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Final Report — Assessment of All Hazards Receipt Facility (AHRF) Screening Protocol, Revision 1.0

SCIENCE

Office of Research and Development
National Homeland Security Research Center

FINAL REPORT

Assessment of All Hazards Receipt Facility (AHRF) Screening Protocol – Revision 1.0

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Cincinnati, OH 45268

Office of Research and Development
National Homeland Security Research Center

Acknowledgments

This report presents results of four assessments of sample screening procedures in All Hazards Receipt Facilities (AHRFs) located at the U.S. Environmental Protection Agency (EPA) Region 1 and New York State Public Health laboratories. The assessments were funded by the EPA National Homeland Security Research Center (NHSRC), and involved representatives from EPA, the U.S. Department of Homeland Security (DHS), Federal Bureau of Investigations (FBI), Association of Public Health Laboratories (APHL), Eastern Research Group, and the New York State Department of Health (NYSDOH) in Albany, New York. This report was prepared by Computer Sciences Corporation (CSC) under Contract EP-W-06-046. CSC also provided technical support throughout the assessments.

Disclaimer

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Foreword

Following the events of September 11, 2001, EPA's mission was expanded to account for critical needs related to homeland security. Presidential Directives identified EPA as the primary federal agency responsible for the country's water supplies and for decontamination following a chemical, biological, and/or radiological (CBR) attack. To provide scientific and technical support to help EPA meet this expanded role, EPA's National Homeland Security Research Center (NHSRC) was established. The NHSRC research program is focused on conducting research and delivering products that improve the capability of the Agency to carry out its homeland security responsibilities.

As a part of this mission, NHSRC provides support to the Environmental Response Laboratory Network (ERLN): a nationwide network of federal and state laboratories responsible for the analysis of environmental samples. The goal of NHSRC's research in this area is to support the technical capabilities of these laboratories in their ability to provide an effective response. **The information provided in this publication summarizes a critical step in providing a screening protocol to help protect laboratory staff, and their facilities, in carrying out their missions.**

In 2005, NHSRC embarked on a collaborative effort to develop, construct, and implement All Hazards Receipt Facilities (AHRFs) for screening samples of unknown and potentially hazardous character, prior to laboratory analysis. In September 2008, EPA and DHS co-published an All Hazards Receipt Facility Screening Protocol, recommending a step-by-step approach to use when screening samples that have been presented to an AHRF. The process of developing this protocol incorporates an EPA field assessment to test and verify the protocol. This report documents the results of four such field assessments and provides recommendations for AHRFs or "AHRF-like" operations.

NHSRC works with partners to achieve results and has conducted this research cooperatively and in partnership with EPA's Program Offices; across the federal government, working with the U.S. Department of Homeland Security (DHS), U.S. Department of Defense, (DoD), and the Federal Bureau of Investigation (FBI); and outside the federal government, working with the Association of Public Health Laboratories (APHL).

This report represents an important next step in developing an All Hazards Receipt Facility Screening Protocol. We value your comments as we move toward the development of an efficient process to screen environmental samples presented to an AHRF and move one step closer to achieving our homeland security mission and our overall mission of protecting human health and the environment.

Gregory D. Sayles, Ph.D., Acting Director
National Homeland Security Research Center

Acronyms and Abbreviations

AHRF	All Hazards Receipt Facility
APHL	Association of Public Health Laboratories
ATP	Adenosine Triphosphate
C-4	Cyclonite – Plastic Explosive
CAD	Chemical Warfare Agent Detector
CAM	Chemical Agent Monitor
CAFA	Celite® Analytical Filter Aid
CEES	2-Chloroethyl ethyl sulfide
CGI	Combustible Gas Indicator
COC	Chain-of-custody
cpm	Counts per minute
CSC	Computer Sciences Corporation
CWA	Chemical Warfare Agent
DB-3	Disperse Blue 3
DEQ	Oregon Department of Environmental Quality
DHS	U.S. Department of Homeland Security
DMMP	Dimethyl methylphosphonate
DoD	U.S. Department of Defense
DOT	U.S. Department of Transportation
ECBC	Edgewood Chemical and Biological Center
ELITE™	Easy Livermore Inspection Test for Explosives
EMT	Emergency Medical Technician
EPA	U.S. Environmental Protection Agency
FBI	Federal Bureau of Investigation
FSP	Flame Spectrophotometer Detector
GB	Sarin
G	G-series nerve agents
H	Blister agent – nitrogen mustard
H_2O_2	Hydrogen peroxide
HAZCAT	Hazardous Characterization
HAZMAT	Hazardous Materials
HCl	Hydrogen chloride
HD	Sulfur mustard – blister agent
HMRU	Hazardous Materials Response Unit
HVAC	Heating, Ventilation, and Air Conditioning
IMS	Ion Mobility Spectrometer
IPA	Isopropanol
L	Blister agent – lewisite
LRN	Laboratory Response Network
M8	Detector Paper for Chemical Agents
LEL	Lower Explosive Limit
µR	Microroentgens
ng	Nanograms
NAV	Nerve agent vapor
NATO	North Atlantic Treaty Organization
NEG	Negative
NEIC	National Enforcement Investigation Center
NHSRC	National Homeland Security Research Center

NYSDOH	New York State Department of Health
ORIA	Office of Radiation and Indoor Air
PID	Photoionization Detector
POS	Positive
PPE	Personal Protective Equipment
ppm	Parts per million
Rad	Radiation
TIC	Toxic industrial compound
Thermal Susc	Thermal Susceptibility Test
TNT	Trinitrotoluene
VOC	Volatile Organic Compounds
VHP	Vaporized hydrogen peroxide
V	V-series nerve agents
VX	O-ethyl-S-(2-diisopropylaminoethyl)methylphophonothiolate
WMD	Weapons of mass destruction

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1.0 Background

1.1 History and Purpose of the All Hazards Receipt Facilities

During 2005 through 2007, several federal agencies and organizations, including the U.S. Department of Homeland Security (DHS), U.S. Environmental Protection Agency (EPA), U.S. Department of Defense (DoD), Federal Bureau of Investigation (FBI), and the Association of Public Health Laboratories (APHL) combined efforts to develop, construct, and implement All Hazards Receipt Facilities (AHRFs) for prescreening unknown and potentially hazardous samples collected under unusual or suspicious circumstances. Towards this goal, draft AHRF sample receipt and screening procedures were developed and documented in a *Draft Interim All Hazards Receipt Facility Protocol, Standard Operating Procedures (Guidance), October 4, 2006*. In 2007, DoD completed construction and deployment of two prototype AHRFs: one located at the EPA Region 1 Laboratory in North Chelmsford, Massachusetts, and the second located at the New York State Public Health Laboratory, New York State Department of Health (NYSDOH) in Albany, New York. During 2007, EPA performed assessments of the AHRF protocol using staff and equipment at each of the prototype AHRFs, for the purpose of evaluating the procedures in terms of protecting laboratory facilities and staff from hazardous samples. Two assessments were performed at each of the two facilities. Initial assessments were performed on May 8 and 9, 2007 and June 12 and 13, 2007, at the EPA and New York State Public Health Laboratory AHRF sites, respectively; follow-up assessments were performed at the EPA and New York Public Health sites on September 11 and 12, 2007 and October 2 and 3, 2007, respectively.

1.2 Purpose of this Report

Detailed results of each of the four assessments are described and presented in the following individual assessment reports:

- Draft Report: Initial Assessment of Draft All Hazards Receipt Facility (AHRF) Protocol at USEPA Region 1 Facility (May 25, 2007)
- Draft Report: Follow-Up Assessment of Draft All Hazards Receipt Facility (AHRF) Protocol at USEPA Region 1 Facility (October 5, 2007)
- Draft Report: Initial Assessment of Draft All Hazards Receipt Facility (AHRF) Protocol at the New York State Department of Health, Wadsworth Center Facility (June 29, 2007)
- Draft Report: Follow-Up Assessment of Draft All Hazards Receipt Facility (AHRF) Protocol at the New York State Department of Health, Wadsworth Center Facility (October 19, 2007)

This final assessment report is intended to provide overall recommendations and suggestions for revising or improving the AHRF facilities and protocol, based on the results of all four assessments, along with a summary of the rationale for the recommendations and suggestions.

2.0 Description of Assessments

2.1 Purpose of the Assessments

The goal of the AHRF protocol is to protect laboratory facilities and staff, and to support laboratory decisions concerning samples containing potentially hazardous unknowns. The purpose of the assessments was to evaluate the AHRF screening protocol and, if necessary, use the results of the evaluation to suggest modifications to the protocol described in a *Draft Interim All Hazards Receipt Facility Protocol, Standard Operating Procedures (Guidance), October 4, 2006*. A flowchart diagram of

the protocol is included in the Draft Interim Procedures and as Attachment 1 of this report. The flowchart in this attachment is marked as obsolete, to distinguish it from the final flowchart resulting from the assessments. Recommended modifications to the protocol, based on results of each assessment, are included in the individual reports for each of the four assessments. A final modified flowchart (based on the results of all four assessments) is provided as Attachment 2 to this final report.

In addition to evaluating the AHRF screening procedures, the assessments also provided observations regarding the facility design, reliability of screening equipment, and the usefulness of the paperwork and documentation associated with sample receipt and subsequent sample screening. Details regarding the approach to assessment of the AHRF protocol are described in *Assessment Plan for Evaluation of All Hazards Receipt Facility Screening Protocols, Draft, 03/26/2007.*

2.2 Agenda

An example of the agendas used during the assessments is provided in Table 1. A goal of each assessment was to complete screening of up to 26 samples in a two-day period. When all samples could not be screened during this period due to time constraints (as was the case during assessments at the EPA Region 1 facility), remaining samples were screened within one to two weeks of the assessment. Discussions took place throughout each assessment, with a debriefing session following the completion of sample screening. All assessment participants were provided the opportunity to witness the processing of samples over the two-day sample screening period. A general outline of assessment agenda is provided in Table 1.

Table 1: AHRF Protocol Assessment Agenda

FIRST DAY

8:30 – 9:00 OVERVIEW AND INTRODUCTIONS

1. Introductions
2. Orient Assessment Panel members in AHRF (15 minutes)
3. Overview of the purpose of the assessment
4. Roles:
   - Sample collector/transporter
   - Radiation Specialist
   - FBI Weapons of Mass Destruction (WMD) Coordinator
   - Observers (Assessment Panel members)
   - Laboratory Director
5. Explanation of checklists/forms
6. Explanation of Assessment Samples (Assessment Panel members only)

9:15 – 12:00 SAMPLE SCREENING
12:00 – 1:00 LUNCH
1:15 – 5:00 SAMPLE SCREENING
5:00 – 5:30 PAPERWORK

SECOND DAY

8:00 – 8:30 SETTLE IN
8:45 – 12:00 SAMPLE SCREENING
12:00 – 1:00 LUNCH
1:15 – 3:00 SAMPLE SCREENING
3:00 – 5:30 DISCUSSION AND PAPERWORK (DEBRIEF)

2.3 Assessment Participants

At a minimum, assessment participants consisted of five AHRF staff responsible for receiving and screening samples using the equipment available in the AHRF and following the procedures described in the October 2006 AHRF protocol; five Assessment Panel members responsible for observing protocol activities, documenting observations, and providing follow-on discussion and recommendations; and one EPA and two EPA-contracted Facilitators responsible for providing assessment samples, establishing schedules, developing and distributing Assessment Checklists and Questionnaires, and documenting discussions and observations. Additional participants from various organizations participated in observing and documenting aspects related to the facility and the equipment and sample handling procedures. A list of individuals participating at one or more of the assessments and their corresponding roles is provided in Table 2.

Table 2: AHRF Assessment Participants

Affiliation	Name	Role
EPA Region 1	Inna Germansderfer	AHRF Chemist
	Jeremy O'Kelly	AHRF Lead Chemist
	Rob Maxfield	Observer
Tech Law Consulting Services (EPA Region 1 AHRF)	Doris Guzman	AHRF Sample Receipt
	Matthew Hein	AHRF Chemist
	Lou Macri	AHRF Chemist
	Robert Perry	AHRF Chemist
Wadsworth Center, NYSDOH	Ken Aldous	AHRF Chemist
	Cassandra Kelly	AHRF Biologist
	Stephen Davis	AHRF Biologist
	Anthony Bucciferro	AHRF Chemist
	Beata Clark	AHRF Scribe
	Nick Cirino	Observer
	Christina Egan	Observer
Eastern Research Group, Inc. (EPA Region 1)	Janet Kaczenski	Health and Safety Evaluation, Observer
EPA National Homeland Security Research Center (NHSRC)	Rob Rothman	Project Manager, Observer
	Matthew Magnuson	Panel Member
	Scott Minamyer	Panel Member
	Erin Silvestri	Facilitator
EPA National Enforcement Investigation Center (NEIC)	Don Smith	Panel Member
FBI Hazardous Materials Response Unit (HMRU)	Brian White	Panel Member
	Sheri Bettis	Panel Member
	Michael Newell	Observer
Edgewood Chemical and Biological Center (ECBC)	Stephen Lawhorne	Panel Member
	Eric Stevens	Observer
DHS, Science and Technology Program	Don Bansleben	Observer
Computer Sciences Corporation (CSC)	Eric Boring	Facilitator, Team Leader
	Caryn Wojtowicz	Facilitator

2.4 Assessment Samples

Each assessment was preceded by preparation of simulant samples and accompanying paperwork to provide scenarios for testing the AHRF protocol. Samples were designed to simulate potential chemical, radiochemical, and biological hazards. Twenty-six samples were prepared for the initial assessments. As this number of samples proved overly ambitious for the two-day assessment period, eighteen samples were prepared for the follow-up assessments. Chemical simulant samples were prepared and provided by the Oregon Department of Environmental Quality (DEQ), and radiological samples were provided by the EPA Office of Radiation and Indoor Air (ORIA). Chemical simulant samples were tested prior to the assessments to ensure the simulants and concentration levels were sufficient to produce a response using the AHRF equipment and to document expected results for comparison with results obtained during the assessment.

Samples were shipped overnight for receipt at the AHRF laboratory three days prior to each assessment. The day before the assessments, the CSC Team Leader repackaged the samples to mimic possible sample receipt scenarios and attached a mock sample report package to each sample. Sample report packages varied from containing a single chain-of-custody (COC) form to containing field reports along with the COC form. All samples were packaged in a transport container, and some were combined on a single COC form and in the same transport container to provide a multi-sample scenario. Repackaged samples were transferred to the AHRF the day after repackaging, for use during the assessment.

2.5 AHRF Screening Equipment and Reagents

The sample screening equipment used at each assessment is listed in Table 3. Descriptions of each piece of equipment used are provided below the table.

Table 3: AHRF Assessment Sample Screening Equipment

Target Analytes	Assessment 1 EPA Region 1	Assessment 1 NYSDOH	Assessment 2 EPA Region 1	Assessment 2 NYSDOH
Gamma Radiation	SAM 935™ Model 935-2B-G (Serial number 30857) with sodium iodide (NaI) external detector	SAM 935™ Model 935-2B-G (Serial number 30858) with NaI external detector	SAM 935™ Model 935-2B-G (Serial number 30857) with NaI external detector	SAM 935™ Model 935-2B-G (Serial number 30858) with NaI external detector
Alpha/beta Radiation	Ludlum 2360 (portable) (Serial number 227428) with Ludlum 43-93 detector	Ludlum 2360 (portable) (Serial number 225178) with Ludlum 43-93 detector	Ludlum 2360 (portable) (Serial number 227428) with Ludlum 43-93 detector	Ludlum 2360 (portable) (Serial numbers 225178 and 227428)) with Ludlum 43-93 detector
	Ludlum 2929 (wipe counter) (Serial number 216261) with Ludlum 43-10-1 detector	Ludlum 2929 (wipe counter) (Serial number 216254) with Ludlum 43-10-1 detector	Ludlum 2929 (wipe counter) (Serial number 216261) with Ludlum 43-10-1 detector	Ludlum 2929 (wipe counter) (Serial number 216254) with Ludlum 43-10-1 detector
G-, H-, and V-agents (phos-phorous or sulfur compounds)	AP2Ce (Serial number 00810)	AP2Ce (Serial number 00811/10019/F6538)	AP2Ce (Serial number 00810)	AP2Ce (Serial number 00811/10019/F6538)
G-, H-, L-, and V-agents	LCD 3.2 (Serial number HH00358)	LCD 3.2 (Serial number HH00357)	LCD 3.2 (Serial number HH00358)	LCD 3.2 (Serial number HH00357)
	M256A1 kit	M256A1 kit	M256A1 kit	M256A1 kit
				Chemical Agent Monitor (CAM™), Type: 0482-0301L, Serial number 17003
H-agents	DB-3 dye test	DB-3 dye test	DB-3 dye test	DB-3 dye test
Volatile Organic Compounds	MultiRAE model PGM50-5P (Serial number 095-519099)	MultiRAE model PGM50-5P (Serial number 095-519100)	MultiRAE model PGM50-5P (Serial number 095-519099)	MultiRAE model PGM50-5P (Serial numbers 095-519099 and 095-519100)
Organic or Aqueous Determination	M8 paper (Lot number 96-1)	M8 paper (Lot number 96-1)	M8 paper (Lot number 96-1)	M8 paper (Lot number 96-1)
Explosives	ELITE™ card	ELITE™ card	ELITE™ card	ELITE™ card
Oxidizers	Starch iodide paper	Starch iodide paper	Starch iodide paper	Starch iodide paper
Peroxide-based oxidizers	—	Quantofix® Peroxide paper	—	Quantofix® Peroxide paper

- **Flame Spectrophotometric (FSP) Detector** – The AP2Ce, manufactured by Proengin, is a version of the AP2C designed to be used in an explosive atmosphere. An FSP detector is used to detect volatile compounds containing phosphorus or sulfur. The response time listed by the vendor is two seconds; sensitivity is listed at 10 mg/m^3 (1.5 ppb) for G-agents and 420 $\mu g/m^3$ (60 ppb) for mustard (HD).
- **Ion Mobility Spectrometer (IMS)** – The LCD 3.2, manufactured by Smiths Detection, is a continuous, real-time detector of chemical warfare agents (CWAs) and toxic chemicals that uses enhanced ion mobility spectroscopy technology with a non-radioactive source. Vapor detection limits are reported as approximately 0.2 mg/m^3 for G-agents, and 10 mg/m^3 for mustard and lewisite [ref. "Detection Performance of Portable Colona Discharge Ionization Type Ion Mobility Spectrometer for Chemical Warfare Agents," *Bunseki Kagaku.* 56(2): 117–124. Annual Report].
- **IMS** – The Chemical Agent Monitor (CAM™) manufactured by Smiths Detection uses IMS principles to respond selectively to toxic chemical agent vapors. CAM™ will detect nerve and blister

agents to specified North Atlantic Treaty Organization (NATO) requirements. Additional programming can be included to extend the range to cover other agents.

- **Photoionization Detector (PID)** – The MultiRAE model PGM50-5P, manufactured by RAE Systems, combines a PID with the standard four gases of a confined space monitor (O_2, lower explosive limit [LEL], and two toxic gas sensors) in one compact monitor with a sampling pump. This instrument measures volatile organic compounds (VOCs) in the range of 0 to 2,000 ppm with 0.1 ppm resolution.
- **Gamma Spectrometer - Radioisotope identifier (RIID)/ MicroR meter** – SAM 935™ Model 935-2B-G, manufactured by Berkeley Nucleonics Corporation (BNC), is a portable gamma spectroscopy radioisotope identifying system, which detects and identifies multiple gamma and x-ray emitting nuclides (from 15 keV to 3 MeV), and provides qualitative and quantitative analysis. The system used during the assessments included an external two inch x two inch thallium activated sodium iodide (NaI(Tl)) beta/gamma detector, which allows the equipment to function as a dose-rate (MicroR) meter, in addition to an isotope identifier. Gamma rays interact with the detector crystal causing ionization. The ionization charge is collected, amplified, and shaped to form an electrical pulse, which is digitized and sorted in a multichannel analyzer according to its amplitude The system's firmware algorithms identify and quantify the radionuclides, based on their characteristic energy(s) in the spectrum.
- **Alpha/Beta Counter** – The Ludlum Model 2929 digital scaler with Model 43-10-1 counting head (wipe counter), manufactured by Ludlum Measurements, Inc., performs alpha/beta sample counting using silver activated zinc sulfide (ZnS(Ag)) detector attached to a thick plastic scintillatior disk as the detector. The ZnS(Ag) scinitillator is used for measuring alpha particles. The plastic scintillator is used for measuring beta particles and has low sensitivity for interference from gamma rays. A pulse height analyzer provides alpha beta separation and displays the counts for each on dedicated readouts. Nominal efficiencies (4-pi geometry) for alpha emitters are reported by the manufacturer as: 32% for ^{230}Th; 39% for ^{238}U; and 37% for ^{239}Pu. Nominal efficiencies for beta emitters are: 5% for ^{14}C; 27% for ^{99}Tc; 29% for ^{137}Cs; 26% for ^{90}Sr/^{90}Y. Nominal background (baseline) levels for alpha radiation is three counts per minute (cpm) or less; background for beta radiation, as determined by the equipment manufacturer, is nominally 80 cpm or less (10 µR/hr field).

- **Alpha/Beta Counter** – The Ludlum 2360 (portable), manufactured by Ludlum Measurements, Inc., performs alpha/beta discrimination and data logging. The Ludlum 43-93 detector, used during the assessments,is dual scintillator, composed of a 100 cm^2 (silver activated zinc sulfide (ZnS(Ag)) scintillator adhered to a thick plastic material scintillation detector. The detector was attached to the Ludlum 2360 alpha beta rate meter, scaler, and data logger. The ZnS(Ag) scinitillator is used for measuring alpha particles. The plastic scintillator is used for measuring beta particles and is relatively insensitive to interference from gamma rays. A pulse height analyzer provides alpha-beta particle discrimination and displays counts in a digital readout, that is selectable by a front panel mounted three-way switch, to view alpha only, beta only, or alpha plus beta. Nominal efficiencies (4-pi geometry) are reported by the manufacturer as 20% for ^{239}Pu; 15% for ^{99}Tc; and 20% for ^{90}Sr/^{90}Y. Nominal background (baseline) level, as determined by the equipment manufacturer for alpha radiation is < 3 cpm; background for beta radiation is typically 300 cpm or less (10 µR/hr field).

- **Colorimetric Paper** – M8 paper is used for determining whether a liquid substance is organic or aqueous. It will turn specific colors in the presence of CWAs (G-agents turn the paper yellow, V-agents turn the paper green, and mustard turns the paper red). It is not specific for CWAs, however, and will turn color in the presence of toxic industrial chemicals and solvents.

- **Colorimetric Explosives Test** – The Easy Livermore Inspection Test for Explosives (ELITE™) card, developed by Lawrence Livermore National Laboratory, will detect more than 30 types of explosives, including Cyclonite (C-4), Semtex, Trinitrotoluene (TNT) and derivatives, ammonium nitrate, and black powder. The card was independently verified down to 25 nanograms (ng).

- **Colorimetric Starch Iodide Paper** – Detects oxidizing compounds, which convert iodide ions to elemental iodine to form triiodide and pentaiodide ions. These ions react with starch to produce a blue complex.

- **Colorimetric Nerve agent, Mustard, and Lewisite Test** – Ticket from M256A1 kit developed by Anachemia Sciences, that can be used to detect nerve agents (G-series, V-series), blood agents (hydrogen cyanide, cyanogen chloride, HD), and lewisite. Sensitivities for HD, sarin (GB), and nerve agent: O-ethyl-S-(2-diisopropylaminoethyl)methylphophonothiolate (VX) vapor are 0.001, 0.0008, and 0.002 ppm (v), respectively. The test will also detect other acetylcholine esterase inhibitors such as organophosphorus pesticides.

- **Colorimetric DB-3 Dye Test** – Detects alkylating agents. Consists of two solutions [(4-(4-nitrobenzyl) pyridine (11.25 mg/mL) in methanol and potassium carbonate (600 mg/mL) in water)] and chromatography-grade silica paper, which turns an intense blue/purple in the presence of mustard. The reported detection level for HD vapor is 0.31 ppm (v).

- **Colorimetric pH Paper** – Measures pH range of 0 to 14. pH is determined by observing the color of several squares on the paper after an aqueous sample has been applied.
- **Quantofix® Colorimetric Peroxide Test** – Quantofix® Peroxide test determines peroxide concentrations in the range of 0 to 25 mg/L. It can also be used for the determination of peracetic acid and other organic and inorganic hydroperoxides.

2.6 Assessment Process

Samples were received and screened by the AHRF staff during each two-day assessment period. A variety of simulants and matrices (neat, aqueous, oil, sand, and building materials) were used to evaluate various pathways through the original draft AHRF screening protocol presented in Attachment 1. Some samples were designed to follow the AHRF protocol through to completion (e.g., blanks and low-level hazards), while others were designed to stop screening early in the process due to early identification of a hazard (e.g., gamma radiation).

AHRF staff received and screened the samples following procedures included in the October 2006 AHRF protocols, and using the equipment listed in Table 3. Some modifications to this protocol were adopted for subsequent assessments based on lessons learned and comments and observations from the discussions during the earlier assessments. Protocol modifications that were used and evaluated during each assessment are described in the individual assessment reports. During discussions at the first assessment, for example, panel members and observers noted that the water solubility test (as written in the Step 4b of the October 2006 protocol), can potentially lead to an incorrect hazard determination.[1] For this reason, during the water solubility test in subsequent assessments, the aqueous portions of samples were evaluated for oxidizers and nerve agents using the pH, starch iodide, and nerve agent ticket tests. If

[1] Although the test would work for many pure substances, many of these substances are only partially soluble in water and AHRF technicians would have difficulty determining solubility. This is particularly true for environmental samples where, even though a matrix is not water soluble, the contaminants present may be water soluble.

an organic layer was present, it was tested with starch iodide paper and the nerve agent ticket. This approach allows for the screening of a wider variety of unknown samples, including samples comprising environmental matrices such as water, soil, and waste fuel/oil. The criterion of pH <4 for continued screening also was removed, because the presence of lewisite could potentially lower the pH of the sample. Removing this criterion allows continued screening for the presence of lewisite. Both of these changes are included in the recommended modifications to the protocol described in Section 4 of this report.

The EPA NHSRC facilitator served as the sample courier transporting samples to the AHRF. CSC facilitators acted as radiation and explosive experts and as the laboratory director to facilitate decisions regarding positive screening hits for the hazard classes.

Throughout each two-day assessment period, panelists and observers discussed their observations. Facilitators took notes of the ongoing discussions. Following completion of all sample screening, assessment participants (AHRF staff, panelists, observers, and facilitators) met for debriefings of the results. Following each assessment, AHRF staff and panelists also completed questionnaires and checklists designed to document and collect feedback regarding the assessment and the AHRF protocol.

2.7 Assessment Forms

Throughout the assessments, the following forms were used to document results of sample receipt, sample screening, and assessment observations:

- Sample Receipt (Attachment 2 of October 2006 AHRF Protocol)
- Sample Transport Container Screening Results (Attachment 4 of October 2006 AHRF Protocol)
- Primary Sample Container Screening Results (Attachment 4 of October 2006 AHRF Protocol)
- Sample Screening Results (Attachment 4 of October 2006 AHRF Protocol)
- Assessment Checklist (for completion by Panelists, Observers, and Facilitators)
- Assessment Staff and Panel Questionnaire

Sample receipt and screening results forms are included as attachments to the October 2006 AHRF Protocols. Responses to the assessment checklist and questionnaires are provided in each assessment report (See Section 1.2).

3.0 Results of Sample Screening

Simulant samples were prepared and evaluated at the DEQ and ORIA prior to the assessments to determine the materials and concentration levels needed to produce expected responses from the AHRF screening equipment during the assessments. Results of this evaluation are presented and discussed in Attachment 1 of the March 2007 AHRF Assessment Plan. Once adequate simulants and concentration levels were determined, samples were prepared at these facilities and used to evaluate the AHRF protocol during the assessments. Based on results and time constraints observed during the initial assessments, the number and type of assessment samples were revised slightly to evaluate recommended changes to the protocol during the follow-up assessments. Table 4 lists samples that were prepared and screened during the initial and follow-up assessments at each AHRF site. Tables 5 and 6 present the screening results from each of the assessments at the EPA Region 1 facility (Table 5) and the Albany Wadsworth Public Health Center facility (Table 6).

Table 4: Samples Used during AHRF Assessments

Initial Assessment EPA Region 1 (May 2007)	**Initial Assessment NYSDOH (September 2007)**	**Follow-up Assessment EPA Region 1 (September 2007)**	**Follow-up Assessment NYSDOH (October 2007)**
Dimethyl methylphosphonate (DMMP), neat	DMMP, neat	Not analyzed	DMMP, neat (applied to carpet)
Not analyzed	Not analyzed	DMMP in water (23.45 mg/g)	DMMP in water (18.5 mg/g)
DMMP in soybean oil (19.12 mg/g)	DMMP in soybean oil (20.3 mg/g)	DMMP in soybean oil (23.73 mg/g)	DMMP in soybean oil (21.4 mg/g)
DMMP in sand (19.02 mg/g)	DMMP in sand (22.8 mg/g)	DMMP in sand (22.07 mg/g)	DMMP in sand (20.8 mg/g)
Dimethoate, neat	Dimethoate, neat	Not analyzed	Not analyzed
Dimethoate in water (20.56 mg/g, dissolved first in unknown solvent)	Dimethoate in water (21.6 mg/g, dissolved first in methylene chloride)	Dimethoate in water (24.16 mg/g)	Not analyzed
Dimethoate in water (11.47 mg/g, dissolved first in unknown solvent)	Dimethoate in water (21.9 mg/g, dissolved first in methylene chloride)	Not analyzed	Not analyzed
Dimethoate in sand (21.49 mg/g)	Dimethoate in sand (39.8 mg/g)	Dimethoate in sand (19.91 mg/g)	Dimethoate in sand (17.9 mg/g)
Dimethoate in soybean oil (18.78 mg/g)	Dimethoate in soybean oil (23.7 mg/g)	Dimethoate in soybean oil (21.87 mg/g)	Dimethoate in soybean oil (20.1 mg/g)
2-Chloroethyl ethyl sulfide (CEES), neat	CEES, neat	Not analyzed	Not analyzed
CEES in sand (11.27 mg/g)	CEES in sand (11.5 mg/g)	CEES in sand (11.75 mg/g)	CEES in sand (11.6 mg/g)
CEES in sand (10.14 mg/g)	CEES in sand (11.6 mg/g)	Not analyzed	Not analyzed
CEES in soybean oil (11.49 mg/g)	CEES in soybean oil (9.90 mg/g)	CEES in soybean oil (10.00 mg/g)	CEES in soybean oil (11.8 mg/g)
Hydrogen peroxide (H_20_2) (35% by weight in water)	H_20_2 (35% by weight in water)	Not analyzed	Not analyzed
H_2O_2 (1.78% by weight in water)	H_2O_2 (3.3% by weight in water)	H_2O_2 (1.30% by weight in water)	H_2O_2 (1.8% by weight in water)
H_2O_2 (1.83% by weight in water)	H_2O_2 (2.9% by weight in water)	Not analyzed	Not analyzed
Nitrocellulose (70% by weight in Isopropanol [IPA])	Nitrocellulose (70% by weight in IPA)	Not analyzed	Not analyzed
Nitrocellulose (7.6% in sand/IPA)	Nitrocellulose (3.4% in sand/IPA)	Nitrocellulose (4.1% in sand/IPA)	Nitrocellulose (2.3% in sand/IPA)
Arsenic trichloride, neat	Arsenic trichloride, neat	Not analyzed	Not analyzed
Arsenic trichloride in sand (18.71 mg/g)	Arsenic trichloride in sand (20.1 mg/g)	Arsenic trichloride in sand (28.76 mg/g)	Arsenic trichloride in sand (31.4 mg/g)
Arsenic trichloride in soybean oil (18.78 mg/g)	Arsenic trichloride in soybean oil (20.2 mg/g)	Arsenic trichloride in soybean oil (30.94 mg/g applied to ceramic tile)	Arsenic trichloride in soybean oil (28.6 mg/g)
<1 µCi Cs-137 button source (gamma)	<1 µCi Cs-137 button source (gamma)	5 µCi Cs-137 calibration disk (gamma)	5 µCi Cs-137 calibration disk (gamma)
Thorium mantle (alpha/beta) [(1)]	Thorium mantle (alpha/beta) [(1)]	0.1 µCi Sr-90 calibration disk (beta)	0.1 µCi Sr-90 calibration disk (beta)
Celite® Analytical Filter Aid (CAFA) [(2)]	*Bacillus thuringiensis*	Aerosil®	Aerosil®
Blank, water	Blank, water	Blank, water	Blank, water
Blank, sand	Blank, sand	Blank, sand	Blank, sand
Blank, soybean oil	Blank, soybean oil	Blank, soybean oil	Blank, soybean oil
Total = 26 Samples	**Total = 26 Samples**	**Total = 18 Samples**	**Total = 18 Samples**

(1) Packages containing these mantles resulted in early detection of gamma radiation and, as a result, were not screened for alpha/beta radiation during the first two assessments. Strontium-90 calibration disks were selected as beta emitters for use during the second-round of assessments.
(2) CAFA was determined to be a poor simulant during the first assessment; *Bacillus thuringiensis* and Aerosil® were selected and used assessments 2, 3, and 4.

Table 5: Comparison of Sample Screening Results at U.S. EPA Region 1 AHRF

Note: Shaded results correspond to samples screened during the second round assessment.
Unshaded results correspond to samples screened during the first round assessment.

Simulant (Matrix)	Equipment											Comments
	Rad	M8	pH	PID	FSP	IMS	ELITE	DB-3	Starch-Iodide	NAV Ticket	Thermal Susc.	
Dimethoate (water)	NEG	NEG	5	POS	POS	NEG	NEG	–	NEG	POS	–	Positive results during sample screen inside glove box.
	NEG	NEG	4–8	POS	POS	NEG	NEG	–	NEG	NEG	–	
	NEG	NEG	5	NEG	NEG	NEG	NEG	–	NEG	NEG	–	–
CEES (sand)	NEG	–	–	POS	POS	POS	–	POS	–	–	–	Positive results during sample screen inside glove box.
	NEG	–	–	POS	POS	POS	–	–	–	–	–	
	NEG	–	–	POS	POS	POS	–	–	–	–	–	
CEES (soybean oil)	NEG	NEG (1)	–	POS	POS	NEG	NEG	POS	–	–	–	
	NEG	NEG (1)	6	POS	POS	NEG	NEG	POS	NEG	–	–	
CEES (neat)	NEG	POS	6	POS	POS	POS	–	–	–	–	–	
Nitrocellulose (sand)	NEG	–	–	NEG	NEG	NEG	POS	–	–	–	–	Positive result during sample screen inside glove box.
	NEG	NEG	–	NEG	NEG	NEG	POS	–	–	–	–	Positive during transport container screen in fume hood.
Nitrocellulose (70% in IPA)	NEG	NEG	–	NEG	NEG	NEG	POS	–	–	–	–	Positive result during sample screen inside glove box.
Gamma emitter (Cs-137 button source)	POS	–	–	–	–	–	–	–	–	–	–	Positive result during transport container screen at sample receipt.
Gamma emitter (Cs-137 calibration disk)	POS	–	–	–	–	–	–	–	–	–	–	
CAFA (neat)	NEG	–	–	NEG	NEG	NEG	–	–	–	–	NEG	–
Aerosil® (neat)	NEG	–	–	NEG	NEG	NEG	–	–	–	–	NEG	–
Alpha/Beta (thorium mantle) (2)	POS	–	–	–	–	–	–	–	–	–	–	Positive result for gamma during package screen at sample receipt.
Alpha/Beta (Sr-90 calibration disk)	POS	–	–	–	–	–	–	–	–	–	–	Positive result for beta during package screening in fume hood.
Arsenic trichloride (sand)	NEG	–	–	POS	POS	POS	–	–	–	–	–	Positive results obtained during sample screen inside glove box.
	NEG	–	–	POS	POS	POS	–	–	–	–	–	
Arsenic trichloride (soybean oil) (3)	NEG	NEG (1)	< 4	NEG	NEG	NEG	NEG	NEG	–	–	–	–
	NEG	NEG (1)	–	NEG	NEG	NEG	NEG	–	–	–	–	–
Arsenic trichloride (neat)	NEG	POS	0	NEG	POS	POS	–	–	–	–	–	Positive result obtained during sample screen inside glove box.
H_2O_2 (1.78% in water)	NEG	NEG	4–7	NEG	NEG	NEG	NEG	–	POS	–	–	Positive result obtained during sample screen inside glove box.
H_2O_2 (1.83% in water)	NEG	NEG	4–7	NEG	NEG	NEG	NEG	–	POS	–	–	
H_2O_2 (1.30% in water)	NEG	NEG	6	NEG	NEG	NEG	NEG	–	POS	–	–	
H_2O_2 (35% in water)	NEG	NEG	1-2	NEG	NEG	NEG	NEG	–	POS	NEG	–	

Simulant (Matrix)	Equipment											Comments
	Rad	**M8**	**pH**	**PID**	**FSP**	**IMS**	**ELITE**	**DB-3**	**Starch-Iodide**	**NAV Ticket**	**Thermal Susc.**	
DMMP (sand)	NEG	–	6	POS	POS	NEG	NEG	NEG	NEG	POS	NEG	Positive results obtained during sample screen inside glove box.
	NEG	–	4–8	POS	POS	NEG	–	–	NEG	POS	–	
DMMP (soybean oil)	NEG	NEG [(1)]	–	POS	POS	NEG	NEG	POS	–	–	–	
	NEG	NEG [(1)]	4–8	POS	POS	NEG	–	NEG	NEG	POS	–	
DMMP (water)	NEG	NEG	4–8	POS	POS	NEG	–	–	–	POS	–	
DMMP (neat)	NEG	POS	–	POS	POS	NEG	NEG	NEG	NEG	POS	–	
Dimethoate (soybean oil)	NEG	NEG [(1)]	–	POS	NEG	NEG	NEG	NEG	–	–	–	Positive result obtained during sample screen inside glove box.
	NEG	–	–	NEG	NEG	NEG	–	–	–	POS	NEG	
Dimethoate (sand)	NEG	–	5	POS	POS	NEG	NEG	NEG	NEG	NEG	–	
	NEG	–	4–8	POS	POS	NEG	NEG	–	NEG	POS	–	
Dimethoate (neat)	NEG	POS	5-6	POS	POS	NEG	NEG	NEG	NEG	POS	–	
Blank (sand)	NEG	–	–	NEG	NEG	NEG	NEG	NEG	–	–	NEG	–
	NEG	NEG	–	NEG	NEG	NEG	NEG	–	–	–	–	–
Blank (soybean oil)	NEG	NEG [(1)]	–	NEG	NEG	NEG	NEG	NEG	–	–	–	–
	NEG	NEG [(1)]	–	NEG	NEG	NEG	NEG	NEG	–	–	–	–
Blank (water)	NEG	NEG	6	NEG	NEG	NEG	NEG	–	NEG	NEG	–	–
	NEG	NEG	4–8	NEG	NEG	NEG	NEG	–	NEG	NEG	–	–

(1) A drop of sample wetted the M8 paper, but no color change was observed after 1 minute.
(2) Sample was intended for alpha/beta emission. Positive result for gamma radiation only; therefore, alpha/beta radiation was not evaluated.
(3) The second sample was prepared by depositing arsenic trichloride in soybean oil onto a ceramic tile.

Table 6: Comparison of Sample Screening Results at Albany Wadsworth Public Health Center AHRF

Note: Shaded results correspond to samples screened during the second round assessment.
Unshaded results correspond to samples screened during the first round assessment.

Simulant (Matrix)	Equipment											Comments
	Rad	**M8**	**pH**	**PID**	**FSP**	**IMS**	**ELITE**	**DB-3**	**Starch Iodide**	**NAV Ticket**	**Thermal Susc**	
CEES (sand)	NEG	POS	1.0	POS	POS	NEG	NEG	POS	NEG	POS[1]	–	Positive results during sample screen inside glove box.
	NEG	POS	1-2	POS	POS	POS	NEG	POS	NEG	POS[1]	–	
	NEG	–	–	POS	POS	POS	–	–	–	–	–	
CEES (soybean oil)	POS[2]	NEG	4-5	POS	NEG	NEG	NEG	POS	NEG	NEG	–	Positive result for alpha during primary container screen in fume hood. All other positives obtained during sample screen in glove box.
	NEG	NEG	4-5	POS	POS	NEG	–	POS	–	–	–	Positive results during sample screen inside glove box.
CEES (neat)	NEG	–	–	POS	POS	POS	–	–	–	–	–	
Nitrocellulose (sand)	NEG	NEG	7	POS	NEG	NEG	POS	–	NEG	–	–	Positive results during sample screen inside glove box.
	NEG	NEG	–	POS	NEG	NEG	POS	–	–	–	POS	Positive result during primary container screen in fume hood.
Nitrocellulose (70% in IPA)	NEG	NEG	7	POS	NEG	NEG	POS	NEG	POS	POS	–	Positive result during sample screen inside glove box.
Gamma emitter (Cs-137 button source)	POS	–	–	–	–	–	–	–	–	–	–	Positive result for gamma during package screen at sample receipt.
Gamma emitter (Cs-137 calibration disk)	POS	–	–	–	–	–	–	–	–	–	–	
B. thuringiensis (pure)	NEG	NEG	–	NEG	NEG	NEG	NEG	–	–	–	–	–
Aerosil® (neat)	NEG	–	–	POS	NEG	NEG	–	–	–	–	–	Positive result during sample screen inside glove box.
Alpha/Beta (thorium mantle)[4]	POS	–	–	–	–	–	–	–	–	–	–	Positive result for gamma during package screen at sample receipt.
Alpha/Beta (Sr-90 calibration disk)	POS	–	–	–	–	–	–	–	–	–	–	Positive result for beta during package screening in fume hood.
Arsenic trichloride (sand)	NEG	NEG[3]	0-1	POS	–	POS	NEG	NEG	NEG	–	–	Positive results during sample screen inside glove box.
	NEG	–	–	POS	POS	POS	–	–	–	–	–	
Arsenic trichloride (soybean oil)	NEG	NEG[3]	2	POS	–	POS	NEG	NEG	NEG	–	–	Positive results during sample screen inside glove box.
	NEG	–	–	NEG	POS	POS	–	–	–	–	–	
Arsenic trichloride (neat)	NEG	POS	0	POS	POS	POS	NEG	POS	NEG	POS[1]	-	

Simulant (Matrix)	Equipment											Comments
	Rad	M8	pH	PID	FSP	IMS	ELITE	DB-3	Starch Iodide	NAV Ticket	Thermal Susc	
H_2O_2 (3.3% in water)	NEG	NEG	5-6	POS	NEG	NEG	NEG	NEG	POS	NEG	–	Positive results during sample screen inside glove box.
H_2O_2 (2.9% in water)	NEG	NEG	5	NEG	NEG	NEG	NEG	NEG	POS	NEG	–	
H_2O_2 (1.30% in water)	NEG	NEG	6	NEG	NEG	NEG	NEG	–	POS	–	–	
H_2O_2 (35% in water)	NEG	NEG	1-2	NEG	NEG	NEG	NEG	–	POS	POS(1)	–	Positive result during sample screen inside the glove box.
DMMP (sand)	NEG	NEG	6-7	POS	POS	NEG	NEG	I(5)	NEG	POS	–	Positive results during sample screen inside glove box.
	NEG	NEG	5-6	POS	POS	NEG	POS(6)	NEG	NEG	POS	–	
DMMP (soybean oil)	NEG	POS	5-6	POS	NEG	NEG	NEG	POS	NEG	POS	–	
	NEG	POS	6	NEG	POS	NEG	–	NEG	NEG	POS	–	
DMMP (water)	NEG	NEG	5	POS	POS	NEG	NEG	–	NEG	POS	–	
DMMP (neat)	NEG	POS	4	POS	POS	NEG	NEG	POS	NEG	POS	–	
DMMP (carpet)	NEG	–	–	POS	POS	NEG	–	–	–	–	–	Positive results screening transport container headspace in fume hood.
Dimethoate (water)	NEG	POS(7)	7	POS	POS	NEG	NEG	POS	NEG	POS	–	Positive results obtained during sample screen inside glove box.
	NEG	POS(7)	4-5	POS	POS	NEG	NEG	POS	NEG	POS	–	
Dimethoate (soybean oil)	NEG	NEG(3)	6-7	POS	NEG	NEG	NEG	POS	NEG	POS	–	
	NEG	POS	6	POS	POS	NEG	–	NEG	NEG	POS	–	
Dimethoate (sand)	NEG	POS	7	POS	POS	NEG	NEG	POS	NEG	POS	–	
	NEG	NEG	7	POS	POS	NEG	NEG	NEG	NEG	POS	–	
Dimethoate (neat)	NEG	POS	5-6	POS	POS	NEG	NEG	POS	NEG	POS	–	
Blank (sand)	NEG	NEG	7.0	POS	-	NEG	NEG	NEG	NEG	NEG	–	Positive result during sample screen inside glove box.
	NEG	NEG	–	NEG	NEG	NEG	NEG	NEG	–	–	NEG	–
Blank (soybean oil)	NEG	NEG(3)	6-7	NEG	NEG	NEG	NEG	POS	NEG	NEG	–	Positive results obtained during sample screen inside glove box.
	NEG	NEG(3)	6	NEG	NEG	NEG	NEG	–	NEG	POS	–	
Blank (water)	NEG	NEG	6	NEG	POS	NEG	NEG	NEG	NEG	POS	–	
	NEG	NEG	6	NEG	NEG	NEG	NEG	–	NEG	NEG	–	

(1) AHRF technicians questioned this result, because the pH was well below the range required for the NAV ticket test.
(2) Beta radiation was detected on the outside of the primary sample container, but was not detected during the sample screen.
(3) Sample drop wetted paper but no color change was observed after 1 minute.
(4) Sample was intended for alpha/beta emission. A positive result was obtained for gamma radiation only; therefore, alpha/beta radiation was not evaluated.
(5) Sample was inconclusive. A very slight color change was observed.
(6) Very small pink spot was observed.
(7) Sample contained both an organic and aqueous layer. The organic layer gave a positive result.

Tables 7 and 8 present summaries of the assessment results in terms of the sample types (matrices) that were tested using the equipment (Table 7) and the screening equipment used (Table 8). Correct hazard detection is indicated by "positive" (for a sample) or "no hazards found" (for a blank). Incorrect hazard detection is indicated by "false positives" (if a hazard was falsely detected) or "false negative" (if a hazard was not detected and should have been). A total of 76 simulant samples and 12 blank samples were evaluated over the course of four assessments, for a total of 88 assessment samples.

Correct hazards were detected in 78 of the 88 assessment samples. False negative results (in terms of hazard detection based on AHRF suite of sample screening tests), were obtained from six samples. Four of these false negative results were obtained from samples containing dimethoate, and are most likely due to the low stability of this compound. One false negative was for a sample containing DMMP in soybean oil, and could have been caused by the low volatility of DMMP in this matrix (making it difficult to detect using headspace detectors such as the FSP and PID) and a non-optimal application of the nerve agent enzyme test strip, which was cut away from the M256A1 kit. The remaining false negative resulted from a sample containing arsenic trichloride in soybean oil that was added to a ceramic tile. It is believed that the arsenic trichloride either reacted with or dissipated from the tile prior to sample screening. For the 76 simulant samples screened, there were 13 false positives (ten for mustard and three for nerve agent) associated with a correct detection of the presence of agent, but an incorrect identification of the agent type. Nine of the twelve blank samples were correctly categorized, with two false positives for nerve agent and one false positive for mustard. It is believed that most of the false positives for nerve agent in samples and blanks were due to incorrect use and interpretation of the nerve agent enzyme tests. The cause of the false positive DB-3 test results is unclear, although it is important to note that false positives were not observed during the follow-up assessments.

Table 7: Hazard Detection Results

Matrix	Simulant/Sample	Hazard Type	# of Samples	Results Summary
Package [(1)]	Cs-137 button source	Gamma radiation	2	2 positives for gamma
	Cs-137 calibration source	Gamma radiation	2	2 positives for gamma
	Sr-90 calibration disk	Beta radiation	2	2 positives for beta
	Thorium lantern mantle [(2)]	Alpha/beta/gamma radiation	2	2 positives for gamma
Water	DMMP	G-series nerve agent (GA, GB, GD)	2	2 positives for nerve agent
	Dimethoate	V-series nerve agent (VX)	5	3 positives for nerve agent 2 false positives for mustard 2 false negatives for nerve agent
	Hydrogen peroxide	Oxidizer	6	6 positives for oxidizer
	Blank	None	4	3 no hazards found 1 false positive for nerve agent
Soybean oil	DMMP	G-series nerve agent (GA, GB, GD)	4	3 positives for nerve agent 1 false negative 2 false positives for mustard
	Dimethoate	V-series nerve agent (VX)	4	3 positives for nerve agent 1 false negative 1 false positive for mustard
	CEES	Mustard	4	4 positives for mustard 1 false positive for beta
	Arsenic trichloride	Lewisite	3	2 positives for lewisite 1 positive for CWA
	Blank	None	4	2 no hazards found 1 false positive for mustard 1 false positive for nerve agent

Matrix	Simulant/Sample	Hazard Type	# of Samples	Results Summary
Sand	DMMP	G-series nerve agent (GA, GB, GD)	4	4 positives for nerve agent 1 false positive for mustard
	Dimethoate	V-series nerve agent (VX)	4	3 positives for nerve agent 1 false positive for mustard 1 false negative
	CEES	Mustard	6	3 positives for mustard 3 positives for CWA 2 false positive for nerve agent
	Arsenic trichloride	Lewisite	4	1 positive for lewisite 3 positives for CWA
	Nitrocellulose	Explosive	4	4 positives for explosives
	Blank	None	4	4 no hazards found
Soybean oil on tile	Arsenic trichloride	Lewisite	1	1 false negative for lewisite
Carpet	DMMP	G-series nerve agent (GA, GB, GD)	1	1 positive for CWA
Neat	DMMP	G-series nerve agent (GA, GB, GD)	2	2 positives for nerve agent 1 false positive for mustard
	Dimethoate	V-series nerve agent (VX)	2	2 positives for nerve agent 1 false positive for mustard
	CEES	Mustard	2	2 positives for CWA
	Arsenic trichloride	Lewisite	2	2 positives for lewisite 1 false positive for mustard
	Nitrocellulose	Explosive	2	2 positives for explosives 1 false positive for nerve agent
	Hydrogen peroxide (35%)	Oxidizer	2	2 positives for oxidizers
	CAFA [(3)]	Biological	1	no hazards found
	Aerosil®	Biological	2	2 positives for biologicals
Powder	*Bacillus thuringiensis*	Biological	1	1 positive for biologicals

No hazards found - Results of testing blank samples (samples without simulant hazard).
False negative - Result indicated no hazard in a sample containing a simulant hazard.
False positive – Result indicated that the hazard was present in a sample that did not contain hazard simulant.

(1) All radiological simulants were packaged in 8”x8”x8” cardboard boxes for use during the assessments. Button sources were 2” x 0.25”. Calibration disks were $1\frac{1}{8}$” in diameter.

(2) Thorium lantern mantles were determined to be an inappropriate choice for alpha/beta screening. Packages containing these mantles resulted in early detection of gamma radiation and, as a result, were not screened for alpha/beta radiation during the first two assessments. Strontium-90 calibration disks were selected as beta emitters for use during the second-round of assessments.

(3) CAFA and *Bacillus thuringiensis* were determined to be poor simulants during the first round of assessments; Aerosil® was selected and used as a replacement during the remaining assessments.

Table 8 presents compiled results of the AHRF sample screening equipment from all four assessments. The results are organized by sample type and compare the frequency of expected results (based on preliminary testing of samples) and results that were not expected. A detailed description of some of the results and possible rationale for the unexpected results are included in each assessment report and are summarized below Table 8 in this report.

Table 8: Equipment Results During Assessments

Test (Refer to Table 1 for target analyte)	Sample Type	Number of Tests Performed	Number of Expected Results	Number of Results Not Expected
MircoR Meter Gamma Scintillator	Package	8	6	2
	Water	18	18	0
	Soybean Oil	19	19	0
	Sand	26	26	0
	Ceramic Tile	1	1	0
	Carpet	1	1	0
	Source	15	15	0
Alpha/Beta Scintillator	Package	4	4	0
	Water	18	18	0
	Soybean Oil	19	18	1
	Sand	26	26	0
	Ceramic Tile	1	1	0
	Carpet	1	1	0
	Source	15	15	0
M8 Paper	Water	16	16	0
	Soybean Oil	18	2	16
	Sand	13	9	4
	Neat	10	10	0
pH	Water	17	17	0
	Soybean Oil	11	11	0
	Sand	9	7	2
	Neat	12	12	0
Photoionization Detector (PID) Screen	Water	17	15	2
	Soybean Oil	19	16	3
	Sand	26	23	3
	Ceramic Tile	1	0	1
	Carpet	1	1	0
	Neat	15	14	1
Flame spectrophotometer (FSP) Screen	Water	17	15	2
	Soybean Oil	18	11	7
	Sand	24	21	3
	Ceramic Tile	1	1	0
	Carpet	1	1	0
	Neat	14	13	1
Ion mobility spectrophotometer (IMS) Screen	Water	17	17	0
	Soybean Oil	19	14	5
	Sand	25	20	5
	Ceramic Tile	1	0	1
	Carpet	1	0	1
	Neat	14	12	2

Test (Refer to Table 1 for target analyte)	Sample Type	Number of Tests Performed	Number of Expected Results	Number of Results Not Expected
ELITE™ card Explosives colorimetric indicator	Water	16	16	0
	Soybean Oil	13	13	0
	Sand	14	13	1
	Ceramic Tile	1	1	0
	Neat	8	8	0
[4-4'-Nitrobenzyl)pyridine] (DB-3) Dye Test	Water	5	3	2
	Soybean Oil	16	12	4
	Sand	12	10	2
	Neat	6	3	3
Starch Iodide Test	Water	18	18	0
	Soybean Oil	10	10	0
	Sand	13	13	0
	Neat	8	7	1
Nerve Agent Enzyme Test	Water	11	8	3
	Soybean Oil	9	8	1
	Sand	11	8	3
	Neat	6	3	3
Thermal Susceptibility Test	Sand	7	7	0
	TOTAL	**Total Number of Tests Performed**	**Expected Results**	**Unexpected Results**
		693	**608**	**85**

Expected Result = Correct hazard detected
Unexpected Result = Hazard type either not detected or unexpected

- Gamma radiation screening (using the SAM 935™ Model 935-2B-G) resulted in expected responses in all but two samples. These two samples (packages) were screened during the round-one assessments and gave a positive result for gamma radiation, even though they contained thorium mantles that were intended to emit primarily alpha radiation, with some beta radiation. Thorium lantern mantles were determined to be an inappropriate choice for alpha/beta screening. Packages containing these mantles resulted in early detection of gamma radiation and, as a result, were not screened for alpha/beta radiation during the first two assessments. Expected results were obtained when a different sample (strontium-90 (Sr-90) calibration disks) was used during the round-two assessments.

- Alpha/beta radiation screening (using the Ludlum 2929 and 2360) resulted in expected responses in all but one sample. This sample was composed of CEES in soybean oil, and it is unclear why it produced a positive response using this equipment to screen the primary sample container. It should be noted that beta radiation was detected on the exterior of the primary sample container, and was not detected during direct screening of the sample. The other three CEES/soybean oil samples were negative when screened for this hazard.

- The M8 paper test produced expected results for all water samples. Although this test produced expected results for soybean oil samples, these took a long time to dry on the paper and a color change was observed only after five minutes. Four of the simulant/sand samples produced unexpected M8 paper test results and did not change the color of the M8 paper. Assessment participants noted that although M8 paper is effective in determining sample matrix type (i.e., organic or aqueous based), it is not as effective in identifying agents. During the assessments, for example, samples produced unexpected color changes (e.g., arsenic trichloride produced a blue color; neat simulants produced various colors).

- The pH test behaved as expected for all samples except for two sand samples. These two samples contained CEES. When the aqueous portion of the samples from the water solubility test was tested for pH, a very low pH was observed. A possible explanation for this may have been due to the formation of acidic degradation products such as hydrogen chloride (HCl).

- The PID screen using the MultiRAE model PGM50-5P produced expected results for 69 of 79 samples screened (see Table 6). The following exceptions were noted in the 10 remaining samples:

  - One water sample containing H_2O_2 produced an unexpected positive for VOC, but the level was below the instrument threshold. A possible explanation may have been contamination of the glove box atmosphere from other samples.
  - One water sample containing dimethoate gave an unexpected negative result, which could be explained by the low volatility of this compound in water.
  - Two arsenic trichloride/soybean oil samples produced unexpected negative readings. The soybean oil matrix, having low volatility, was not expected to interfere with the PID reading. However, this matrix may have inhibited the volatility of the arsenic trichloride. In sand matrices, it was observed that arsenic trichloride always produced a positive response.
  - One of three dimethoate/soybean oil samples produced an unexpected negative result, which could be explained by the low volatility of this compound. Positive results produced by the other dimethoate/soybean oil samples may have been caused by the organic solvent carrier used to dissolve the dimethoate during sample preparation.
  - Two sand samples containing nitrocellulose/isopropanol (70/30 by weight) gave an unexpected negative result, which is surprising particularly because of the volatility of isopropanol. A possible explanation is that the isopropanol may have evaporated during preparation, shipping, and handling of the sample.
  - One blank sand sample gave a positive reading. This result was very low, however, and may have been due to contamination.
  - The ceramic tile sample containing arsenic trichloride in soybean oil produced an unexpected negative reading. Due to the nature of the sample and time limitations, this sample type was not tested prior to use during the assessment. It is suspected that the arsenic trichloride could have reacted with the tile prior to assessment sample screening.
  - All but one of the neat samples resulted in expected PID response. The positive response produced by the Aerosil® sample may have been due to contamination of the glove box atmosphere from other samples.

- The FSP screen (using the AP2Ce) produced expected results for 62 of 75 samples screened (see Table 6). The following exceptions were noted in the 13 remaining samples:

  - One dimethoate/water sample produced a negative response, which could be a result of the low volatility of this compound. It is also worth noting that the FSP scraper feature for direct sample screening was not used to screen this sample.
  - One blank water sample produced a positive response, which could be the result of contamination from previous samples. Again, the scraper feature of the FSP was not used to test this sample.
  - Five soybean oil samples produced unexpected negative responses during the FSP screen: three dimethoate samples, one DMMP sample, and one CEES sample. It is important to note that, for samples producing negative responses, the scraper feature of the FSP was not used. Sample screening results indicate that many of the simulants used during the assessments exhibited low volatility in the soybean oil matrix.

- Two arsenic trichloride/soybean oil samples, three arsenic trichloride/sand samples, and one neat arsenic trichloride sample produced unexpected positive responses. All of these samples contained arsenic trichloride, which does not contain sulfur or nitrogen and should not produce a positive result. A possible explanation for the FSP response is that arsenic atoms are in the same family of elements as sulfur.

- The IMS screen (using the LCD 3.2) produced expected results for 63 of 77 samples screened (see Table 6). The following exceptions were noted in the 14 remaining samples:

  - All four CEES/soybean oil samples gave negative results, while CEES in other matrices gave positive results. A possible explanation is that the volatility of CEES was not high enough to illicit a response when the headspace of the soybean oil samples was tested.
  - One arsenic trichloride sample in soybean oil produced an unexpected negative result. Low volatility or decomposition of the arsenic trichloride is a possible explanation.
  - All five CEES/sand samples gave unexpected results. One of these samples produced a negative result, while the other four gave positive results. Although the positive results were expected, the results were positive for G-agent rather than the expected H-agent. CEES is a mustard simulant; therefore, a positive for H was expected. An explanation may be that the IMS is calibrated for specific CWA ions and not the simulants.
  - The ceramic tile sample containing arsenic trichloride in soybean oil. It is suspected that the arsenic trichloride reacted with the tile surface or decomposed in the soybean oil prior to assessment screening.
  - The carpet sample containing DMMP produced an unexpected positive response. It is believed that the IMS is not calibrated for DMMP-specific ions, thus this positive result is puzzling. The IMS screen resulted in negative responses for all other DMMP samples.
  - Two of the neat CEES samples gave unexpected positive results for G-agent rather than the expected positive H-agent results. Although the positive results were expected, the results were positive for G-agent rather than the expected H-agent.

- The ELITE™ card test for explosives performed as expected for all but one, out of 52 samples. A DMMP/sand sample produced a positive response; however, the response was a slight pink (rather than a deep purple) color change. All other positive results using this test (i.e., samples containing nitrocellulose) exhibited a more pronounced color change.

- The DB3-test for alkylating agents (e.g., mustard) produced the expected results for 28 of 39 samples screened (see Table 6), with the following exceptions noted in the remaining 11 samples:

  - Two dimethoate/water samples produced unexpected positive responses. One possible explanation is that the test color change was misinterpreted.
  - Four soybean oil samples (two containing DMMP, one containing dimethoate, and one blank), two sand samples (one containing DMMP and one containing dimethoate), three neat samples (DMMP, dimethoate, and arsenic trichloride) produced unexpected positive results. The cause of these positive results is uncertain.

- The starch iodide test performed as expected for all but one neat nitrocellulose sample, which produced an unexpected positive response. However, only a slight color change was observed.

- The nerve agent enzyme test produced expected responses for 34 of the 44 samples screened (see Table 6). The following exceptions were noted for the remaining 10 samples:

  - Two dimethoate/water samples and one dimethoate/sand sample, gave unexpected negative results. Two CEES/sand samples, one blank water sample, one neat nitrocellulose sample, and one blank soybean sample gave unexpected positive results. There are several possible explanations for these results, including 1) the interpretation of the test results proved to be problematic and further training may be required and 2) the tickets were separated from the complete M256A1 kit, which may have impacted their effectiveness.
  - Two neat samples (hydrogen peroxide and arsenic trichloride) gave unexpected positive results. The pH of these samples was lower than the recommended working range of this test (4 to 7) and it is possible that the low pH of the samples could have deactivated the enzyme.

- The thermal susceptibility test was used to test only solid samples and produced the expected results for all solid samples tested.

Along with observations made during the assessments, results of the sample screening during each of the four assessments were evaluated and used to provide the recommended modifications; the results prompted changes to the AHRF protocol described in Section 4.2.4. In summary, recommended changes based on assessment sample results emphasize the need for evaluation of alternative sample screening technologies (particularly to address screening and identification of chemical warfare agents), as well as increased training and instruction in the use of colorimetric test kits.

4.0 Recommendations

In general, the protocol demonstrated the ability to protect laboratory facilities and staff from the types of hazards presented or simulated by the samples screened during the assessments. AHRF staff successfully completed sample receipt and screening procedures, making appropriate decisions regarding additional screening or sample dissemination. This section presents recommended modifications to the AHRF facilities, equipment, and protocol based on the results of the four assessments. An overview of a new AHRF protocol, designed to address the recommended modifications, is presented in the flowchart in Attachment 2.

In all, there are nine major and three minor recommended changes to the AHRF screening protocols and equipment. These recommendations result in seven changes to the AHRF protocol flowchart (see Attachment 1 for original draft protocol, and Attachment 2 for revised final protocol). A brief summary of changes to the flowchart is provided in Table 7, along with the step of the protocol that is affected by the change. Table 9 also includes a column indicating whether each change was evaluated during one or more of the assessments.

Table 9: Summary of Flowchart Changes

#	Recommended Change	Step (see Attachment 2)	Assessment including evaluation of recommended change
1	Perform gamma radiation screen prior to sample acceptance	Step 1	Follow-up assessment at each facility
2	Add "Stop and Consult" points	Throughout flowchart	Follow-up assessment at each facility
3	Add ELITE™ test to transport container screening	Step 2	Follow-up assessment at each facility
4	Replace nerve agent vapor (NAV) ticket with M256A nerve agent test	Step 5*	Change incorporated prior to all assessments
5	Add ELITE™ test to initial sample screening	Step 4**	Follow-up assessment at each facility
6	Add arsenic test from M256A1 kit to sample screening	Step 5*	Follow-up assessment at each facility
7	Test all sample fractions formed during water solubility test with pH, peroxides, alkylating agents, nerve agents, and arsenic (as appropriate to matrix and pH)	Step 5*	Follow-up assessment at each facility

* Formerly Step 4b
** Formerly Step 4a

A summary of all recommended modifications to the AHRF facility, equipment, and protocol is presented in Table 10; descriptions of each recommendation are provided below the table. Recommendations are ranked by relative importance, i.e., a major recommendation, a minor recommendation, or a suggestion. These rankings were determined by the Assessment Panel, based on a number of considerations including cost, the impact of the recommendation on facilitating sample screening, and the feasibility of applying the recommendation in the short-term versus long-term. The last row of the table describes activities that are recommended to improve and enhance the AHRF facilities, equipment, protocols, and future AHRF development.

Table 10: Recommendations and Suggestions for AHRF Protocol

	Facility	Equipment	Protocol
Major Recommendations & Upgrades	● Purchase a second set of equipment to allow use of the equipment in both the bleaching station and glove box areas. At a minimum, have a second IMS and FSP. (A second PID and Rad detector would also be beneficial.) ● Add wall clocks/timers to assist in monitoring test times and glove changes. ● Have antidote for nerve agents readily available (training required for acquisition, storage, and use). ● Supply appropriate, secure, and weather-protected radiation/explosives containment for samples refused entry to AHRF. ● Include weather protection (shelter) for sample delivery personnel. ● Have a readily available "reach-back" list posted in the AHRF. ● Have a communication system between AHRF staff and decision makers, equipped with video and audio feed. ● Place a camera in the bleaching station to allow viewing of the sample screening by personnel outside AHRF.	● Replace NAV tickets with M256A1 nerve ticket (already incorporated into procedures used during assessments).	● Include more detailed procedures for receipt and handling of suspicious powders (e.g., overpacking, contacting FBI WMD Coordinator, etc.). ● Rearrange order of sample receipt interview questions to address safety concerns first. ● Perform gamma screening prior to the sample receipt interview. ● Change the water solubility testing portion of the protocol to include testing of all phases; include information regarding how to handle questionable density samples and the formation of precipitates. ● Add additional decision points to seek assistance from FBI WMD Coordinator and/or others. ● Incorporate arsenic test from M256A1 (Step 5 of Attachment 2). ● Clarify levels of radioactivity acceptable for sample receipt. ● Add ELITE™ card test to Step 2 (Transport Container Screening) and Step 4 (Initial Sample Screening) as an additional test for explosives. ● Revise protocol to ensure it is consistent with flowchart (e.g., include float test for biologicals).
Minor Recommendations	● Provide additional storage space, writing surfaces, and magnetic surfaces for affixing paperwork or protocol flowchart. ● Adjust intercom position for clearer communication at sample receipt. ● Use larger volume waste storage containers. ● Design a separate pass-through for documentation to avoid contamination from samples.	—	● Adapt/streamline reporting forms to be more useful and less redundant. Consider adding start/stop times. ● Provide procedures needed if the AHRF is not in the ambient temperature range. ● Include more "hints" / "cautions" to the protocol (e.g., regarding false positives, hotplate settings, use of the FSP scraper feature, etc.).

	Facility	Equipment	Protocol
Additional Suggestions	● Have blunt, round-tip scissors available in glove box for cutting sample containers. ● Choose different colors for outer and inner gloves to better monitor proper glove use.	● Use a high-quality butane lighter for a cleaner burn and improved observation during thermal susceptibility test. ● Use platinum wire in place of spatula to improve observation during thermal susceptibility test. ● Use plastic tongs when adding waste to bleach containers.	● Guidelines should be provided regarding how to proceed if ambiguous results are obtained.
Recommended Activities	● Develop guidelines for installing and implementing future AHRF sites including waste management, safety concerns, recommended staffing (including time on duty recommendations), site-specific guidelines. ● Perform vulnerability assessments to determine AHRF vulnerability and prevent the impact of possible threats. ● Build relationships with HAZMAT, EMT, hospitals, laboratories, etc. ● Explore use of vaporized hydrogen peroxide (VHP) or modified VHP for decontamination.	● Continue evaluation of new and alternative technologies, such as Sabre 4000, 3-way paper, Hazardous Characterization (HAZCAT) kits, Agentase™ CAD-kits, bioscreening, peroxide paper, water-finding paper, entire M256A1 kit, etc. ● Develop booklet showing visual results for colorimetric tests. ● Provide additional training for equipment use, especially radioactivity testing and paper test kits.	● Develop training programs for AHRF operations, including resources and requirements. ● Address evidentiary, preservation, and shipping issues. ● Provide instructions for handling packages that are too large for the sample pass-through or radioactive samples that are refused entry. ● Discuss how to handle samples requiring redirection/repackaging. ● Perform additional assessments of protocol using a greater variety of samples (e.g., multiple contaminants in a sample, additional toxic industrial compounds [TICs], variety of matrices, “device” sample, etc.) and including local decision makers in the assessment exercise. ● Develop procedures for periodic proficiency testing of facilities, equipment, and protocols.

4.1 Facilities

4.1.1 Major Recommendations and Upgrades

- *Second Set of Equipment*: Currently, each AHRF is equipped with only one IMS, FSP, PID, and alpha-/beta-radiation detector. To use a single set of this equipment in both the bleaching station and glove box sides of the AHRF, the equipment must be thoroughly decontaminated and passed back and forth. This is not only time consuming, but poses the risk of spreading contamination if the equipment is not sufficiently decontaminated. With the use of two sets of equipment, the AHRF staff was able to reduce the average time for sample screening from approximately one hour to 35 to 40 minutes per sample, resulting in more sample throughput and reduced hours in the AHRF for the staff wearing personal protective equipment (PPE). At a minimum, purchase of a second IMS and FSP is seen as a necessity. A second PID and radiation detector also would be beneficial, but is not as critical. A second set of equipment provides a backup in case of equipment failure (e.g., battery failure, calibration failure, is dropped, etc.).

- *Wall Clocks and Timers*: Synchronized wall clocks and timers designed to be used while wearing gloves or other personal protective gear should be located at various locations throughout the AHRF. This would provide the staff with easily visible assistance in monitoring test timing and proper frequency of glove changes. Currently, staff are forced to estimate time or risk contamination to view their watches.

- *Nerve Agent Antidote*: From a health and safety standpoint, it is extremely important to have nerve agent antidote readily available to AHRF staff who might be exposed to fast-acting nerve agents present in unknown samples. It is important to note, however, that use of the antidote requires training. Antidotes, and training on the use of the antidotes, should be provided to all AHRF staff working with samples that potentially contain these agents.

- *Radiation and Explosives Containment*: The protocol currently directs AHRF staff to refuse samples containing high levels of radiation and to place these samples in a steel- or lead-lined box or other appropriate containment. Appropriate, secure, and weather-protected radiation and explosives containment for samples that are refused entry should be supplied at each facility. Ideally, a lead-lined box or cement bunker outside the AHRF, but within the line of vision, should be available. Requirements for design and type of containment may vary from site to site, and consultation with local regulators is recommended. Containment also is needed for samples awaiting removal by the bomb squad.

- *Shelter for Sample Delivery Personnel*: Although the NYSDOH AHRF included some facility adaptations for inclement weather, such as metal-grated steps and roll-down awnings, there is currently no shelter or weather protection for sample delivery personnel faced with lengthy interviews (approximately 15 to 20 minutes) when dropping off samples at the AHRF.

- *Call/Contact List*: Many of the AHRF screening results and decisions require AHRF staff to contact various technical experts and/or decision makers. Each AHRF should be equipped with a posted "reach-back" list containing the name and telephone numbers of contacts who may be needed to respond to questions or emergencies at the AHRF. At a minimum, the posting should contain the numbers of the Laboratory Director, HAZMAT contacts, and local FBI WMD Coordinator. All AHRF staff should be familiar with the location of the list and when to use it.

- *Communication System*: AHRF sites participating in the assessments provided a "command center," equipped with video feed from four locations within and outside the AHRF for assessment panelists to observe the activities taking place in the AHRF. The ability to teleconference between the AHRF and the center also was provided, although limited to one staff member on each side of the AHRF. This ability proved extremely useful during the assessments and would also facilitate communication with technical experts and decision makers during an actual scenario. Communication systems providing the ability for all AHRF staff to communicate via both video and audio is recommended for each facility. Audio systems that do not require manipulation by AHRF staff (e.g., manual manipulation of off/on switch) are recommended to avoid contamination and activity disruption.

- *Video Camera in Bleaching Station*: Neither of the AHRFs used during the assessments contained a camera in the bleaching station, and transport container screening was not visible to personnel outside the AHRF. If a camera were placed in this area, decision makers would be able to observe and comment regarding the sample transport container, primary sample container, container labeling, contamination, and/or results of screening tests.

4.1.2 Minor Recommendations

- *Storage space*: AHRFs at each site participating in the assessments had limited storage space and writing surfaces. Spaces were expanded using rolling carts and by affixing paperwork and flowcharts to horizontal surfaces. The addition of magnetic surfaces (e.g., magnetic boards), storage areas, and writing surfaces would be beneficial in reducing clutter and working more safely in confined areas.

- *Adjust intercom position*: Currently, the intercom used by the sample delivery person is located approximately waist high. This results in unclear and sometimes garbled communication. Adjusting the speakers to a more natural height for speaking will improve communication and protect delivery personnel.

- *Larger volume waste storage containers*: During the assessments, the sample waste did not always fit conveniently in the (approximately one liter) waste containers used at the AHRF. The availability of larger waste containers would be helpful.

- *Provide a document pass-through port*: Currently, both the sample and the sample paperwork enter the AHRF through the same pass-through portal. A separate pass-through for documentation would avoid contamination from samples.

4.1.3 Additional Suggestions

- *Scissors*: Blunt, round-tip scissors should be available in the glove box for easy removal of sample packaging and container materials.

- *Different Colored Gloves*: Different colors for inner and outer gloves are recommended to facilitate the monitoring of proper glove use.

4.1.4 Recommended Activities

- *Considerations and Guidelines for Future AHRF Installations*: Laboratories and other facilities that are considering installing and using an AHRF would benefit from information regarding issues that should be considered, and possibly resolved, prior to installation. The guidelines should address site-specific issues such as waste management, safety concerns, costs, maintenance, recommended staffing levels (including time on duty recommendations), and other site-specific guidelines.

- *Vulnerability Assessments*: Assessment panel members expressed some concern regarding the possibility of AHRFs becoming targets of vandalism and/or terrorist activity. Assessing the vulnerability of each AHRF, particularly prior to AHRF installation, could mitigate or prevent the impact of possible threats. Incident response plans also would be useful.

- *Build Relationships*: Personnel at AHRF sites should build relationships with local decision makers, first responders, hospitals, and laboratories. These relationships would prove invaluable during an incident. Suggestions for establishing and/or maintaining these relationships include participation in periodic AHRF assessments, training exercises, work sessions, and presentations.

- *Vaporized Hydrogen Peroxide*: VHP has proven to be an effective decontaminating agent and is used routinely by biosafety level-3 (BSL-3) laboratories. Modified VHP (e.g., via ammonia addition) can be used also for chemical decontamination. Incorporation of this technology in the AHRF might be an improvement or beneficial addition to the manual bleach washes currently being recommended and used. The VHP system is capable of getting into all crevices and hard-to-reach areas.

4.2 Equipment

4.2.1 Major Recommendations & Upgrades

M256A1 Nerve Agent Ticket: During the evaluation of simulants prior to the assessments, it was discovered that the NAV tickets used to detect nerve agents were problematic and subject to substantial false positive and false negative results. As a result, an alternative test (the nerve agent ticket from the M256A1 kit) was incorporated into the AHRF screening protocol used during the assessments. This alternative test is recommended for use in the AHRF screening protocol.

4.2.2 Minor Recommendations

There are no minor recommendations for equipment modifications.

4.2.3 Additional Suggestions

- *High-Quality Butane Lighter*: Assessments demonstrated that the use of low-quality lighters or flame sources during the thermal susceptibility test result in cooler flames and soot deposits that make interpretation of results difficult. Using a high-quality butane lighter will provide for a cleaner burn and improved observation during this test.

- *Platinum Wire*: Stainless steel spatulas used during the assessments were occasionally overloaded with material causing an uneven burn and difficult observation of results. Use of a platinum wire in place of a stainless steel spatula provided for improved visuals during thermal susceptibility testing.

- *Plastic Tongs*: During the assessments, observers noted occasional discoloration of metal tongs, which could be an indication of corrosion that could cause sample screening interferences or contamination. Plastic tongs are recommended to mitigate this concern.

4.2.4 Recommended Activities

- *Evaluate New and Alternative Technologies*: Since the availability of the October 2006 draft AHRF protocol, new technologies have been developed for testing the presence of nerve agents and explosives. Instrumentation continues to be improved, providing more specificity and sensitivity. Continued evaluation of new and alternative technologies (e.g., Sabre 4000, 3-way paper, HAZCAT kits, Agentase™ CAD-kits, bioscreening, peroxide paper, water-finding paper, the entire M256A1 kit, etc.) would ensure that the AHRFs are optimized to provide reliable information.

- *Colorimetric Test Results Booklet*: During the assessments, AHRF staff experienced some difficulty in determining positive and negative results from colorimetric paper tests used in the screening procedures. For example, staff was uncertain regarding the intensity of the pink color needed to indicate a positive result with the ELITE™ test card. Although the ELITE™ test includes an example positive result, development of a booklet or other easy-reference documentation showing visual results (both positive and negative) for colorimetric tests would be helpful in training AHRF staff and in providing a quick reference during sample screening.

- *Equipment Training*: In all assessments, AHRF staff felt additional training was required regarding proper use the equipment and interpretation of the colorimetric tests. Of particular concern was the need for training regarding the proper use and interpretation of the radiation detectors. Additional training materials for equipment use, particularly in the use of radioactivity testing equipment and paper test kits, should be developed and training should be provided.

4.3 Protocol

4.3.1 Major Recommendations and Upgrades

- *Handling Suspicious Powder*: The protocol should include more detailed procedures for receipt and handling of suspicious powders. The AHRF protocol currently provides minimum direction on how to handle suspicious powders, and the assessment demonstrated some confusion when the AHRF staff encountered white powders in envelopes or suspicious packages. The AHRF protocol should include details regarding how these samples should be handled, for example, instructions regarding overpacking (e.g., placing a suspicious envelope inside a plastic bag), when to contact the local FBI WMD Coordinator, etc.

- *Sample Receipt Forms*: The sample receipt forms included in the October 2006 protocol are lengthy and time consuming. As a result, the sample delivery person and the sample receiver may be exposing themselves to a dangerous situation before some critical safety questions are asked. The sample receipt forms should be streamlined, and rearranged so that the more critical safety questions (e.g., initial screening for radiation or explosive hazards) are addressed earlier in the process.

- *Immediate Gamma Screening*: The AHRF sample receipt process involves a lengthy interview process prior to initial sample screening. The protocol instructs the AHRF staff not to accept samples exceeding a specific gamma radiation limit. It is recommended that the protocol be modified so that a gamma radiation screen of the sample transport container is performed through the AHRF sample receipt window, prior to the interview process. This would minimize exposure and allow for a more timely call to local FBI WMD Coordinators or radiation experts, if necessary.

- *Water Solubility Test (See Step 5 of Attachment 2)*: The protocol does not include continued testing of all the sample phases created during the water solubility test (only the water-soluble portions are tested). As it may be possible for hazards to be present in any of the phases, all phases should be tested. Additionally, many substances are only partially soluble in water and the technician might have difficulty determining solubility, particularly for environmental samples. During the water solubility test in the last three assessments, the aqueous portion was evaluated for oxidizers and nerve agents using the pH, starch iodide, and nerve agent ticket tests. If an organic layer was present, it was tested with starch iodide paper, nerve agent ticket, DB-3 test, and M256A1 arsenic test strip.

  This approach allows for the screening of a wider variety of unknown samples, including samples comprising environmental matrices such as water, soil, and waste fuel/oil. The criterion of pH <4 for continued screening also was removed because samples containing lewisite could potentially have a low pH and should be screened using the M256A1 arsenic test. Clarification also is needed concerning how to handle samples with questionable density or precipitation.

- *Add Decision Points*: Additional decision points should be added throughout the protocol to require consultation with the Laboratory Director, FBI WMD Coordinator, and/or other technical experts. In many cases, sufficient information may be available to stop testing and direct the sample elsewhere. Specific new decision points should include (also refer to Attachment 2):

  - Step 2: If the response to the question "Was there a communicated threat?" is yes, stop and consult.
  - Step 2: If the response to the question "Is either screen positive?" is yes, stop and consult.
  - Step 3: If there is a positive response to the colorimetric explosive screen, stop and consult.
  - Step 4 (formerly Step 4a): Direct the analyst to stop and consult if the ELITE™ test or the thermal susceptibility test is positive.
  - Step 5 (formerly Step 4b): If the aqueous portion gives a positive starch iodide test or has a pH greater than 8 or less than 4, stop and consult.

- *M256A1 Arsenic Test (See Step 5 of Attachment 2)*: The formation of a precipitate during the water solubility test, combined with a pH < 4, did not prove to be a reliable test for lewisite, as the formation of a precipitate is not always easily visible when dealing with small amounts of sample. By incorporating the arsenic test from the M256A1 test kit, another means of detecting lewisite would be available. The M256A1 test is already used in the AHRF protocol as the nerve agent test; therefore, addition of the arsenic test does not require additional equipment. Training in the use of the M256 test tickets is also highly recommended (see Section 4.2.4).

- *Clarify Radioactivity Levels*: Some confusion arose during one assessment regarding the levels of radioactivity used to determine whether or not to continue AHRF testing or refuse the sample. A specific threshold level is listed in the protocol, however, a statement saying each facility should set its own threshold (i.e., based on site background levels) also is listed. The levels of radioactivity that are acceptable for sample receipt at the AHRF should be more clearly defined.

- *Add ELITE™ Card Test to Steps 2 and 4*: The ELITE™ card test proved to be a user-friendly and reliable test for detecting explosives during the assessments. Use of this test is recommended for detection of explosives on the transport container during Step 2, along with the M8 paper already being used. The test also is recommended for use prior to the thermal susceptibility test in Step 4, particularly because liquids are not tested during thermal susceptibility testing.

- *Revise protocol to ensure it is consistent with the flowchart*: The protocol includes a figure that presents the flow of samples through the screening process; it is important that the protocol describes the tests that are included in the figure. For example, the protocol should describe the float test used to screen for biological hazards. A revised flowchart is provided as Attachment 2 to this report. The AHRF protocol should be revised for consistency with this flowchart.

4.3.2 Minor Recommendations

- *Reporting Forms*: Assessment observers and AHRF staff noted some redundancy in the AHRF Sample Receipt and Screening Results forms. Removing some of this redundancy would expedite sample processing and decision making. The addition of start and stop times for some of the sample screening tests on these forms is recommended for documentation and verification of proper test times.

- *AHRF Temperature*: Both AHRFs used during the assessments are located in the Northeastern United States, where temperatures can fall below 0 ºF in the winter or above 90 ºF in the summer. Guidelines regarding temperature ranges that would be considered appropriate for AHRF functioning in cases when there are heating, ventilation, and air conditioning (HVAC) problems should be provided. The protocol documentation should include guidelines regarding required temperatures for testing and actions to take if the AHRF is not in this range.

- *Hints and Cautions*: ARHF staff and the assessment panelists agreed that the "Note" and "Warning" text boxes included throughout the protocol were helpful. Additional "hints" and "cautions" (such as what might cause false positives to occur, appropriate hot plate settings, how to use the FSP scraper feature) also would be beneficial.

4.3.3 Additional Suggestions

Overarching Procedures: Assessment participants noted that the protocol does not adequately address "overarching" procedures, such as decisions regarding how samples should be handled when screening tests are indicative, but not confirmatory (e.g., negative M8, positive alkylation test). The protocol should describe how to proceed in these situations.

4.3.4 Recommended Activities

- *Training Resources and Requirements*: Training programs should be developed for AHRF operations, including recommended training requirements and frequencies. It is recommended that a list of training resources be prepared and included as an attachment to the AHRF Protocol. This list should include instrument and colorimetric test training resources from vendors and others. The protocol also does not provide guidelines regarding training that would be required for AHRF technicians/chemists. A required minimum frequency of training and what the training should include should be specified. AHRF staff should be trained in the proper use of AHRF equipment and tests, the AHRF protocol, the proper use of PPE, proper handling of CWAs and other hazards, and other health and safety procedures.

- *Evidentiary, Preservation, and Shipping Issues*: The protocol does not provide sufficient guidelines regarding how to handle evidentiary samples or preserve evidence. Guidelines should be developed in consultation with the FBI, and provided in the protocol. Sample shipment to other facilities or locations also is not adequately addressed. Issues such as proper packaging, labeling, and U.S. Department of Transportation (DOT) requirements should be addressed or, at a minimum, a reference supplied as to where that information can be obtained.

- *Large Packages*: The pass-through for samples into the AHRF is not adequate for receipt of samples that do not fit through the sample receipt portal. The protocol does not address how these samples should be handled. The EPA Region 1 and NYSDOH AHRFs faced this problem in an assessment scenario, and each handled the situation differently. Instructions for handling these packages should be developed and provided. Instructions also are needed regarding how to handle radioactive samples that are refused entry. Because these procedures may be dependent on local requirements or practices, the protocol should, at a minimum, provide instructions to follow the site's standard operating procedure for handling these samples.

- *Redirection/Repackaging*: Guidelines or instructions regarding the handling of samples that are redirected to another laboratory should be developed and provided. The guidelines should address how AHRF staff should determine which laboratory will receive the sample, what preservation (if any) is required, and how the sample should be packaged. Currently, the protocol directs specific decontamination of sample containers and references DOT shipping regulations, but does not address sample preservation. The protocol also mentions the possibility of sending sample aliquots to a laboratory, but does not adequately address what to do with the remaining sample. Because the biosafety cabinet does not provide adequate space for long-term sample storage, sample storage in the AHRF is not an option.

- *Additional Assessments*: Additional assessments of the AHRF protocol, using a greater variety of samples (e.g., multiple contaminants in a sample, additional contaminants, a greater variety of matrices, addition of an explosive "device" sample, etc.) and including local decision makers (local FBI, first responders, public health laboratory, etc.) should be performed on a regular basis.

- *Proficiency Testing*: To determine that AHRFs are maintained, performing optimally, and are able to support correct decision making in evaluating the potential threat of unknown samples, routine (e.g., at least annual) proficiency testing should be planned. Procedures for periodic proficiency testing of facilities, equipment, and protocols should be developed and implemented. These procedures, for example, could be similar to proficiency testing procedures under which the laboratory currently operates.

5.0 Conclusions

All AHRF staff, panelists, and observers participating in the AHRF protocol assessments agreed that the AHRFs meet the purpose of protecting laboratory facilities and staff, and can support decisions concerning samples containing potentially hazardous unknowns. The modifications described in Section 4.0 of this report are recommended as improvements to ensure that the AHRFs perform optimally to meet this purpose. The existing AHRF prototypes provide the engineering controls required to allow the operators to handle samples safely and efficiently. AHRF staff at each facility was well trained and experienced with the protocol. During the assessments, excellent communication also was observed between staff performing activities in both the bleaching station and glove box areas, and between the bleaching station team and the sample delivery person. This level of communication was critical to appropriate decision making and safety.

Recommendations and suggestions resulting from the assessments that could be immediately incorporated into the AHRF protocol were included in the final AHRF Protocol published September 2008 (EPA/600/R-08/105). Those directly impacting the sample screening procedures are reflected in the final flowchart, which is included in the final Protocol and as Attachment 2 to this report. Incorporated recommendations include the following:

- Replace NAV tickets with M256A1 nerve ticket (already incorporated into procedures used during assessments).
- Rearrange order of sample receipt interview questions to address safety concerns first.
- Perform gamma screening prior to the sample receipt interview.
- Change the water solubility testing portion of the protocol to include testing of all phases; include information regarding how to handle questionable density samples and the formation of precipitates.
- Add additional decision points to seek assistance from the FBI WMD Coordinator and/or others.
- Incorporate arsenic test from M256A1 (Step 5 of Attachment 2).
- Clarify levels of radioactivity acceptable for sample receipt.
- Add ELITE™ card test to Step 2 (Transport Container Screening) and Step 4 (Initial Sample Screening) as an additional test for explosives.
- Revise protocol to ensure it is consistent with flowchart (e.g., include float test for biologicals).
- Include more "hints"/"cautions" to the protocol (e.g., regarding false positives, hotplate settings, use of the FSP scraper feature, etc.).
- Use a high-quality butane lighter for a cleaner burn and improved observation during thermal susceptibility test.
- Use platinum wire in place of spatula to improve observation during thermal susceptibility test.
- Use plastic tongs when adding waste to bleach containers.

Additional recommendations and suggestions resulting from the assessments were not incorporated into the protocols because they either required site-specific considerations or time for development. The existing AHRF prototype host sites have since addressed several of these recommendations by initiating staff training and equipment testing activities, purchasing additional sets of equipment, and preparing modified reporting forms.

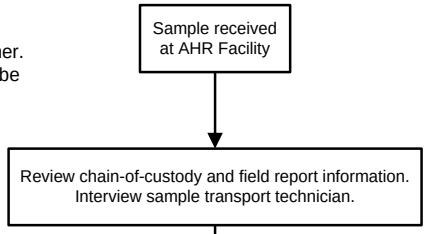
Attachment 1

Flowchart (Obsolete) – Sample Screening Procedures from the October 2006 AHRF Protocol

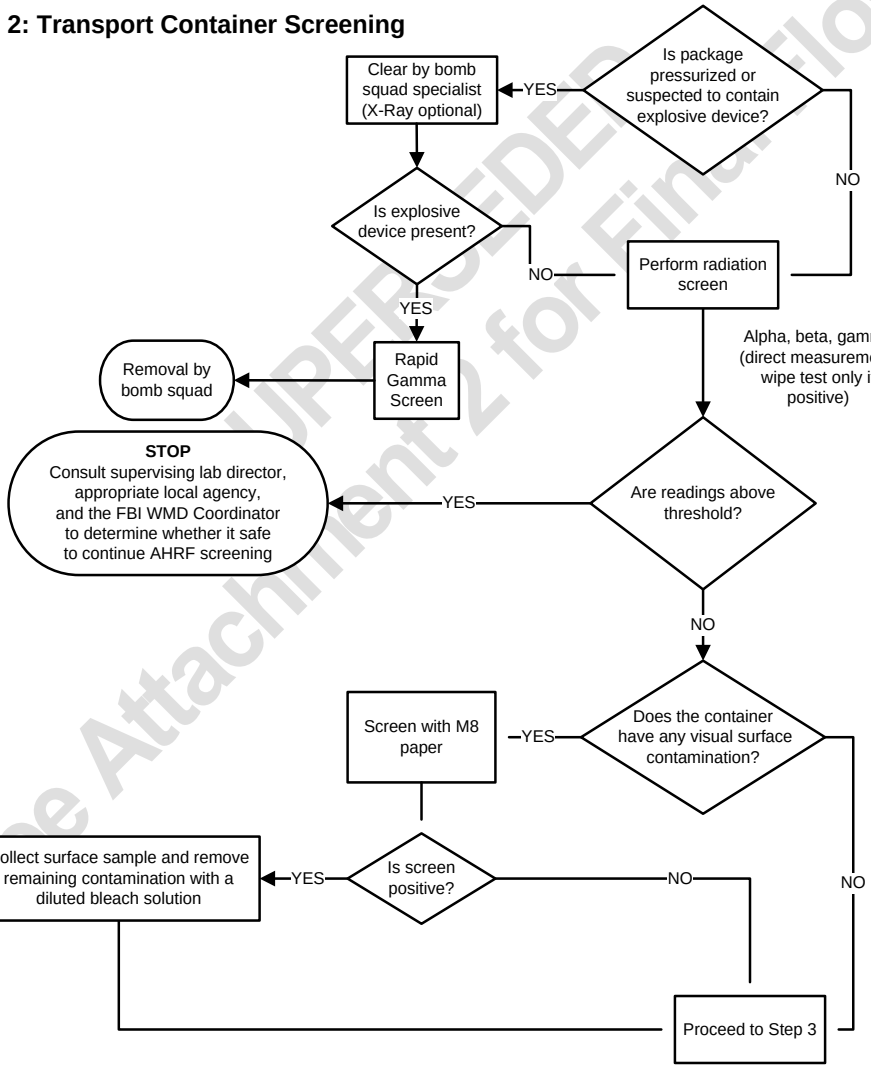
AHRF Sample Screening Procedures (Obsolete)

STEP 1: Sample Receipt

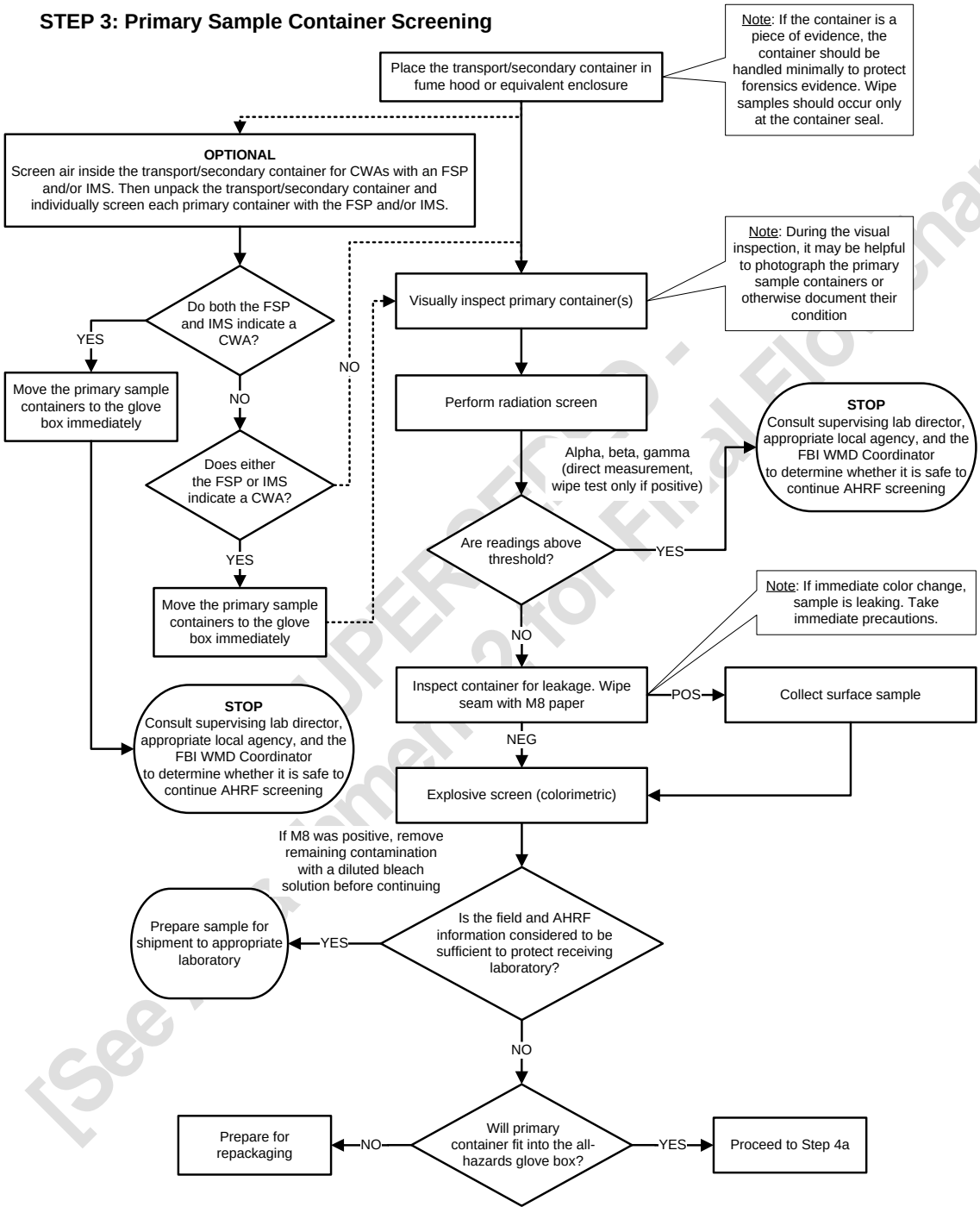
It is assumed that a sample will be collected by first responders and packaged in a primary sample container. It is also assumed that primary sample containers will be further packaged into a transport container. If a suspicious package is encountered, it also will be packaged in a transport container.



STEP 2: Transport Container Screening

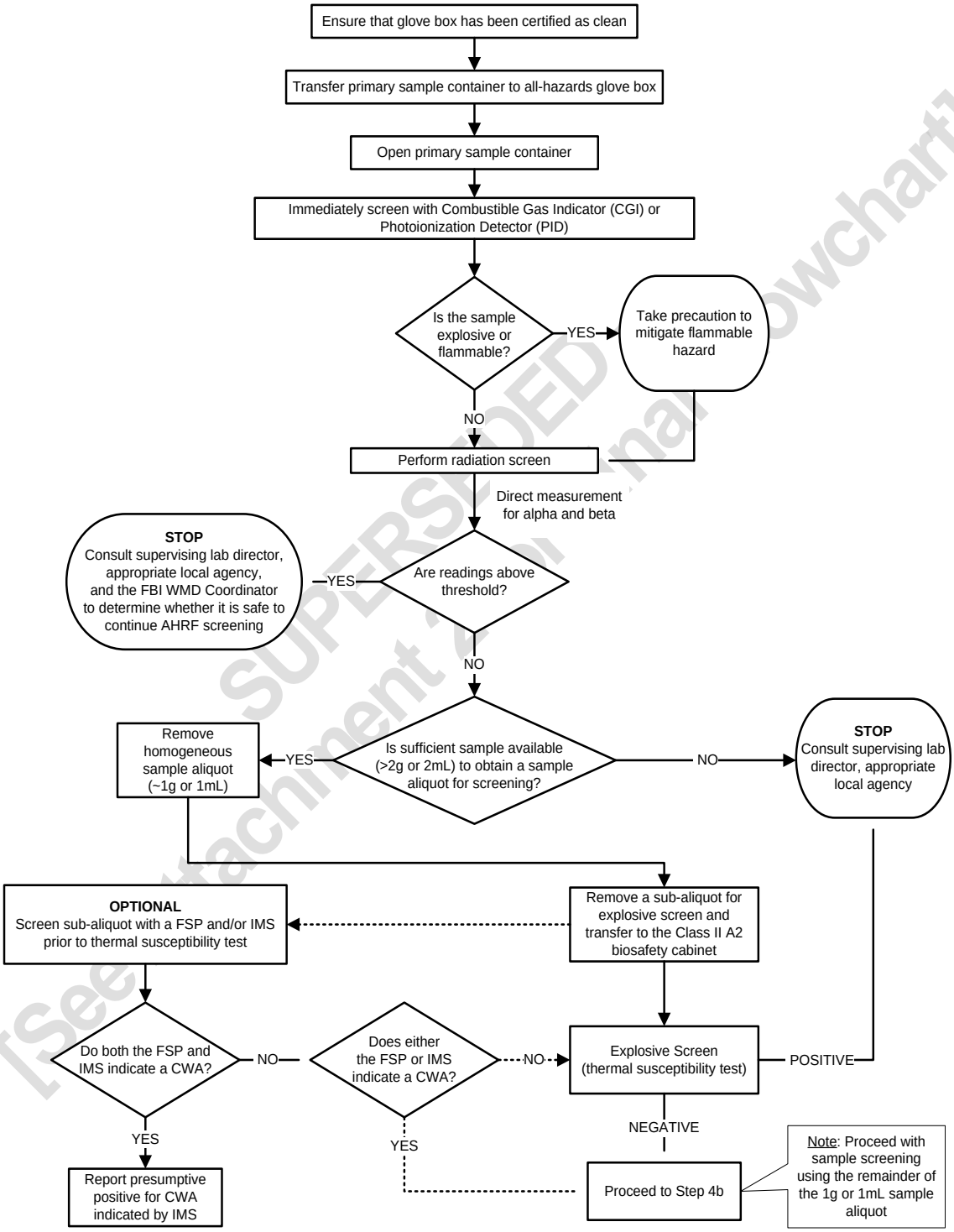


AHRF Sample Screening Procedures (Obsolete) (Continued)

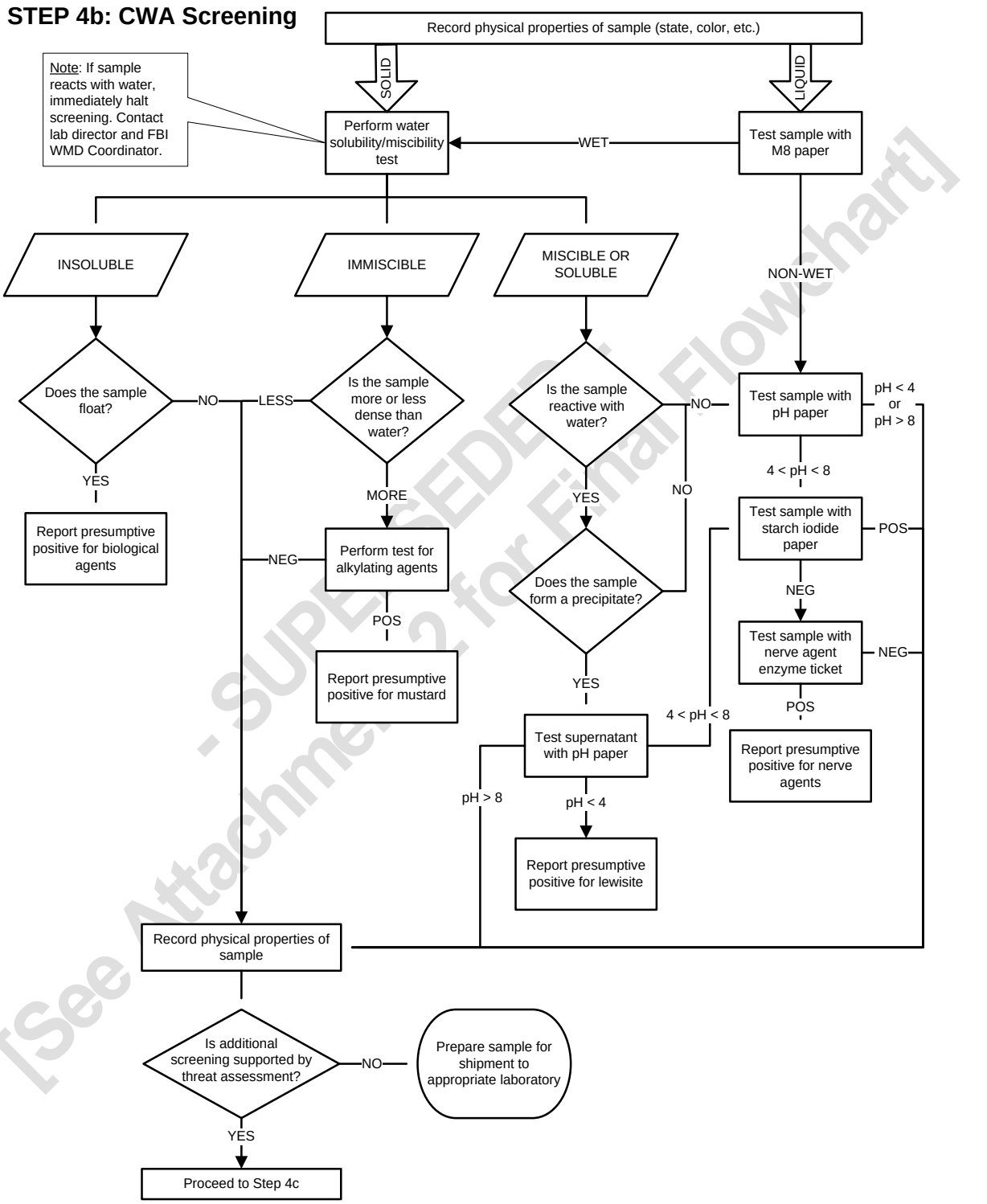


AHRF Sample Screening Procedures (Obsolete) (Continued)

STEP 4a: Initial Sample Screening

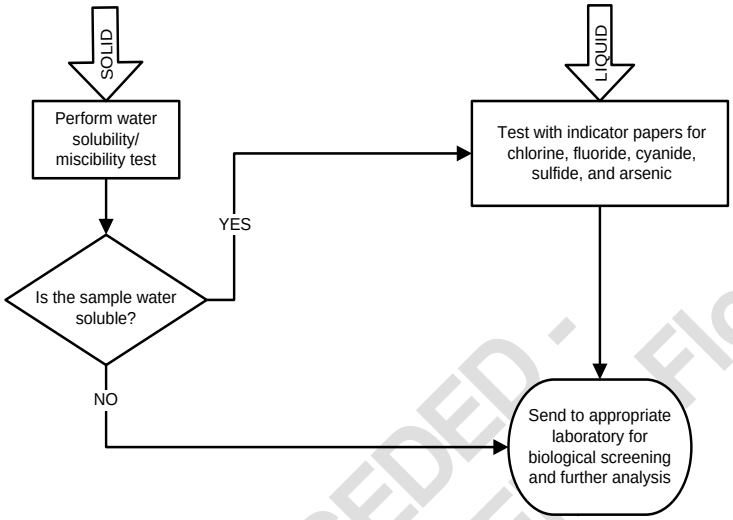


AHRF Sample Screening Procedures (Obsolete) (Continued)



AHRF Sample Screening Procedures (Obsolete) (Continued)

STEP 4c: Additional Screening of Sample



Note: This Interim All Hazards Receipt Facility Protocol currently does not include a biological screening process. Potential "low tech" and low cost screening methods are being assessed and may be added at a later date.

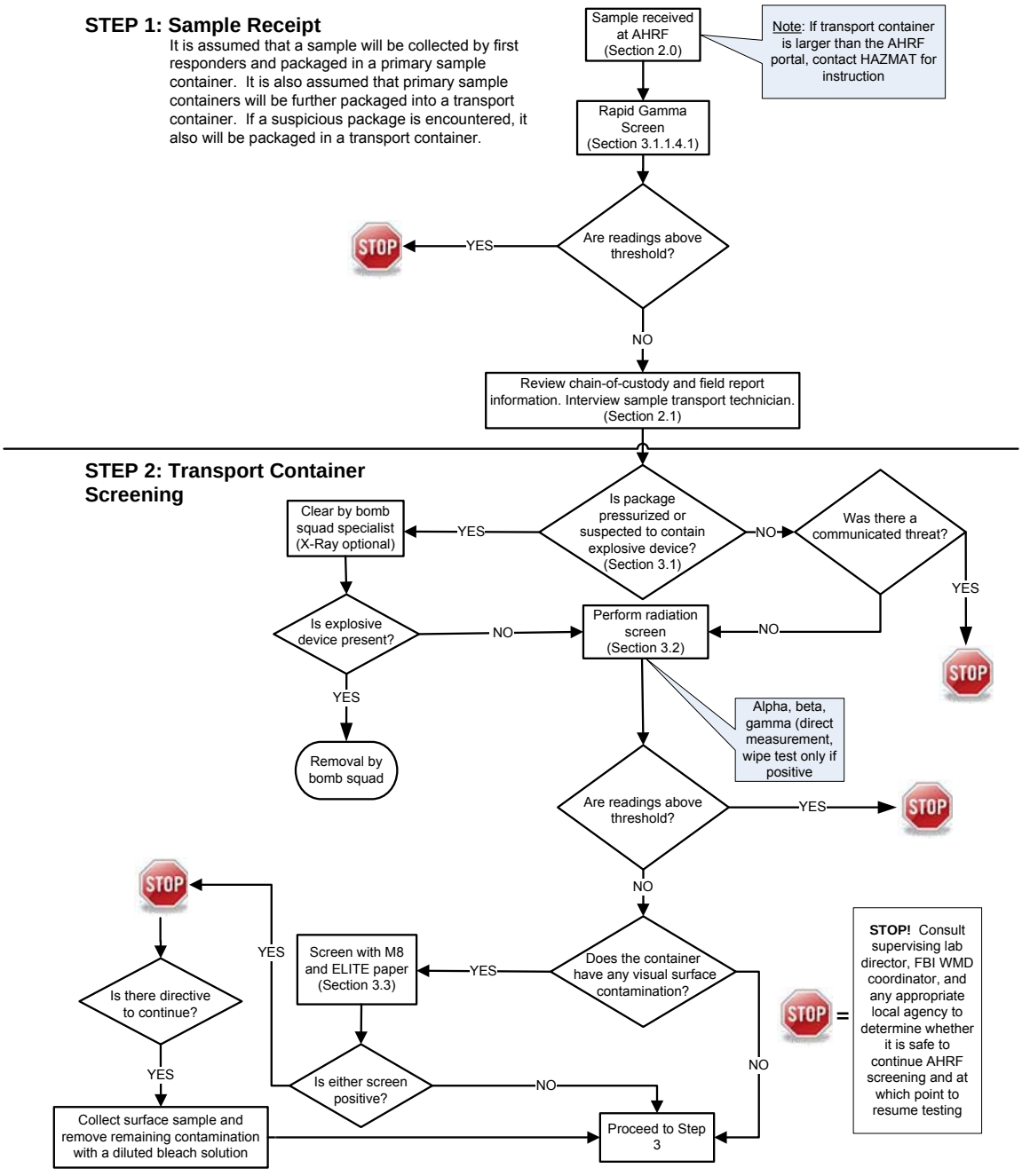
Some interested parties have suggested that it may be more practical to screen unknown samples for radiological, explosive, and chemical threats and then send the sample directly to a Laboratory Response Network (LRN) lab. This suggestion is based on concerns related to the amount of available sample material, timing (urgency), and qualified expertise. Others, however, have suggested that using minimal biological screening (e.g., immunoassay or ATP bioluminescence) to detect the presence of biological activity may be warranted under some conditions. These techniques may be reasonable and appropriate depending on a given facility's capabilities. EPA is continuing to assess the feasibility of biological screens for the purposes of this project.

Attachment 2

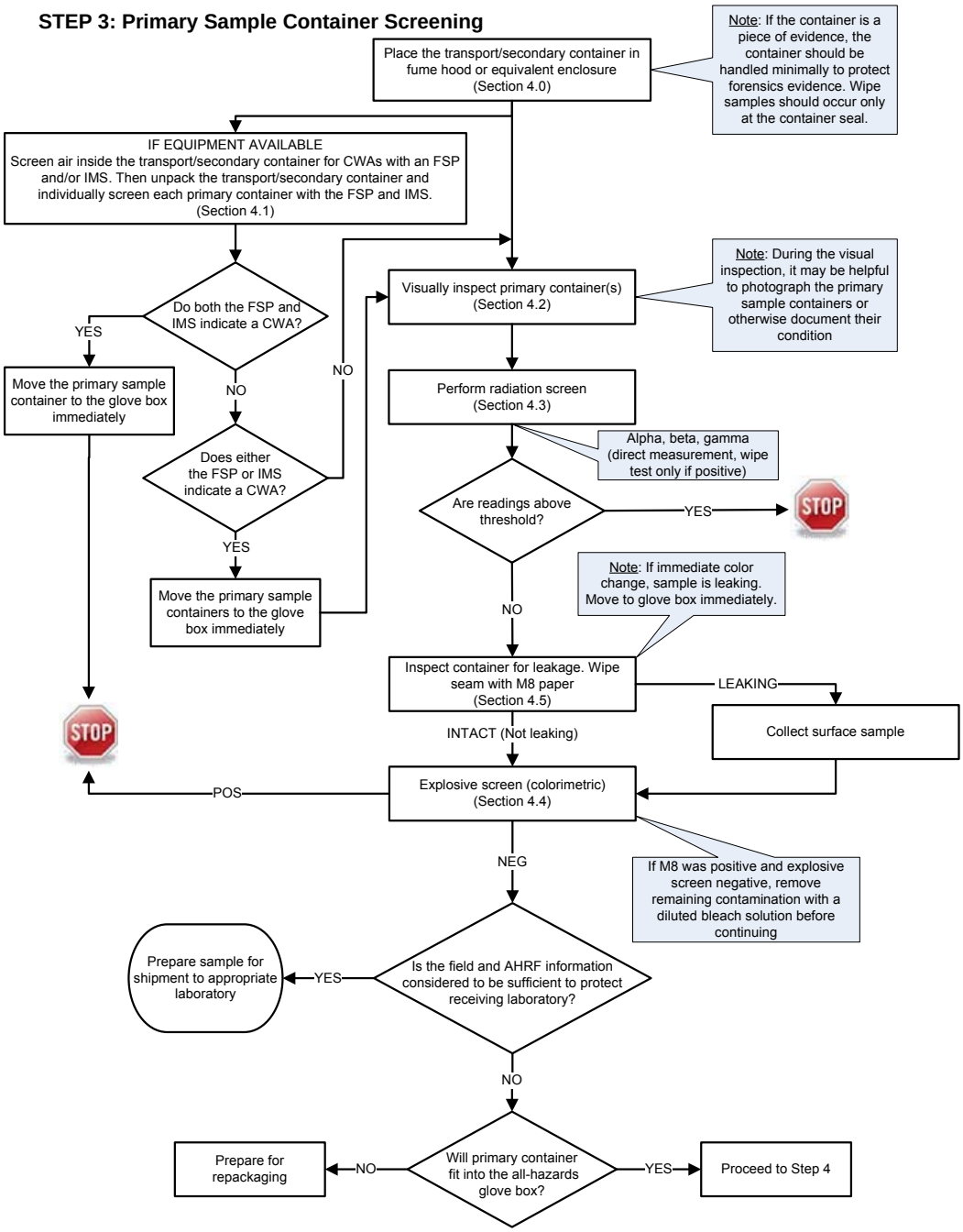
Flowchart (Final) – Recommended Modifications to AHRF Sample Screening Procedures Based on Assessments

[Note: Detailed procedures are included in EPA's All Hazards Receipt Facility (AHRF) Screening Protocol, EPA/600/R-08/105, DHS/S&T-PUB-08-0001).]

Recommended Modifications to AHRF Sample Screening Procedures

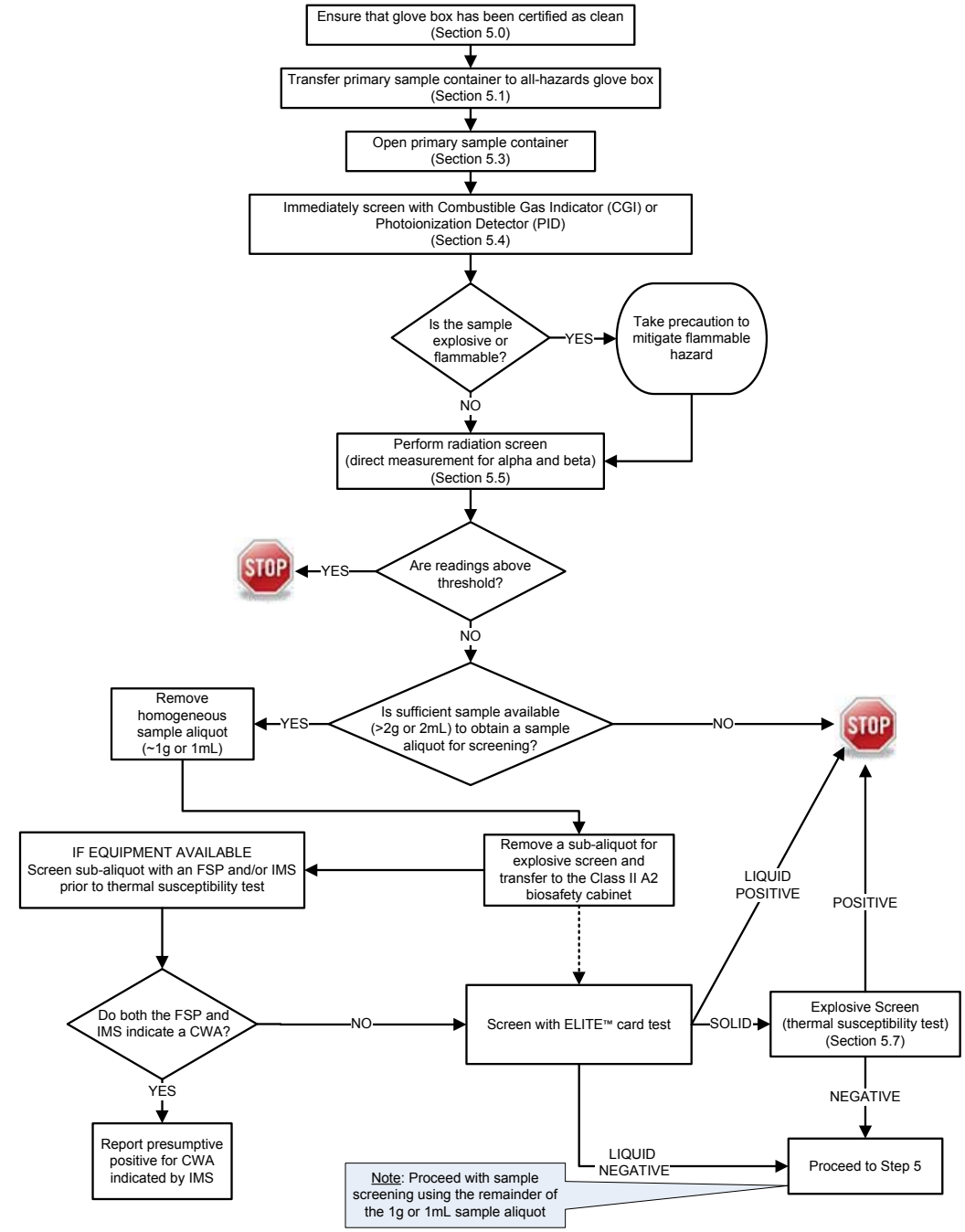


Recommended Modifications to AHRF Sample Screening Procedures (Continued)



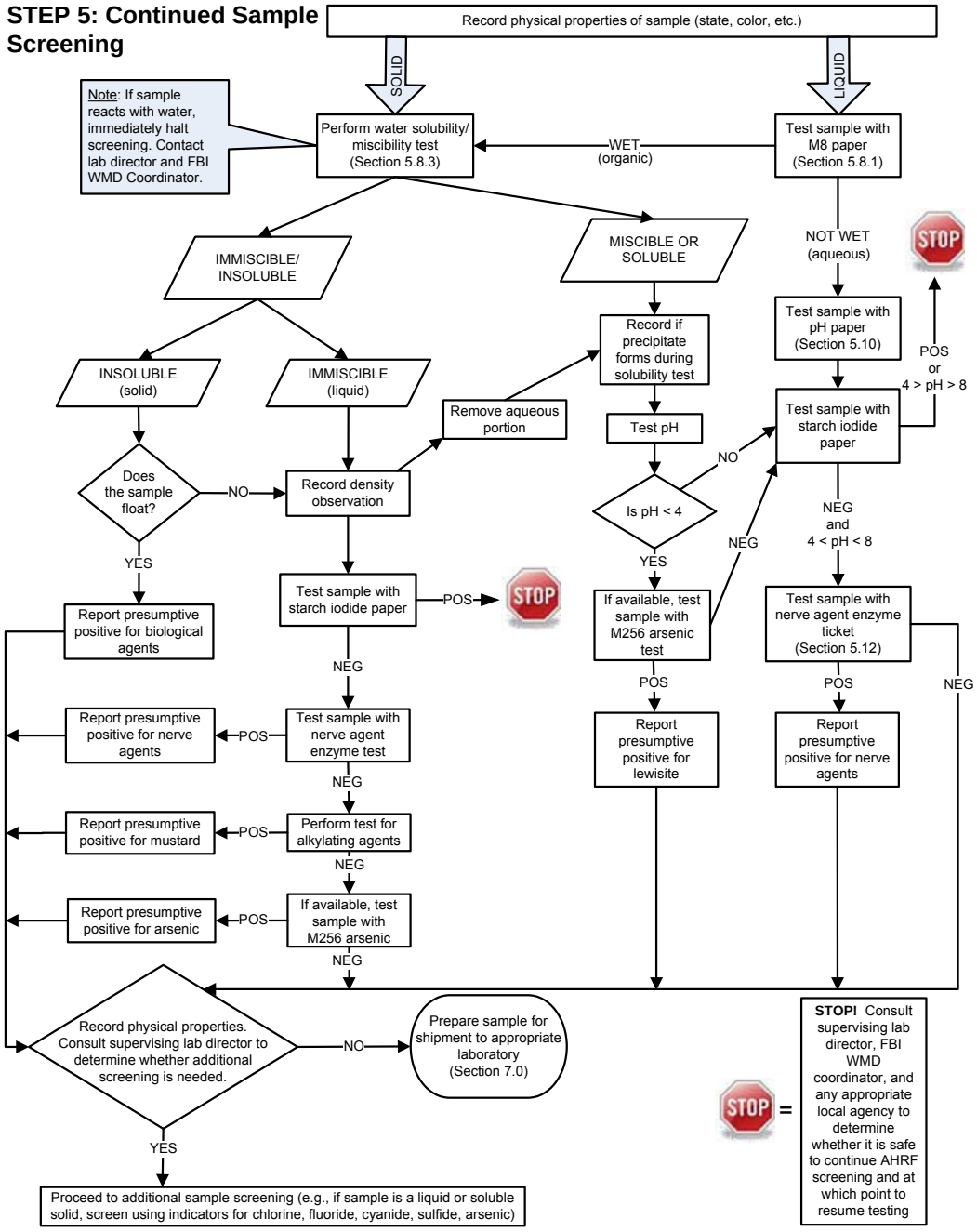
Recommended Modifications to AHRF Sample Screening Procedures (Continued)

STEP 4: Initial Sample Screening



Recommended Modifications to AHRF Sample Screening Procedures (Continued)

STEP 5: Continued Sample Screening



Recommended Modifications to AHRF Sample Screening Procedures (Continued)

Note: This Interim All Hazards Receipt Facility Protocol currently does not include a biological screening process. Potential "low tech" and low cost screening methods are being assessed and may be added at a later date.

Some interested parties have suggested that it may be more practical to screen unknown samples for radiological, explosive, and chemical threats and then send the sample directly to a Laboratory Response Network (LRN) lab. This suggestion is based on concerns related to the amount of available sample material, timing (urgency), and qualified expertise. Others, however, have suggested that using minimal biological screening (e.g., immunoassay or ATP bioluminescence) to detect the presence of biological activity may be warranted under some conditions. These techniques may be reasonable and appropriate depending on a given facility's capabilities. EPA is continuing to assess the feasibility of biological screens for the purposes of this project.

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