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**FUNCTIONAL DESIGN CRITERIA FOR THE STANDARD HYDROGEN MONITORING SYSTEM
PORTABLE PLATFORM**

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Functional design description for a Standard-E cabinet arrangement Standard Hydrogen Monitoring System Portable Platform.

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FUNCTIONAL DESIGN CRITERIA
FOR
STANDARD HYDROGEN MONITORING SYSTEM
PORTABLE PLATFORM

January 17, 1997

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FUNCTIONAL DESIGN CRITERIA FOR STANDARD HYDROGEN MONITORING SYSTEM PLATFORM

1.0 INTRODUCTION

1.1 BACKGROUND

Pre-mitigation, tank 241-SY-101 (SY-101) was known to experience periodic tank level increases and decreases during which significant amounts of hydrogen, and other flammable gasses were released. It is suspected that the generated gases accumulated in the solids-containing layer near the bottom of the tank. The accumulation of gases created a buoyancy that eventually overcame the density and cohesive strength of the bottom layer. When this happened, the gas was released upward through the liquid layer and also carried some of the bottom layer upward. This phenomenon is referred to as a Gas Release Event (GRE). The pre-mitigation monitoring of Tank SY-101 indicated release concentrations greater than the lower flammability limit (LFL) of hydrogen (H_2) in a hydrogen/nitrous oxide (N_2O) atmosphere. Since the mitigation of SY-101, the measured hydrogen concentrations in the tank vapor space have remained in the low ppm range.

Several other waste tanks have been identified as having the potential to behave similarly to SY-101. These tanks have been placed on the flammable gas watch list (FGWL) which is continually reevaluated based upon new data and criteria. It has been determined that all tanks on the FGWL will have a vapor space monitoring system installed to measure hydrogen. In order to meet program and regulatory commitments for continuous gas monitoring and characterization of FGWL tanks with a low to medium probability for a GRE, a portable, temporary gas monitoring system is needed that can be used to demonstrate that extended continuous monitoring is not required.

For rapid assessment, a portable version of the Standard Hydrogen Monitoring System E or E+ (SHMS-E or SHMS-E+) is being developed. The purpose of this system is to quickly provide the vapor space characterization necessary to determine the actual lower flammability limit of these tanks, to accurately measure low baseline gas release concentrations, and to determine potential hazards associated with vapor releases. The vapor monitoring instruments to be installed in the portable gas characterization facility will allow accurate analysis of the tank vapor. With the SHMS-E, it will be possible to detect a wide range of hydrogen, from parts per million to percent by volume. With the additional gas monitoring devices installed in the SHMS-E+, it will be possible to detect a wide range of hydrogen as well as two or three other gas species suspected to be generated in tanks.

1.2 SCOPE

The scope of this functional design criteria (FDC) document is to define the design criteria specific to a portable Standard Hydrogen Monitoring System E or E+ Platform and its associated portable bottle rack skid, with provisions for a portable generator skid which can be sited at selected waste tanks.

1.3 SITE LOCATION

The SHMS-E or SHMS-E+ Platform shall be located near the tank riser or ventilation exhaust header from which the vapor sample is taken. The current flammable gas control requirements will govern the proximity to a potential open riser. Each site's location shall be selected to minimize the delivery time of the tank gas sample, power availability, and access to data transmission facilities. The portable platform shall be designed to be installed in an unsheltered area in the tank farms.

1.4 JUSTIFICATION

Tank SY-101 has one of the highest safety priorities for both the Hanford Site and the U.S. Department of Energy (DOE). However, other waste tanks have been identified as tanks which can potentially release high level bursts of hydrogen (H_2). Currently, 19 waste tanks have been identified as requiring temporary monitoring for additional characterization and verification of status.

2.0 FUNCTIONAL DESCRIPTION

2.1 SYSTEM DESCRIPTION

The primary function of the portable SHMS-E Platform is to provide a mobile environmentally controlled facility to sample the identified waste tank's vapor space gasses and analyze the sampled gasses for hydrogen (H_2). The portable SHMS-E+ Platform will analyze the sampled gasses for hydrogen (H_2) as well as other suspected gas species such as methane (CH_4), nitrous oxide (N_2O) and ammonia (NH_3). The SHMS Platform consists of five major components: the grounded platform structure with the installed SHMS test facility (which includes: the sample gas delivery system, the sample gas analytical system, the sample gas grab sample system, and a data system), the gas bottle rack, the pump stand, the sample line chiller, and the provisional, grounded power generation skid. The bottle rack and pump stand may be included on the SHMS Platform, but the bottle rack must be seismically qualified. The portable SHMS Platforms shall be designed to accommodate lifting at the four corners, and to allow for transportation on a trailer without over-width load limitation.

3.0 PROCESS CRITERIA

3.1 INSTRUMENTATION AND CONTROL

3.1.1 Instruments, Type, Range, and Accuracy

The SHMS-E sample gas analytical system shall consist of two Whittaker electro-chemical cells. The SHMS-E+ additional features include one dual column gas chromatograph, and one infra-red photo acoustic detector.

The SHMS-E+ design provides systems for automatic routine validations of the gas analysis for the gas chromatograph and IR photo-acoustic monitor with one or more gas species. The IR photo-acoustic monitor will be removed from the cabinet and calibrated once every six months in the laboratory. The electro-chemical cells will be calibrated once a quarter. Engineering process instrumentation shall be able to operate for at least one year between calibrations.

The potential measurement ranges and accuracies for all gasses are listed below for a gaseous mixture consisting primarily of moist air with concentrations of the gasses.

Measured Gas	Range	Accuracy
H ₂	3 - 30 ppm	± 3 ppm
	30 - 3,000 ppm	± 10% of Reading
	0.2 - 10.0 Vol. %	± 0.20 Vol. %
CH ₄	10 - 30 ppm	± 3 ppm
	20 - 4,000 ppm	± 10% of reading
NH ₃	10 - 100 ppm	± 10 ppm
	100 - 10,000 ppm	± 10% of Reading
N ₂ O	10 - 30 ppm	± 3 ppm
	30 - 4,000 ppm	± 10% of Reading

3.1.2 Spare Equipment Requirements

The gas analysis instrumentation requires a "hot" spare complete instrument when a field instrument fails or is removed for scheduled maintenance and/or calibration. Thus, at least one spare GC and IR photo-acoustic monitor shall be required as "hot" spares to replace field instruments per five (5) SHMS-E+ facilities deployed or installed. The process instrumentation shall have one spare for each instrument type for up to ten (10) SHMS-E+ facilities deployed or installed.

3.2 PIPING AND VESSELS

A temporary, heat traced piping connection from the installed sample probe to the SHMS Platform shall be provided. The heat trace power connection shall be supplied at the SHMS Platform. The SHMS Platform may potentially be deployed up to 15 meters (50 feet) from the designated tank riser.

The sample stream shall be completely contained within piping or instrumentation between the inlet ports on the tank exhaust header or sample port and released back to the exhaust header or tank vapor space. Any devices that come into contact with the sample stream or are stationed at the sample riser must be qualified or approved for use in a potentially flammable environment (Per the definitions in NFPA 70, Article 500, Class I, Division 1, Group B). Non-qualified Apparatus (devices not approved for use in the sample gas stream) must be separated from the sample stream by engineered barriers. Note: The current flammable gas control requirements will govern the proximity to a potential open riser. The current Flammable Gas Standing Order states that a System must be at least 15 feet or 18 diameters of riser opening.

3.3 GENERAL MECHANICAL PROCESSES

The sample gas delivery system with the installed Chiller shall meet the following requirements:

- A. Provide the ability to draw a tank gas sample under pressures between -12 and +60 inches of water and be able to structurally withstand temperatures between -10°C and 100°C and condensed vapors considered to have a pH between 8 and 12.
- B. Provide the sampled gas from the sample point to the analytical instruments in less than 30 seconds. Maintain sample delivery speed upon isolation of any analytical instrument.
- C. Exterior sample gas lines shall be trace heated to maintain a minimum sample temperature of 30°C to avoid condensate buildup.
- D. Manual isolation valves shall be located as close to the tank sample and return points as possible.
- E. Manual isolation valves shall be located in the sample system in such a way to minimize large volumes of trapped gas that would dilute the analyzed sample or calibration gases.
- F. The sample shall not be allowed to vent unfiltered to the environment.

3.4 BONDING AND GROUNDING

All equipment shall be bonded and grounded as required by ANSI/NFPA-70 and NFPA-78, Lightning Protection Code." Equipment inserted into the tank shall be 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 NFPA-77 "Recommended Practice on Static Electricity", whichever is more conservative.

3.5 SYSTEMS INTERFACE

The process instrumentation monitoring pressure, temperature, and flow interface to the stand-alone data system via 4-20 mA current loops or discrete contact closures. The analytical instrumentation have the potential for connection to HLAN for communication of data, paging the responsible engineer in case of system error, for remote status monitoring, and for diagnostics. Some possible methods for connection include an optic link, a telephone twisted pair, and a radio modem.

4.0 FACILITY CRITERIA

4.1 ARCHITECTURAL AND CIVIL/STRUCTURAL

The design of the portable SHMS Platform shall meet the requirements for Safety Significant (SC-3) structures as specified in GC-LOAD-01. As such, it shall be designed to maintain the analytical equipment in a clean, dry and mechanically stable environment when the following external conditions exist:

- air temperature of -20 to 49°C (-20 to +120°F)
- relative humidity of 5 to 100% condensing
- wind speeds up to 112.7 Km/hr (70 miles/hour)
- rain, snow, sleet, lightning, hail, blowing sand and dust
- radiation up to 100 mR/hour

4.1.1 Bottle Rack

A portable, seismically qualified, outside bottle rack with manifolds shall be provided for several compressed gasses.

4.1.2 Pump Stand

A portable pump stand platform shall be provided.

4.2 UTILITIES

4.2.1 Electrical

The portable SHMS platforms shall be configured with a weather protected stepdown transformer to function from the 480 VAC welding or tool power outlets installed on many tank farms. For designated tank risers where electric power is not available, the SHMS Platform system shall be designed to allow for an auxiliary power generation unit with ground.

The AC power to the computers and process instruments shall be conditioned to reduce voltage surges and electrical noise.

4.2.2 Lighting

An outlet shall be provided near the personnel access door to allow provisions for outside lighting.

4.3 COMMUNICATIONS

The SHMS Platform may be provided with a connection to an HLAN drop.

4.4 COMPRESSED GASSES

A seismically qualified, outside bottle rack with manifolds shall be provided for several compressed gasses which will be used for GC carrier gas, instrument calibration, and valve actuation.

5.0 GENERAL REQUIREMENTS

5.1 SAFETY

5.1.1 Safety Class

The SHMS Platform has been classified as a non-safety related General Service system in accordance with the requirements of WHC-CM-4-46, "Safety Analysis Manual". Failure of the Portable SHMS Platform does not adversely effect the environment or the health and safety of the personnel operating the enclosure. General design and quality assurance requirements for Non-Safety items shall be followed. This Safety Classification is only for the platform and related hardware. The Safety Classification for the installed SHMS-E cabinet is defined in HNF-SD-WM-FDC-054, Gas Characterization Monitoring System Functional Design Criteria.

5.1.2 Contamination Control

The primary contamination that a SHMS Platform will experience is internal (sample piping and vessels), tank farm standard contamination control procedures shall be utilized when any gas sample line is opened or any exposed instrumentation is disconnected. Relocation of the portable SHMS Platform from farm to farm may require exterior decontamination.

5.2 QUALITY ASSURANCE

Documentation associated with the design and construction of the SHMS Platform shall be assigned Approval Designator SQ for purposes of document approval. This is based on the requirements of WHC-CM-3-5, Section 12.7, Rev. 0, Approval of Environmental, Safety, and Quality Affecting Documents. Quality Assurance (QA) activities for all contractors involved in the design, construction, and testing of the project shall be formulated and executed in accordance with a project specific QA plan. Program requirements established in the specific QA plan shall be consistent with 10CFR 830.120 "Quality Assurance".

5.3 DESIGN FORMAT

The criteria below define requirements for the design, procurement and fabrication specification. The portable SHMS-E and SHMS-E+ Platform design shall maintain the basic SHMS design configuration and instrument numbering while converting the SHMS-E+ gas monitoring and the portable facility Platform into a complete system. The following are the main system components:

A. The SHMS-E, which provides an environmental enclosure to protect the analytical instruments.

1. Two Whittaker electro-chemical cells with their associated intrinsic safety barriers, readout devices and calibration gas valves.

SHMS-E+ additional features:

2. One dual column MTI gas chromatograph with its associated moisture filter, isolation and sample/cal. gas control valves, differential pressure transmitter, flowmeter and flow control valve. The MTI will have a dedicated computer to operate the system and provide data to the SHMS-E+ host computer.

4. One host computer to collect data from the analytical instruments through dedicated serial data ports and local networks. The data will be displayed on the host computer using manufacturer supplied software and custom software.

The enclosure has an air conditioner and heater to maintain the internal temperature within the specification requirements.

B. The main sample loop delivery system with a heat traced pipe segment connection to the installed sample probes, associated isolation and check valves, filters, flow meter, flow control valve and sample delivery pump. The main sample gas flow shall meet the following requirements:

1. The gas sampling tubing shall be sized so that:

- The transit time from the sampling port, nominally 50 feet from the cabinet, to the exit port of the hydrogen monitor or the grab sampler shall be less than 30 seconds at a flow rate of 0.4 CFM.
- The sample delivery tubing, from the sample point to the cabinet input connector, will have less than 1 psig drop at the above rated flow.

C. A portable, six bottle, bottle rack to support carrier and calibration gases. The bottle rack will provide shade for the bottles, regulators and gages. (SEISMIC QUALIFICATIONS FOR THE BOTTLE RACK WILL BE DETERMINED PRIOR TO ISSUING THIS SPEC.)

D. A sample pump and a portable sample pump stand located outside the environmental enclosure.

E. A provisional portable generator skid for use where power is not available.

5.4 OPERATING PERSONNEL AND SERVICES

The portable SHMS Platform shall be designed such that the facility shall not normally need to be staffed by operating personnel.

6.0 REFERENCES

1. WHC-SP-1101, Rev.1, Tank Waste Remediation System Milestone Description Sheet, COMPLETE VAPOR SPACE MONITORING FOR ALL FLAMMABLE GAS GENERATING TANKS (M-40-10).
2. Correspondence No. 9654881, FLAMMABLE GAS PROJECT: REVISED STRATEGY FOR CONTINUOUS MONITORING, from J. W. Lentsch to S. Marchetti, 10/15/96.
3. GC-LOAD-01, A/E Civil/Structural Standards Design Criteria, Design Loads for Facilities.
4. WHC-CM-4-46, Safety Analysis Manual, Safety Classification of Systems, Components and Structures.
5. WHC-CM-3-5, Document Control and Records Management Manual, Section 12.7, Rev. 0, Approval of Environmental, Safety, and Quality Affecting Documents.
6. WHC-SD-FDC-054 Rev. 0, GAS CHARACTERIZATION MONITORING SYSTEM FUNCTIONAL DESIGN CRITERIA, T.C. Schneider.
7. WHC-SD-WM-BIO-001, Tank Waste Remediation System Basis for Interim Operation.

DISTRIBUTION SHEET

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