



STANDARD OPERATING PROCEDURES

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OPERATION OF UC AP2CE CHEMICAL WARFARE AGENT DETECTOR

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OPERATION OF UC AP2CE CHEMICAL WARFARE AGENT DETECTOR

1.0 SCOPE AND APPLICATION

This standard operating procedure (SOP) describes the setup and operation of the PROENGIN, Inc. UC AP2Ce Chemical Warfare Agent Detector. The procedures and figures contained in this SOP are taken from the Proengin, Inc. *UC AP2Ce M232 E00 003 OPERATING INSTRUCTIONS* (2003). Some material is excerpted without change from this manual. This SOP will be used for educational and training purposes only.

The AP2Ce is designed to detect the presence of chemical warfare (CW) agents in the vapor phase, and CW agents in liquid and solid phases with the addition of an S4PE sampling and evaporation system. The AP2Ce is capable of detection and identification of chemical nerve agents (Tabun [GA], Sarin [GB], Soman [GD], and VX) and blister/mustard agents (H, HD, and HT) in the presence of explosive atmospheres. The unit not only detects CW agents but also quantifies and alerts to hazardous concentrations. Typical applications include:

- Monitoring initial contamination and screening of casualties.
- Monitoring residual contamination after decontamination of personnel, casualties, equipment, infrastructure and ground.

A Quality Assurance Project Plan (QAPP) in Uniform Federal Policy (UFP) format describing the project objectives must be prepared prior to deploying for a sampling event. The sampler needs to ensure that the methods used are adequate to satisfy the data quality objectives listed in the QAPP for a particular site.

The procedures in this SOP may be varied or changed as required, dependent on site conditions, equipment limitations or other procedural limitations. In all instances, the procedures employed must be documented on a Field Change Form and attached to the QAPP. These changes must be documented in the final deliverable.

2.0 METHOD SUMMARY

The AP2Ce is a flame spectrophotometer based on burning ambient air with hydrogen gas. The flame decomposes any chemical agents present and the characteristic radiation emitted by the particular excited molecular species during its transition to the ground state is measured. The S4PE system is utilized to convert liquid or liquid adsorbed to solid phase materials to vapor for analysis by the flame spectrophotometer. A small liquid or solid sample is collected by a scraper on the nose of the S4PE as it is pressed into the surface to be sampled. The nose of the S4PE is then inserted into the AP2Ce sampling port where the liquid CW agent or CW in contaminated solid is converted into vapor by activating the heating system of the S4PE. The vapor is then analyzed by the AP2Ce.

The operation of the AP2Ce is based on the principle that sulfur- and phosphorous- containing compounds introduced in a hydrogen rich flame decompose, give rise to excited S_2^* and HPO^* molecular species respectively, where * represents the excited atomic or molecular state. At the elevated flame temperature, the phosphorus and sulfur emit light of specific wavelengths. These chemiluminescent emissions are isolated by appropriate narrow band optical filters and converted into measurable electrical signals by a photomultiplier tube, which produces an analog signal related to the concentration of the phosphorus and sulfur containing compounds in the sample. Because the nerve agents all contain phosphorus and sulfur, and mustard contains sulfur, these agents are readily detected by flame photometry. Flame photometry is sensitive and allows ambient air to be sampled directly. Alternating internal light filters for phosphorous and sulfur spectra detection allow both nerve and blister agent detection without the need for manually changing the detection mode.



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3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

This section is not applicable to this SOP.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

- Prone to false positives from non-CW compounds containing phosphorus and sulfur.
- Direct sampling of grease or hydrocarbons may cause false positives.
- Sampling involving a matrix containing solvents with a very high vapor pressure, such as methylene chloride, may extinguish the flame.
- Will not detect nitrogen mustard, Lewisite or irritants.
- The instrument will not operate properly above 10,000 feet in elevation or in oxygen (O₂) deficient atmospheres (O₂ less than [\leq] 19 percent [%]).
- The AP2Ce requires the use of proprietary batteries and proprietary hydrogen storage devices.

5.0 EQUIPMENT/APPARATUS

The following equipment is used in the operation of the AP2Ce Chemical Warfare Agent Detector:

- AP2Ce
- S4PE sampling and evaporation system
- 1 to 2 hydrogen storage devices
- 1 to 2 packs of AP2Ce LSH2O batteries
- 6 S4PE LSH2O batteries
- 1 to 3 packs (10/pack) black sample scrapers
- 1 to 3 packs of (10/pack) blue test scrapers
- 1 buzzer clip
- 1 S4PE sampling tube
- 1 spare sampling nozzle
- 1 Technical Guide
- 1 to 2 rechargeable batteries with recharger

6.0 REAGENTS

- Hydrogen gas in storage device

7.0 PROCEDURES

7.1 Setup

7.1.1 AP2Ce Setup

- Extract the battery slide unit from the body of the AP2Ce.
- Insert a battery block in the slide unit with the descriptive key upwards and push until it latches.

NOTE: Insert battery in non-explosive atmosphere.



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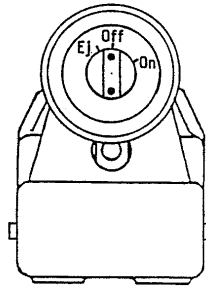
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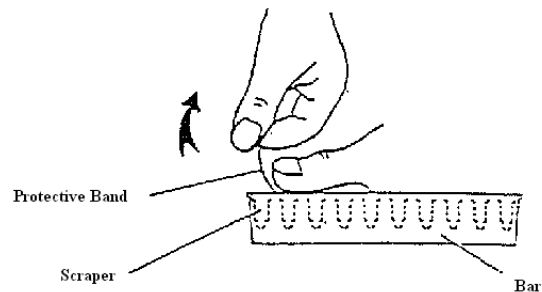
- Insert a hydrogen cartridge in the handle of the device lining up on the two marks on the cartridge in front of the "OFF" index located on the body of the AP2Ce.



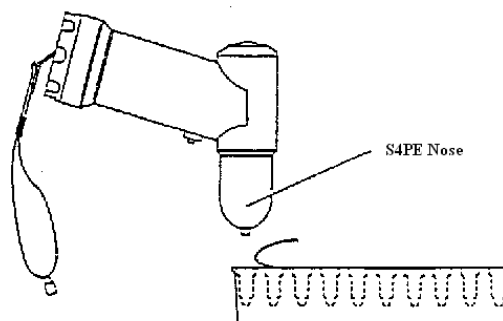
- Push the storage device into handle until it latches.

7.1.2 S4PE Setup

- Install the LSH2O battery in the handle.
- Take a scraper bar from the pack.
- Uncover a single scraper from the bar, holding the protective band.



- Place the nose of the S4PE facing the scraper to be installed.



- Force the nose of the S4PE into the opening of the scraper.



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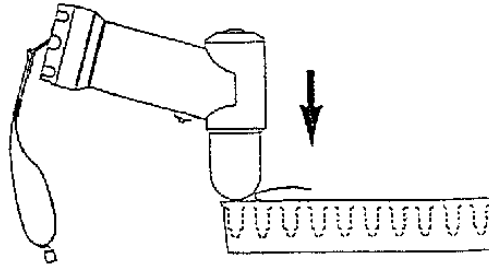
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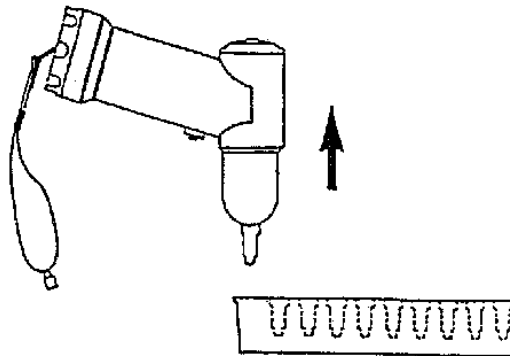
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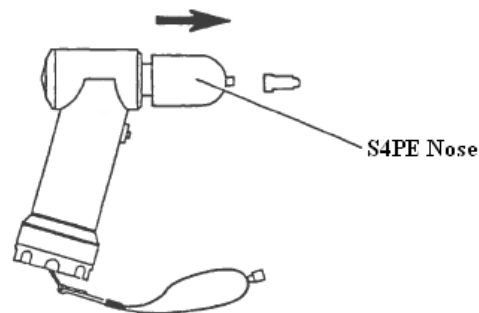
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- Take the scraper out of the pack.



- To eject scraper, push nose of S4PE forward.





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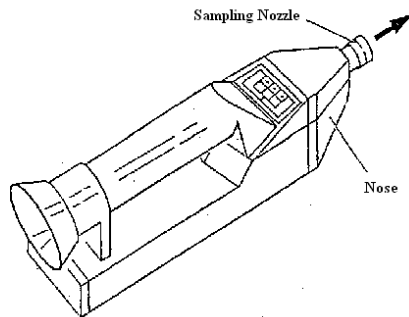
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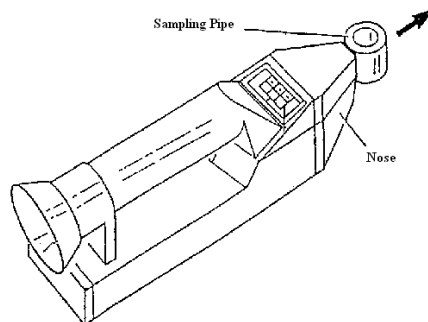
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7.1.3 Sample Collection Accessory Setup

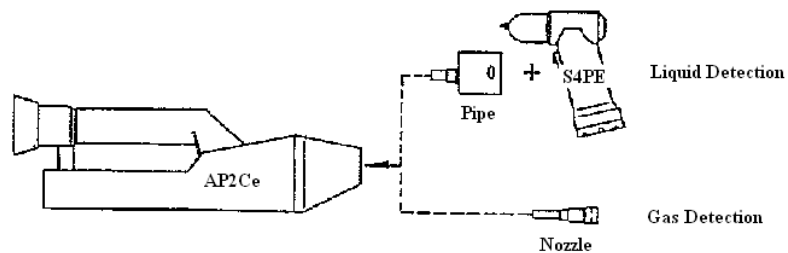
- Gas Detection Sampling Nozzle



- Liquid Detection Sampling Pipe



- Sample Collection Type Selection



7.1.4 Buzzer Clip Setup

- The buzzer emits audible pulses; low pitched for a positive detection of phosphorated (G and V) agents and high pitched for a positive detection of sulfurated (HD and V) agents.
- The pulse rhythm is proportional to the detected concentration.
- To attach, connect the buzzer clip to the two contacts located at the base of the handle.



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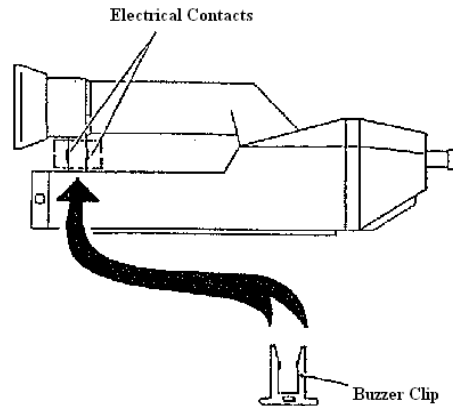
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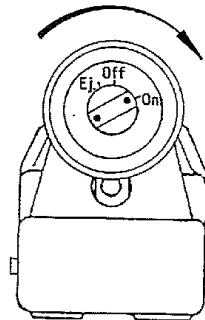
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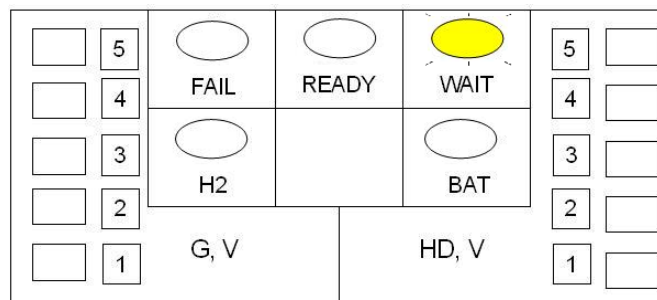
7.2 Gas Detection Procedure

7.2.1 Startup

- Turn the end piece of the hydrogen storage device until the white mark is opposite the "ON" index.



- All the lights on the display unit should flash momentarily and then the "WAIT" indicator lights up.
- The yellow "WAIT" light on the display unit blinks to indicate pre-heating and purging of the hydrogen circuit.





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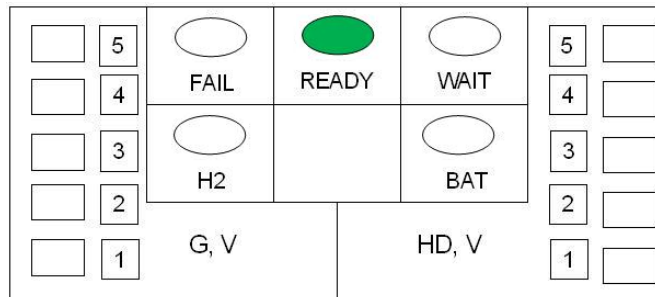
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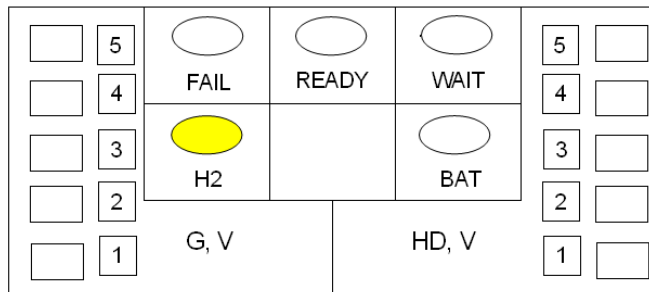
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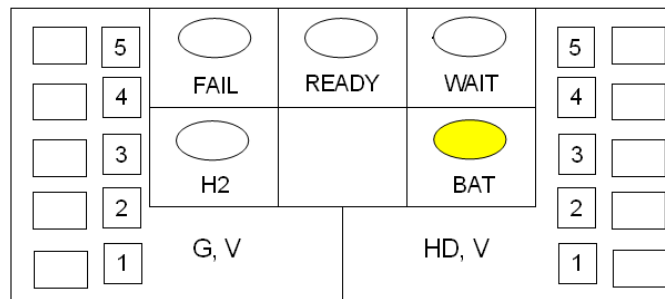
- After 2 to 15 minutes, the "WAIT" light switches off.
- If the green "READY" indicator lights up, the AP2Ce is operational.



- If the yellow "H2" indicator lights up, the hydrogen storage device is empty.



- If the yellow "BAT" indicator lights up, the battery voltage is below operational limits.



- If the red "FAIL" indicator lights up, the AP2Ce is inoperative.



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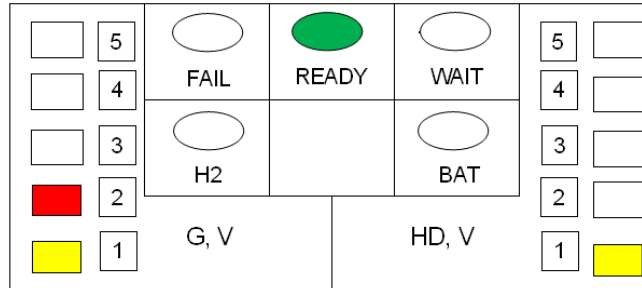
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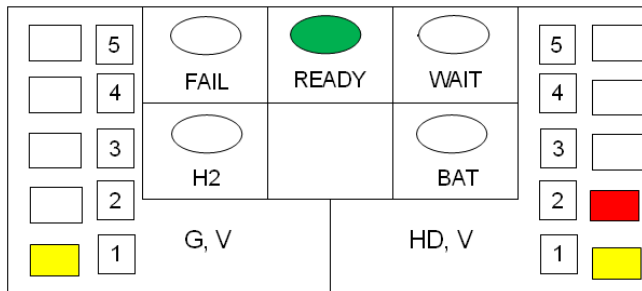
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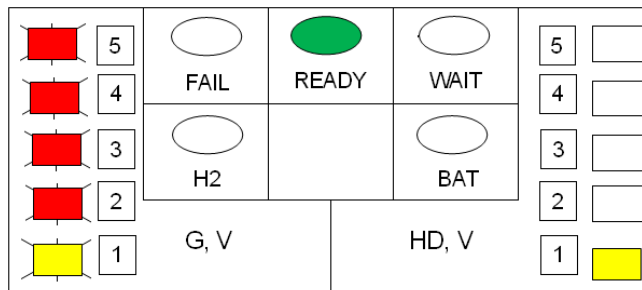
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- The HD, V five-level display bar graph indicates the concentration of sulfur containing agents, such as mustard gas and VX.



- The simultaneous blinking of all five bars indicates a toxic concentration higher than the fifth level.



7.3 Liquid Detection Procedure

7.3.1 Liquid Sample Collection Setup

- Setup the S4PE as instructed in *Section 7.1.2 S4PE Setup*.
- Configure the APC2e for liquid sampling by attaching the liquid detection sampling pipe to the AP2Ce nose as shown below.



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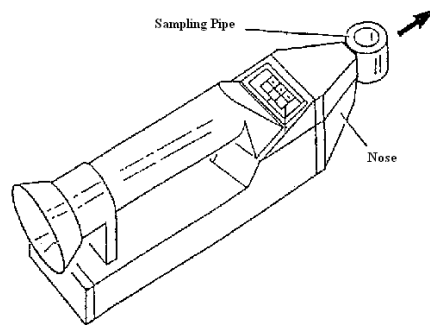
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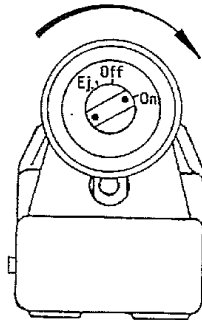
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7.3.2 Startup

- Turn the end piece of the hydrogen storage device until the white mark is opposite the "ON" index.



- All the lights on the display unit should flash momentarily and then the "WAIT" indicator lights up.
- The yellow "WAIT" light on the display unit blinks to indicate pre-heating and purging of the hydrogen circuit.

<input type="checkbox"/>	5	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	5	<input type="checkbox"/>
<input type="checkbox"/>	4	FAIL	READY	WAIT	4	<input type="checkbox"/>
<input type="checkbox"/>	3	<input type="checkbox"/>		<input type="checkbox"/>	3	<input type="checkbox"/>
<input type="checkbox"/>	2	H2		BAT	2	<input type="checkbox"/>
<input type="checkbox"/>	1	G, V		HD, V	1	<input type="checkbox"/>

- After 2 to 15 minutes, the "WAIT" light switches off.
- If the AP2Ce is operational, the green "READY" indicator lights up, blinking to indicate the unit is in liquid collection mode.



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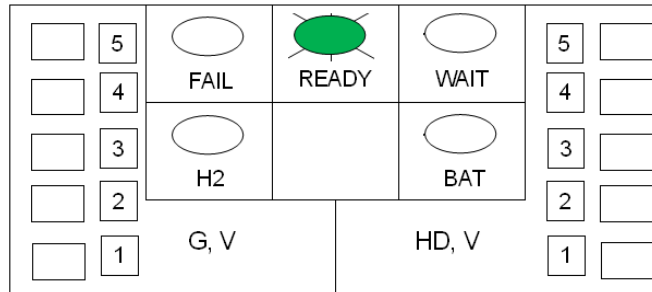
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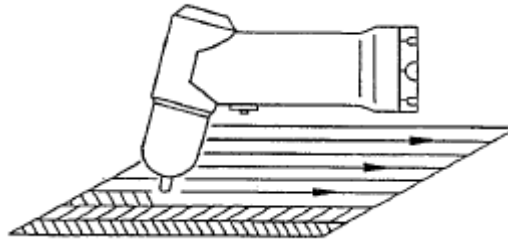
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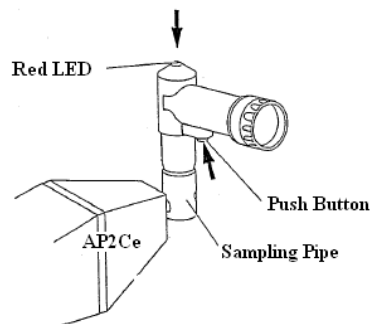


7.3.3 Liquid Detection Operation

- Confirm AP2Ce is operational by verifying that the green “READY” light is illuminated and blinking.
- Locate a 10 centimeter (cm) x 10 cm area for sample collection.
- Collect a sample by pulling the scraper of the S4PE along lines in the sample area 1 cm apart as indicated below.



- After sample collection, insert and hold the nose of the S4PE in the AP2Ce sampling pipe keeping the S4PE perpendicular to the AP2Ce.



- Press the push button on the S4PE for about 10 seconds to apply heat to the sampling scraper.
- Verify the S4PE red LED lights up to indicate heating.
- If detection is negative, the concentration indicator bars do not illuminate and the



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scraper may be used again for further sampling.

- If detection is positive, the indicator display G, V and HD, V concentration bars illuminated as indicated in *Section 7.2.2 Gas Detection Operation*.

8.0 CALCULATIONS

No calculations are required to operate the AP2Ce Chemical Warfare Agent Detector.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

- Instrument will be checked for operability and performance monthly. Results and observations are recorded in a bound instrument maintenance logbook.
- All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the project UFP-QAPP.
- Equipment check out activities must occur prior to operation and must be documented in a field log book, calibration workbook or monitoring/sampling data sheets.
- An instrument log will be maintained to document specific corrective actions taken to alleviate any instrumental problems, or for recording any service that has been performed in the calibration workbook.
- Records must be maintained, documenting the training of the operators that use instrumentation and equipment for the collection of environmental information.

10.0 DATA VALIDATION

The operator will ensure that the AP2Ce was operated in accordance with this SOP, within instrument specifications, and all operational checks have been completed and are within the criteria specified in the site-specific UFP-QAPP. The ERT contractor's Task Leader is responsible for completing the UFP-QAPP verification checklist for each project.

11.0 HEALTH AND SAFETY

11.1 General Guidelines

Based on Occupational Safety and Health Administration (OSHA) requirements, a site-specific health and safety plan (HASP) must be prepared for response operations under the Hazardous Waste Operations and Emergency Response (HAZWOPER) standard, [29 CFR 1910.120](#). Field personnel working for EPA's Environmental Response Team (ERT) should consult the Emergency Responder Health and Safety Manual at <https://response.epa.gov/HealthSafetyManual/manual-index.htm> for the development of the HASP, required personal protective equipment (PPE) and respiratory protection.

11.2 Analysis Safe Practices Guidelines

- Handle and store potential CW material only in specifically designated and authorized locations.
- If any CW material is identified, decontaminate before leaving the work area. Plan work in advance to save time.
- No Food or Drink in sample analysis area.
- Dispose of identified CW material in specially designated and clearly identified waste



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containers.

11.3 Hydrogen Storage Device

- Do not incinerate or store at high temperature (storage temperature : -39 degrees centigrade [$^{\circ}\text{C}$] to +71 $^{\circ}\text{C}$)
- Do not puncture

11.4 Lithium Batteries

- Do not incinerate
- Do not recharge
- Do not short
- Do not solder connections
- Do not pierce
- Do not crush

12.0 REFERENCES

PROENGIN, Inc., 2003. *UC AP2Ce M232 E00 003 OPERATING INSTRUCTIONS*

13.0 APPENDIX

A - Troubleshooting



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APPENDIX A
Troubleshooting
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January 2021

(Source: PROENGINE, Inc., 2003. *UC AP2Ce M232 E00 003 OPERATING INSTRUCTIONS*)



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AP2Ce DETECTOR

INCIDENT	POSSIBLE CAUSE	REMEDIAL ACTION
On starting, the indicators do not light up	<ul style="list-style-type: none"> - No batteries - Faulty battery - Faulty AP2C 	<ul style="list-style-type: none"> - Install battery - Change the battery - Change the AP2Ce - Have the faulty AP2Ce checked on NT11
Yellow "H2" indicator lights up	- H2 storage device empty	- Change the "H2" storage device
Yellow "BATTERIES" indicator lights up	- No more battery	- Change the battery
Red "FAILURE" indicator lights up	- Faulty AP2Ce	<ul style="list-style-type: none"> - Switch off the apparatus, then switch on again to confirm the failure - If the failure continues check the apparatus on the NT11
On positive detection, the buzzer clip emits no audible pulse.	<ul style="list-style-type: none"> - Buzzer clip badly connected - Faulty buzzer clip - Faulty AP2Ce 	<ul style="list-style-type: none"> - Check and re-establish the connection of the buzzer - Change the buzzer - Change the AP2Ce - Have the faulty AP2Ce checked on the NT11

S4PE SAMPLING SYSTEM

INCIDENT	POSSIBLE CAUSE	REMEDIAL ACTION
The red indicator does light on when pressing the push-button	<ul style="list-style-type: none"> - No battery - No scraper - Battery faulty - Faulty scraper - Faulty S4PE 	<ul style="list-style-type: none"> - Install the battery - Install a scraper - Change the battery - Change the scraper - Change the S4PE - Have the S4PE checked on the NT11



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DETECTION CHAIN (AP2Ce+S4PE)

INCIDENT	POSSIBLE CAUSE	REMEDIAL ACTION
The red indicators - G,V - HD,V do not light up	<ul style="list-style-type: none">- Sampling tube blocked or badly positioned- TEST scraper badly positioned- Faulty TEST scraper- Faulty S4PE- Faulty AP2Ce	<ul style="list-style-type: none">- Check the sampling tube- Check the TEST scraper- Change the TEST scraper- Change the S4PE- Have the S4PE checked on the NT11- Change the AP2Ce- Have the faulty AP2Ce checked on the NT11