System Assessment and Validation for Emergency Responders (SAVER)

Subsistence and Sanitation Systems Technical Guide

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System Assessment and Validation for Emergency Responders

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FOREWORD

The U.S. Department of Homeland Security (DHS) established the System Assessment and Validation for Emergency Responders (SAVER) Program to assist emergency responders making procurement decisions. Located within the Science and Technology Directorate (S&T) of DHS, the SAVER Program conducts objective assessments and validations on commercial equipment and systems, and provides those results along with other relevant equipment information to the emergency response community in an operationally useful form. SAVER provides information on equipment that falls within the categories listed in the DHS Authorized Equipment List (AEL). The SAVER Program mission includes:

- Conducting impartial, practitioner-relevant, operationally oriented assessments of emergency responder equipment; and
- Providing information, in the form of knowledge products, that enables decision-makers and responders to better select, procure, use, and maintain emergency responder equipment.

Information provided by the SAVER Program will be shared nationally with the responder community, providing a life- and cost-saving asset to DHS, as well as to Federal, state, and local responders.

The SAVER Program is supported by a network of Technical Agents who perform assessment and validation activities. Further SAVER focuses primarily on two main questions for the emergency responder community: "What equipment is available?" and "How does it perform?"

As a SAVER Program Technical Agent, the U.S. Army Natick Soldier Research, Development and Engineering Center (NSRDEC) has been tasked to provide expertise and analysis on key subject areas, such as personal protective equipment, rapid deployment shelters, and shelf stable food. In support of this tasking, NSRDEC prepared a technical guide on subsistence and sanitation systems, which fall under the AEL reference number 19GN-00-HSSF.

Visit the SAVER website at www.dhs.gov/science-and-technology/SAVER for more information on the SAVER Program or to view additional reports on subsistence and sanitation systems or other technologies.

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1. INTRODUCTION

The System Assessment and Validation for Emergency Responders (SAVER) Program developed this technical guide to provide emergency responders with key information on subsistence and sanitation systems (Authorized Equipment List [AEL] reference number 19GN-00-HSSF). This guide provides information on factors that should be taken into consideration when determining the appropriate system for procurement.

The emergency response community utilizes subsistence and sanitation systems to support response and recovery operations in areas without basic infrastructure. These systems include field kitchens, showers, restrooms, and laundry systems that allow continued operations in areas where such systems are unavailable, either because they did not previously exist due to the remote location, or because they have been compromised as a result of an emergency.

The information in this report represents an effort to exercise due diligence in the collection of valuable support information for emergency responders. It is not intended to cover all aspects of operations and procurement.

2. SUBSISTENCE AND SANITATION SYSTEMS OVERVIEW

Subsistence and sanitation systems allow emergency responders to continue extended operations when local food service and/or sanitation system infrastructure is unavailable or damaged.

A subsistence system consists of a mobile or modular kitchen that provides the ability to store, prepare, and cook food, while sanitation systems consist of mobile units that provide restroom, shower, and/or laundry facilities.

Most systems run on electricity that is provided by a generator, which uses either diesel fuel or liquid propane gas. Alternatively, some systems may be plugged into an existing electrical power source to eliminate the need for a generator. Systems are road, air, or rail transportable. Over the road systems are trailer-mounted, self-driven, or semi-truck towable.

This guide provides information to assist first responders in better understanding subsistence and sanitation systems and making more informed procurement decisions.

3. SELECTION CONSIDERATIONS

There are a number of commercially available subsistence and sanitation systems on the market, many with different features and capabilities. Some of the key considerations when purchasing, renting, or leasing these systems are described below.

3.1 Capacity

In choosing the appropriate system, one of the primary decision-making criteria is capacity, which refers to the number of people that the system may support during any given time period. Subsistence systems are measured by the number of meals served per hour, while sanitation systems are measured by the number of toilets, shower stalls, and/or washers and dryers contained in the system.

Some systems are expandable, modular, or can be connected to provide increased capacity, which may be achieved by moving walls or internal parts in a single unit or by combining multiple units of the same system into a single, larger system.

In order to increase the feeding capacity to serve large groups, many subsistence systems are intended to be connected together to form a single system supporting multiple serving lines. The menu may be limited to enable food preparation in larger quantities, while providing full balanced nutrition and hot food items for larger groups. It is important that the purchaser discuss the specific details related to capacity with the vendor before making a purchasing decision. It is also important to understand how long capacity can be sustained, as some systems rely on advance food preparation to feed large groups for short periods of time and may not support the ability to prepare large quantities of food continuously to keep up with high demand.

The guidelines listed below may be helpful in determining capacity requirements.

- Kitchen capacity is determined by the amount of time it takes to prepare a certain number of meals, the type of meal that can be prepared, and how much refrigerated or heated storage is available. The appropriate kitchen capacity can be determined based on discussions with vendors regarding the specific needs of a population;
- The number of toilets provided should be equal to approximately five percent of the population;
- Showers can be expected to serve an average of six people per hour, which takes into account water conservation needs; and
- An average of 10 pounds of clothes per person, per day is customarily used to determine washer and dryer capacity needs. Washers and dryers vary widely in the number of pounds of clothes they hold per load, so the number of systems required will vary based on the individual capacity of each washer and dryer.

3.2 System Cost

Subsistence and sanitation systems are available for purchase, rent, and long- and short-term lease. Due to the overall cost, the decision to purchase, lease, or rent is partially based on the duration of need; agencies with long-term requirements tend to purchase systems, while agencies with short-term (i.e., within 45 days of a disaster) requirements tend to lease or rent.

The decision to purchase can be practical in cases where emergency situations are probable, as systems can be stocked for future needs and mobilized immediately. However, many companies experienced in disaster relief frequently offer next day delivery of available units. If purchasing, storage space availability and maintenance costs should be considered.

Leasing or renting often includes turn-key services in addition to the systems themselves, up to full-scale site replenishment. Some of the services include:

- Site design;
- Transportation;
- Set-up and tear-down;
- Waste disposal;
- Food, water, and fuel services; and
- System maintenance.

Price comparisons should be made between similar systems, with similar components, as some products may have higher up-front costs, but may also include more equipment than a lower-cost system. The life-cycle cost is the sum of all recurring and non-recurring costs over the full life span of the system. This should be discussed with the vendors and is an important decision-making criterion because maintenance, operation, and disposal costs often make up a much larger portion of the overall system cost than the up-front cost alone.

The system purchase price varies widely per system based on a number of factors, including but not limited to: system capacity, delivery location, urgency of need, and the quantity of systems required. The cost to lease a system also varies widely depending on the terms and conditions of the lease and is customarily situation-specific rather than standard across all leases. In addition to the factors affecting the system purchase price, the lease cost is also affected by the duration of need, and normally consists of a down-payment, fee for lease, and a monthly lease fee. Lease terms are likely to differ by vendor and should be discussed in detail to ensure an accurate cost comparison between similar terms of use.

Finally, warranties and service or maintenance agreements offered by the manufacturers should be considered. It is recommended that research on all of the options be conducted prior to an emergency.

3.3 Resource Consumption and Cost

Different systems use varying amounts of fresh water and fuel and consume different levels of power, whether from electric, diesel, propane, or renewable energy sources. Resource cost and availability varies by location, climate, and local regulations, and this variance in cost and availability of resources may also affect the choice of systems.

General guidelines are available to assist in determining the required system components for a given population size. These guidelines are based on calculations used for military base camps.

- Water: Approximately 25 gallons of water are required per person, per day. This accounts for both potable uses, such as consumption and cooking, and non-potable water uses including bathing, washing clothes, and sanitation, as well as waste due to leaks and overuse; and
- Diesel Fuel: Approximately 20 gallons of fuel is required per person, per day. This accounts for uses such as electricity, cooking, environmental control, etc.

3.4 Waste Disposal

Health codes determine disposal requirements for solid and liquid waste and will vary by state and local jurisdiction. Local regulations should be examined before disposing of solid or liquid waste from subsistence and sanitation systems in order to ensure compliance with laws and minimize the risk of environmental contamination. Some regulations may be temporarily modified or waived during emergency situations.

- Solid waste includes trash, food, packaging, and human waste. Approximately 15 pounds of solid waste is generated per person, per day. Options for disposal include:
    - Removal of waste to an alternate site for disposal, such as a landfill. This reduces trash buildup in the area, but requires transportation equipment and a place to store waste between collections; and
    - Incineration of waste. This reduces the need for storage space and transportation, but has the potential to produce hazardous fumes if waste is improperly burned.
- Options for liquid waste include:
    - Gray water is wastewater from kitchens, showers, and laundry facilities. An average of 12 to 15 gallons is generated per person, per day. Some systems are equipped with gray water recycling technology, which is further described in Section 3.9. Gray water, even when filtered and treated, is never safe to drink; and
    - Black water is wastewater from toilets. This type of waste has very stringent disposal requirements to prevent illness from contamination. Approximately eight gallons of black water is generated per person, per day with flush toilets. It must be disposed of into sewage treatment systems or wastewater holding tanks that must be pumped out and transported for treatment using the appropriate equipment. Black water must be disposed of in accordance with Federal, state, and local regulations.

3.5 Equipment

Standard and optional equipment varies by manufacturer and by system. Discussions should be held with the vendor to ensure a full understanding of the equipment included in the purchase price; optional equipment; and any additional recommended equipment that may be needed in case of an emergency, such as backup power sources, light towers, and dry storage. Additional tanks for fuel, wastewater, and potable water are frequently available in multiple sizes to suit the needs of a specific operation and should be discussed.

The type, weight, and dimensions of the system can affect the equipment required for transportation and set-up. Trailered systems are driven or towed to their destination, but containerized systems may require ancillary equipment to place them, such as forklifts. In addition, it is important to discuss the types of water and electrical connectors provided with the system, as adaptors may be needed.

A detailed listing of equipment is provided in the SAVER *Subsistence and Sanitation Systems Market Survey Report* available in the SAVER section of the Responder Knowledge Base (RKB) website at https://www.rkb.us/saver.

3.6 Location

Location is an important factor to consider when choosing a system, both in terms of accessibility of infrastructure and extreme local weather conditions. Depending on the infrastructure available, some of the transportation options include air, rail, or road. Some systems may be operational during transport, others may require set-up upon arrival at the destination site, and some may require specialized equipment such as a forklift. In addition, availability of space may affect system selection as dimensions and weight vary widely.

System selection can be limited by extreme local weather conditions because the systems have a range of operational temperatures. Some systems include insulation and/or environmental control units while others do not. Some systems may be inappropriate for extremely hot or cold weather temperatures, or may require the purchase of additional equipment to operate.

In addition, location should be considered in estimating resource costs, as very remote locations or areas where infrastructure is damaged are likely to increase the cost to transport resources for use in the system.

3.7 Time and Personnel

Time and personnel availability can be a factor in choosing a system. Skill levels for both set-up/tear-down and operation of systems vary widely. Procuring authorities will need to ensure that properly skilled personnel are available to perform the necessary maintenance and operation of the system. Some required specialists may include electricians, plumbers, and forklift operators. For leased systems, vendors generally offer these services to their customers.

3.8 Technology Options

Subsistence and sanitation systems offer similar technologies and basic capabilities; however, there are some additional options to consider. Some of the more common options are listed:

3.8.1 Mobile Kitchen

- Cooking capabilities
    - Ability to prepare and cook raw food items is provided in some systems; and
    - Others just have the ability to reheat previously cooked food.
- Cold food storage
    - Integrated refrigeration capacity is provided in some systems; and
    - Freezers are included in some.
- Heat-on-the-move capability
    - Some systems have the ability to perform some degree of operation during transport.
- Onboard fuel/water tanks
    - Some systems have integrated storage as part of the base system.

3.8.2 Laundry

- Top-load vs. front-load washing machines
    - Top-load washers generate more wastewater and use more fresh water, but wash clothes in less time; and
    - Front-load washers have a higher up-front cost and require more time to wash clothes, but use less water and are more space efficient because they can be stacked.
- Electric vs. propane dryers
    - Vendors that primarily offer one type of dryer are typically able to substitute if the other type is preferred;
    - Due to transportation and safety requirements, propane dryers may not be preferable for some areas; and
    - Typically, propane dryers have a higher up-front cost, but can cost less to operate.
- Capacity
    - Washers and dryers vary in capacity from less than 50 to greater than 200 pounds per load, so it is important to discuss this with the vendor to ensure that the system is capable of serving the entire population as required.

3.8.3 Showers

- Anti-scalding technology
    - This technology limits the water temperature to be between 105 to 110 degrees Fahrenheit (^{o}F).
- Shave stands
    - Shave stands may be available in select units.
- Gang showers vs. privacy stalls
    - Gang showers consist of multiple shower heads within the same room, which allows for a higher capacity but minimal privacy; and
    - Privacy stalls require more space per person for each stall causing decreased capacity, but provide individuals with privacy while using the facility.
- Standard vs. WaterSense®
    - A WaterSense label certifies that a particular product has demonstrated its ability to meet U.S. Environmental Protection Agency criteria for water efficiency; and
    - WaterSense technology generally has a higher up-front cost, but can save money through reduced water requirements.

3.8.4 Restrooms

- Direct drop: Port-a-potty type;
- Dry flapper valve: Foot pedal/handle that drops the flapper and turns on the water to rinse;
- Porcelain flushing toilet: Typical household toilet with plumbing;
- Air-assisted flushing: Uses compressed air or a small electric pump to create pressure that increases water flow with decreased water volume, reducing water flushing volume while resulting in cleaner waste pipes and preventing clogs; and
- Single vs. dual flush: Permits user to choose between a smaller volume of water for liquid waste and a larger volume for solid waste.

3.9 Emerging Technologies

Many of the emerging technologies today focus on energy needs. Some of the areas being researched are listed below.

- Energy efficiency
    - Renewable energy powered
        - Generates electricity using renewable energy sources such as solar, wind, geothermal, and biofuel.
    - Light Emitting Diode (LED) lighting
    - Insulation
        - Reduces need for environmental control unit in extreme hot or cold temperatures.
    - Power distribution system
        - Balances electrical load to reduce overall need for power.
- Gray water recycling
    - Captures gray water for reuse in non-consumption applications, such as recycling wastewater from kitchens, showers, and laundry systems for use in flushing toilets. Water may be filtered and reused in order to reduce fresh water requirements and waste generation.

4. STANDARDS/REGULATIONS

Mobile subsistence and sanitation systems are required to meet numerous safety and sanitation requirements that include, but are not limited to: electrical, health, materials, transportation, and ventilation. Most vendors state that they meet all applicable regulations and standards.

5. CONCLUSION

Procurement of subsistence and sanitation systems should be made based on research, knowledge of requirements, and detailed conversations with vendors to ensure that any systems purchased or leased are capable of meeting the needs of the mission. Due to the wide range of products available in the commercial market and varying capabilities, the decision-making process for which system to purchase or lease may be a long and involved process. In an emergency situation, vendors may be capable of providing subsistence and sanitation systems at a fast pace in order to ensure that emergency responders are equipped to fulfill their mission. However, since there are a variety of criteria to consider, it is recommended that planning be conducted prior to an actual emergency.