSS) from the 242-S Evaporator, 122 m³ (32,200 gallons) of uranium sludge from ion exchange processing, 496 m³ (131,000 gallons) of interstitial liquid and waste from tank 241-SX-104, and about 114 m³ (30,000 gallons) of waste from other operations.

Tanks 241-AW-101, 241-AN-104, and 241-AN-105 contain about 3785 m³ (1,000,000 gallons) each of double-shell slurry feed from the 242-A Evaporator. Tank 241-AN-103 contains about 3785 m³ (1,000,000 gallons) of double-shell slurry from the 242-A Evaporator.

3.0 HYDROGEN MONITORING

Standard hydrogen monitoring systems (SHMS cabinets) have been installed near the vent headers of Tanks 241-AW-101, 241-SY-103, 241-AN-103, 241-AN-104, and 241-AN-105. Hydrogen in the exhaust gas is detected with two Whittaker cells, which rely on the reaction of the gas with an electrode in an electrolyte. One cell has a range of 0 - 1%, and the other has a range of 0 - 10%. The instruments are tested and calibrated quarterly. Further details on the SHMS design and how the Whittaker cells function can be found in the Appendix.

To provide a baseline for the Whittaker cells, grab samples were taken from the SHMS cabinets. These samples were analyzed using mass spectroscopy at Pacific National Laboratories (PNL). To take a grab sample, the air flow through the SHMS is diverted to a side loop which contains a sample cylinder. The air flow through the loop is set between 0.22 and 0.44 CFM. The air stream passes through the cylinder for at least five minutes. The valves leading to the side loop and the sample cylinder are then closed, and the sample cylinder is removed and sent to PNL for analysis.

Tank 241-SY-103

A SHMS was installed in Tank 241-SY-103 (103-SY) in late June. It is located by riser 7A in the exhaust vent header. Since June, the readings have been steady at 0% H₂. The stripchart will show changes in concentration only if the change is greater than 100 ppm (0.01%). Therefore, the hydrogen concentrations in the vent header have been below 100 ppm. Grab samples taken between August and October confirm this (see Table 1). The average hydrogen concentration was 28 ppm, and the average nitrous oxide concentration was 14 ppm. H₂/N₂O ratios have ranged from 0.3 to 5.6. When the gas averages and ratios are determined, the "less than" values were assumed to be the actual values. These concentrations and the ratio of hydrogen to nitrous oxide are very similar to those found in Tank 241-SY-101, which ranges from 1 to 1.3.

Table 1. 103-SY Grab Samples.

DATE	H ₂ , ppm	N ₂ O, ppm	OTHER, ppm
August 18	19	<10	
August 18	19	<10	
August 25	16	<10	
August 25	38	18	
September 1	63	39	CH ₄ = 11 *
September 1	3	<10	
September 7	<40	<10	
September 7	38	32	
September 15	27	23	
September 15	15	<10	
September 23	28	12	
September 23	48	23	
October 6	16	<5	
October 6	22	5	
October 19	22	<5	
October 19	28	<5	

* Methane was normally reported as being less than 10 ppm

Tank 241-AW-101

A SHMS was installed in Tank 241-AW-101 (101-AW) in late September. Two gas release events occurred soon afterwards on October 2 and 4, 1994 (see Fig. 1). The chart recorder on this cabinet has a 200 ppm offset. The hydrogen concentration increased from 800 ppm to 5500 ppm early on October 2 and had decreased to 1500 ppm by October 4. It increased again to 8800 ppm on October 4. This last increase corresponded to a 0.55 inch waste surface level drop. Also at that time, the tank dome pressure increased about 0.2 in. w.g., but it returned to the baseline in less than a minute. An analysis of this release using the GOTHIC computer code concluded that the concentration of hydrogen in the release gas may be greater than 60%, and the amount of gas released during the two events is estimated to be between 800 and 1100 ft³ (23 and 31 m³) (McLaren, 1994).

Only two more sharp hydrogen increases have been noted since early October. On October 21, the hydrogen increased to 3000 ppm, and on November 27, it increased to 5000 ppm. Otherwise, hydrogen concentrations have stayed between 200 and 800 ppm. Results from grab sample analyses tend to be lower than the Whittaker cell readings (see Table 2). The average hydrogen concentration in these grab samples was 682 ppm. The average nitrous oxide concentration was 22. The H₂/N₂O ratios ranged from 1.2 to 58. These ratios are much higher than the gas ratios for the SY tanks.

Table 2. 101-AW Grab Samples.

DATE	H ₂ , ppm	N ₂ O, ppm	NH ₃ , ppm	CH ₄ , ppm
September 28	467	8	≥9	<10
September 28	65	9	≥6	<10
October 6	12	<10	none detected	<10
October 6	13	5	none detected	<10
October 21	2960	94	none detected	31
October 21	2980	93	none detected	30
October 27	240	<10	none detected	<10
November 2	173	<10		<10
November 10	400	<10		<10
November 16	380	10		<10
November 22	170	5		<10
November 30	910	31		<10
December 7	120	5		<10
December 14	260	6		<10

Figure 1. Tank 241-AW-101 Hydrogen Concentrations.

Tank 241-AN-103

Hydrogen has been monitored in Tank 241-AN-103 (103-AN) since late September. Whittaker cell readings have been near 0% H_2 almost consistently since its installation. However, every few weeks the hydrogen increases to 200 - 400 ppm for about 24 hours. The highest concentration seen was 700 ppm on November 29. It had decreased back to the baseline by November 30. Nine grab samples have been analyzed (see Table 3). The average H_2 concentration was 69.2 ppm, and the average N_2O concentration was 8.3 ppm. The H_2/N_2O ratios have ranged from 2.0 to 16.4.

Tank 241-AN-104

A SHMS cabinet was installed in Tank 241-AN-104 (104-AN) in late September. The Whittaker cell readings have stayed below 200 ppm since its installation. An on-line gas chromatograph was placed at the vent header in mid-October to test how well the instrument performs in field conditions. Its range is 5 - 5000 ppm hydrogen, and it is calibrated every 24 hours. Baseline readings have been below 80 ppm (see Fig. 2). Data from the gas chromatograph have been consistent with data from the Whittaker cells.

A possible gas release occurred on November 6. At 1417 hours, the hydrogen concentration was 62 ppm. Ten minutes later, the concentration was 1245 ppm. The concentration peaked at 3050 ppm at 1734 hours. It then decreased and stabilized between 15 and 20 ppm about midnight on November 11. These concentrations were measured with the gas chromatograph; the stripchart recorder was not functioning properly during this period, and no data are available from the SHMS cabinet at the time of the peak. Grab samples taken before and after the release confirm the gas chromatograph measurements (see Table 3). The average H_2 concentration in the eight grab samples analyzed was 67.4 ppm, and the average N_2O concentration was 9.6 ppm. The H_2/N_2O ratios in the grab samples have ranged from 4.7 to 8.4.

Tank 241-AN-105

A SHMS cabinet was installed in Tank 241-AN-105 (105-AN) in late September. The hydrogen concentrations recorded have been below 200 ppm, except from October 13 - 15. The hydrogen concentration began to rise on October 13, reaching a maximum of 600 ppm on October 14. It decreased back to 200 ppm on October 15. Six grab samples have been analyzed (see Table 3). The average H_2 concentration in these samples was 133.7 ppm, and the average N_2O concentration was 22.7 ppm. The H_2/N_2O ratios have ranged from 4.8 to 7.1.

Table 3. Grab Sample Data For AN Tanks.

TANK	DATE	H ₂ , ppm	N ₂ O, ppm
103-AN	November 2	77	<10
	November 10	34	<10
	November 16	81	6
	November 22	22	< 5
	November 30	230	14
	December 7	10	< 5
	December 14	25	5
	December 21	120	<10
	January 4	24	<10
104-AN	November 2	47	<10
	November 9	154	19
	November 16	59	7
	November 22	32	5
	November 30	67	8
	December 7	52	8
	December 21	66	<10
	January 4	62	<10
105-AN	November 2	101	19
	November 9	220	31
	November 16	96	20
	November 22	98	20
	November 30	114	20
	December 14	173	26

Figure 2. Tank 241-AN-104 Hydrogen Concentrations.

4.0 REFERENCE

McLaren, J. M., 1994, *Gothic Simulation of Tank 241-AW-101 GRE, October 1 - 4, 1994*, (internal memo 71120-94-JMM-004 to G. D. Johnson, November 28), Westinghouse Hanford Company, Richland, WA.

APPENDIX

Considerations in the Design of the
Standard Monitoring System for
Hanford Flammable Gas Watch List Tanks

CONSIDERATIONS IN THE DESIGN OF THE STANDARD HYDROGEN MONITORING SYSTEM FOR HANFORD FLAMMABLE GAS WATCH LIST TANKS

D. J. Sherwood, November 16, 1994

ABSTRACT

Flammable gas meters are used by several industries to monitor and/or detect the presence of flammable gases. Westinghouse Hanford Company has designed, built, and installed Standard Hydrogen Monitoring Systems on double shell tanks that are on the Flammable Gas Watch List. The *Standard Hydrogen Monitoring System* consists of a cabinet with piping and instrumentation which supports an on-line hydrogen detector and a "grab sampler." The cabinet isolates the equipment from the environment, i.e. rain, wind, and temperature extremes. The hydrogen detector is presently a Whittaker electrochemical cell, but other detectors could be accommodated and, in fact, are being looked into. The grab sampler is a sub-system which allows gas samples to be removed from the tank for highly detailed analyses in a specially-equipped laboratory. The Standard Hydrogen Monitoring System therefore allows for both continuous, gross measurements of the hydrogen concentration and, extremely precise "snap-shots" of the gas concentrations in Hanford high-level radioactive liquid waste tanks.

INTRODUCTION

Potentially dangerous gases are often evolved from industrial processes. The primary hazards associated with small levels of gas are toxicity and combustion. Regular inspection of storage facilities, proper work controls and procedures, and adequate ventilation ensure that dangerous accumulations of gas are either avoided or dealt with promptly.

Protection of hazardous areas from explosions has been a concern since the industrial revolution. Passive methods, with the emphasis on preventing an ignition source from reaching flammable gases, have been used historically; the supposition being that a flammable gas mixture is present. The *lower flammability limit* (LFL) is the minimum concentration of a flammable gas in air that will support combustion; typically 1 - 10% of such a gas in air is flammable. Table 1 gives values of the LFL in terms of the volume percent of gas in air for a selection of flammable gases. There is also an *upper flammability limit* because if there is insufficient oxygen in a gas mixture then combustion can not be supported.

Table 1. Lower Flammability Limits (LFLs)
for Common Gases.

Gas	Minimum Concentration (vol. %) of Gas in Air Capable of Supporting Combustion (LFL)
Hydrogen	4.0%
Ammonia	15%
Methane	5.0%
Acetylene	2.5%
Butane	1.9%
Naphthalene	0.9%
Carbon Monoxide	12.5%

Two types of gas sensor to detect flammable gases are in widespread use today: 1) the metal oxide semiconductor sensor and 2) the catalytic gas detector (or pellistor). Optical methods for gas detection have also attracted interest because they are immune to poisoning, have a response that is selective, unambiguous and rapid, and can be remotely located and connected by optical fibre

cables which do not carry current and are free from electromagnetic interference. Optical methods, however, lack robustness and are expensive.

Radioactive liquid waste produces hydrogen from the interaction of γ -radiation and water. If the waste contains organic chelating agents, additional hydrogen gas, as well as nitrous oxide and ammonia, can be produced by thermal and radiolytic decomposition of these organics. Twenty-five high-level radioactive liquid waste storage tanks located underground at the Hanford site in Washington state contain waste that also retains gas; the waste is very viscous, is under large pressures at the bottom of the tanks (hydrostatic head), and has a yield strength. Gas retention by the waste results in accumulations which are released to the tank vapor space when the buoyant force from the retained gas exceeds the density and strength of the waste. Tanks that are nearly filled to capacity have relatively little vapor space. So if the waste rapidly releases hydrogen and nitrous oxide (an oxidizer), a flammable gas mixture may result. For example, waste stored in tank 241-SY-101 has upon at least two occasions released flammable gas mixtures to the tank dome space.

Twenty-five of the one-hundred and seventy-seven high-level radioactive liquid waste storage tanks in the Hanford 200-Area are on a *Flammable Gas Watch List* (FGWL); nineteen are single-shell tanks that have been partially or fully stabilized (isolated) while the remaining six are the newer double-shell tanks. The double-shell tank 241-SY-101 has been the subject of a large data gathering/analysis program to understand why waste stored in this tank episodically releases large quantities (thousands of cubic feet) of hydrogen and nitrous oxide. The amount of hydrogen released into the dome space of tank 241-SY-101 by two of these "gas release events" was large enough to establish a

concentration greater than the LFL,¹ and therefore the gas might have burned if ignited. This is why a large mixer pump was installed in the tank to slowly release the gas generated in the waste, thereby precluding episodic gas release events and maintaining hydrogen levels to less than twenty-five percent of the LFL (a common safety factor). Vapor in the dome space of the other five FGWL double-shell tanks, 241-AW-101, 241-SY-103, 241-AN-103, 241-AN-104 and 241-AN-105, are all being monitored now; the single-shell tanks on the FGWL will have Standard Hydrogen Monitoring Systems installed on them shortly. Design considerations for the Standard Hydrogen Monitoring System are presented herein.

DESCRIPTION OF THE STANDARD HYDROGEN MONITORING SYSTEM

The Standard Hydrogen Monitoring System consists of a hydrogen specific gas detector along with the capability to remove grab samples from the tank dome space. The gas sampling system consists of tubing, valves, vacuum pump, and data acquisition devices. The Standard Hydrogen Monitoring System complies with the requirements of ANSI/NFPA-70 for use in a Class I, Division I, Group B hazardous location.²

The instrumentation required to measure gas concentrations in FGWL tanks is placed inside of a weather proof cabinet; ambient conditions at Hanford range from -20 to 120 °F, with winds speeds to 80 MPH. Hydrogen is measured on-line with a Whittaker electrochemical cell; other gases are measured by analyzing grab

¹The LFL for a gas mixture, e.g. H₂ and NH₃ in air, will differ from that for H₂ in air or NH₃ in air.

²Also, equipment inserted into FGWL tanks is bonded in accordance with WHC-SD-AR-001, "Recommended Bonding Practices for Equipment Near Sources of Potential Hydrogen Release in 200E and 200W Tank Farms to Avoid Static Discharge," or ANSI/NFPA-77, "Recommended Practice on Static Electricity," whichever is more conservative. ANSI/NFPA-70 and ANSI/NFPA-78 are also applicable standards for the FGWL tanks.

samples taken from the tank. Redundant instrumentation (*i.e.* two Whittakers) assures collection of a continuous data set in the event of component failures. The gas sampling and measurement system is intrinsically safe: it does not introduce any potential ignition sources. The system and its components are robust enough for use in the field. Enclosures for electrical or electronic components meet requirements for Type 4 enclosures per NEMA 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)."

Hydrogen sensors are selected to measure hydrogen in an atmosphere which may also contain unknown quantities of air, nitrous oxide (N_2O), ammonia (NH_3), water vapor (H_2O), carbon dioxide (CO_2), carbon monoxide (CO), and other gaseous constituents.

The design of the Standard Hydrogen Monitoring System provides a physical interface to both local and remote data acquisition systems. The signal output from the system is 4-20 mAdc for interfacing with a remote computer/data logging system. It also provides a local readout display, and a local strip chart recorder display as a backup recording system.

The gas sampling system draws a sample of gas from the vapor space or ventilation duct of a FGWL tank operating normally between -0.25 and -4 inches water gage (-6 and +20 inches water gage under abnormal conditions). Tubing and valves are sized to minimize the pressure drop between the sampling inlet port and the first filter in the sample conditioning system at a flow rate of 15 CFM ($ft.^3$ air per minute). The tubing provides a transit time from the sampling port to the exit port of less than 30 seconds for a flow rate of 0.2 CFM. Uncollected gas from the stream is returned to the tank upstream of the HEPA filter and downstream of the sample location. Sample lines are insulated and/or heat traced to avoid condensate buildup.

The gas sampling system is designed for pressures between -12 to 60 inches water gage, temperatures from 50 to 140 °F, relative humidity of 5% to 100%, and radiation fields of 100 mrad/hr.

ON-LINE MEASUREMENTS

Accuracy, repeatability, and stability requirements as stated in this section apply only to the individual instruments comprising the Standard Hydrogen Monitoring System. To determine the overall accuracy, repeatability, and stability of any final recorded measurements, errors introduced by field wiring, signal conditioners, other readout devices, etc., must be added to the values given in this section.

The on-line hydrogen sensors in the Standard Hydrogen Monitoring System will be capable of detecting hydrogen with an absolute accuracy of no less than $\pm 0.2\%$ hydrogen when initially assembled into the cabinet. The measurement repeatability is equal to or better than $\pm 1.0\%$ of full scale when tested over an eight hour period with an increasing hydrogen level. The sensors have a temperature stability of not less than $\pm 0.005\% \text{ H}_2/\text{°C}$. The sensors must reach 90% of the final value within two minutes when hydrogen levels are stepped up or down by at least 2%; the *response time* of the system is at most two minutes. Signal outputs are expected to be 4-20 mAdc with a signal level capable of driving 500 ohms of purely resistive load.

THE WHITTAKER ELECTROCHEMICAL CELL

The Whittaker electrochemical cell is an adaptation of a "standard" electrochemical cell. Such electrochemical gas sensors rely on reaction of the gas with an electrode in an electrolyte. The *electrolyte* is usually dilute

sulfuric acid. The two half reactions are the *reduction* of metallic oxide (not identified by Whittaker but probably HgO or Ag_2O) and the *oxidation* of H_2 ; for the former,

and the latter,

the net reaction being,

The voltage, $\mathcal{E}$, across an electrochemical cell is³

$$\mathcal{E} = \mathcal{E}_0(\text{H}_2) + \mathcal{E}_0(\text{MO}) - (kT/z\mathcal{F})\ln[\text{H}_2],$$

where:

$\mathcal{E}_0$ is the standard potential, e.g. for the metal oxide (MO);

[] denotes activity, which, for hydrogen (H_2), is the partial pressure,

$$[\text{H}_2] = p_{\text{H}_2};$$

kT is the temperature times Boltzmann's constant;

z is the valence of the metal (M);

$\mathcal{F} = 96,500$ coulombs is Faraday's constant.

Hydrogen is in its standard state at a pressure of one atmosphere, and its potential is defined as zero: $\mathcal{E}_0(\text{H}_2; 1 \text{ atm.}) = 0$. For lower pressures the cell

³In order to pass an electric current through an electrolytic solution two pieces of metal, or other conducting material, are inserted into a solution and connected to each pole of a battery. The pieces of metal are called *electrodes*. The one connected to the positive pole of the battery is called the *anode* and the one connected to the negative pole is the *cathode*.

voltage $\mathcal{E}$ will be less than the voltage of the half reaction in which the metal oxide is reduced.

A key component of the Whittaker cell is a Kapton⁴ diffusion barrier that covers the hydrogen electrode. Oxidizing agents such as NO_2 , NO , and possibly N_2O , as well as unsaturated organics, tend to interfere with electrochemical cells; these species have to diffuse through the Kapton to have an effect. This film is more than a barrier to gaseous interferences, however; it controls the mass transfer of hydrogen to the platinum electrode ($\text{H}_2|\text{Pt}$) where hydrogen is oxidized. Because the Whittaker cell has a chemical reaction rate that is large compared to the rate of transfer of hydrogen across the diffusion barrier, the actual H_2 concentration at the $\text{H}_2|\text{Pt}$ electrode surface is negligible at all but very large H_2 concentrations (50 percent).

It is reasonable to expect that hydrogen (as protons) will have a diffusivity in Kapton, D_{H} , that is 3-5 times greater than other species, except for those with a high solubility in Kapton (*i.e.* chemicals similar to Kapton). The time constant, τ_{H} , for diffusion of hydrogen across the Kapton film is approximately 40 seconds; $\tau_{\text{H}} \approx t^2/D_{\text{H}} \approx 40 \text{ s}$, t denoting the film thickness. It does not appear likely that there is a compound that both diffuses rapidly in Kapton and interferes with the $\text{H}_2|\text{Pt}$ electrode and also is present at sufficiently high concentration to obviate the Whittaker cell measurements.

The linearity of the Whittaker cell is expected to be good. The cell will become non-linear when the hydrogen mass transfer across the Kapton film is so large that it exceeds the rate at which hydrogen ions can migrate through the electrolyte (ion transport limitation). This point appears to be for H_2

⁴Kapton is a polyamide. Organics are not soluble in this material, and consequently will have low diffusivities as well.

concentrations greater than 50 percent. At very low H_2 concentrations the current will be so low that the noise voltage of the two resistances will be significant compared to the voltage appearing across the temperature compensating resistance. Because the Whittaker requires a large H_2 concentration before non-linearity is apparent, and the cell responds linearly over a very large range (10^3 concentration factor), it appears that the counter electrode is either Ag_2O or HgO .

The temperature coefficient of the cell is dominated by the characteristics of the electrolyte. The electrolyte acts as a resistance that is inversely proportional to absolute temperature. Over a limited temperature range the temperature compensating network will track this effect and produce a voltage proportional to the external H_2 concentration.

The voltage noise of the cell is very low. The voltmeter has a resolution (least significant digit) of $1 \mu V$. At 51 ppmv (parts per million by volume) of H_2 the voltage is $3-4 \mu V$. Over significant periods of time the display does not change when the H_2 remains constant: the least significant digit does not exhibit any tendency to vary during several minutes of operation at intermediate H_2 concentrations.

The cell is inherently sensitive to H_2 concentrations of less than 50 ppmv and has a measurement accuracy of about $\pm 0.15\%$ and a detection limit of about 100 ppmv with the present voltmeter.

FIGURES

The following three figures, two pictures and a strip chart, are discussed in turn.

Figure 1. Two Standard Hydrogen Monitoring Systems are shown on top of tank 241-SY-101, located in the 200-West Area of the Hanford Site. This is the tank which has exhibited episodic gas release events at a frequency of about every one-hundred days; these events generally resulted in H_2 concentrations in the tank dome space exceeding 25% of the LFL for H_2 .

Figure 2. This is an interior view of a Standard Hydrogen Monitoring System cabinet. The cabinet is heated during the winter and alarms if either high H_2 ($> 25\%$ of the LFL) is measured or an equipment malfunction occurs. Whittaker electrochemical cells measure H_2 in the tank dome space; measurements are displayed electronically and recorded on a strip chart. Grab samples of gas from the tank can also be taken with the Standard Hydrogen Monitoring System.

Figure 3. Output of the Whittaker hydrogen sensors in a Standard Hydrogen Monitoring System is recorded on a strip chart. The strip chart shown here was taken from a Standard Hydrogen Monitoring System above tank 241-AW-101, located in the 200-East Area of the Hanford Site. On October 4, 1994, this tank had an episodic gas release event which produced a concentration of 0.87% H_2 in the tank dome space, as shown by the strip chart.

	06:06	00:00	NIT-121	1 hour/74	GAF EN
00:01:54	06:06	00:00			

מחזור
החדש

007.01.54

77777

000
5:20
33-04-94

02:50	Δ2H2
02:50	Δ2H2
02:50	Δ1H1
02:50	Δ1H1
02:50	Δ1H1
02:50	Δ1H1

81:50	2H2A
81:50	2H2A
81:50	2H2A
81:50	2H2A
81:50	2H2A