Military Field Water Mission

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Agenda

• TARDEC Overview
• Field Water Supply Mission Background
• Producing Safe Water
  – source water selection and protection
  – water treatment
  – disinfection
  – proper operation and maintenance of storage and distribution systems, and
  – operational water quality monitoring
• Questions
TARDEC develops, integrates, and sustains the right technology solutions for all manned and unmanned DOD ground systems and combat support systems to improve Current Force effectiveness and provide superior capabilities for the Future Force.

Accomplished by

- Leading Systems Integration excellence across the Life Cycle
- Continuous pursuit of innovation in our technology focus areas
- Living our core and enterprise values

TARDEC - Responsible for Research, Development and Engineering Support to 2,800 Army systems and many of the Army’s and DOD’s top joint warfighter development programs.
Portfolio

**Combat Vehicles**
- Heavy Brigade Combat Teams
- Strykers
- MRAPs
- Ground Combat Vehicles (Future)

**Force Projection**
- Fuel & Water Distribution
- Force Sustainment
- Construction Equipment
- Bridging
- Assured Mobility Systems

**Tactical Vehicles**
- HMMWVs
- Trailers
- Heavy, Medium and Light Tactical Vehicles

**Watercraft**
- High Speed Vessel
- Causeways
- Harbor Craft
- Landing Craft

**Robotics**
- Technology Components
- Demonstrators
- Military Relevant Test & Experimentation
- Transition and Requirements Development

TARDEC Engineers Provide Cradle-To-Grave Engineering Support

Unclassified/FOUO
Freshwater Test Facility @ SANG B350
- Year Round Water Access
- Approved NPDES discharge permit for 500K GPD
- 6” exterior sanitary drain and interior drains are easily accessible
- 7,500 square feet of heated floor space; 1,500 square feet of loft area over office for storage
- 440V, 240V and 120V power available
- Military water purifiers (TWPS, LWP, ROWPUs) are available for use

Seawater Test Facility – Port Hueneme, CA
- Year-round access to natural seawater
- Approved discharge permit
- Military water purifiers (TWPS, LWP, ROWPUs) are available for use

Water Quality Lab – B210
- Organic and inorganic analysis

Water Treatment Test Lab – B210
- Reverse osmosis membrane test stands
- Water and wastewater treatment component testing
- GAC/IX testing
THE WORLDS ULTIMATE WEAPON RUNS ON WATER... EVERYTHING ELSE RUNS ON FUEL.
Background

- Drinking Water Related Health Problems in WWI lead to development of the Mobile Water Purification Unit
- The Mobile Water Purification Unit found to be only partially effective during WWII
- After WWII, multiple units developed for various types of source water
  - Seawater Distillation Unit
  - NBC Treatment Unit
  - Fresh Water Purifier (ERDLATOR)
- Use of multiple units led to logistics and training problems
- US Government funded research in Reverse Osmosis led to fielding of Reverse Osmosis Water Purification Units (ROWPUs) in the 1980’s
Early Water Treatment Equipment

Army Engineering Research and Development Laboratory

ERDLATOR

Army Mobile Water Purification System
Soldier Water Requirements

- 3-4% Water deficit (2-3 quarts) significantly reduces performance (up to 48%)

- 6-8% Water deficit (4-6 quarts) renders a soldier completely ineffective

- Minimum water consumption is 1 gallon/soldier/day to 3 gallon/soldier/day

- Universal unit level average is 6.6 gallon/soldier/day (53 pounds)

- Fully developed theater requires 15.6 gallon/soldier/day (129.5 pounds)

- Water is projected to be 30 to 40% of the daily sustainment requirement
Producing Safe Water

- Multiple Barrier Approach
  - source water selection and protection
  - water treatment
  - disinfection
  - proper operation and maintenance of storage and distribution systems, and
  - operational water quality monitoring
Source Water Selection

- Sources
  - Surface
  - Ground
  - Host Nation Municipal

- Criteria
  - Quality / Quantity
  - Pollution Sources
  - Vulnerability

RAW WATER IS CONSIDERED NON-POTABLE UNTIL TREATED AND CERTIFIED TO MEET THE Tri Service Field Water Standards
• Multiple Barrier Approach
  – source water selection and protection
  – water treatment
  – disinfection
  – proper operation and maintenance of storage and distribution systems, and
  – operational water quality monitoring
Military Water Treatment Equipment

- **Lightweight Water Purifier (LWP)** - Fielded 2005
- **3000 GPH ROWPU** - Fielded 1989
- **600 ROWPU** – Fielded 1981
- **1500 GPH Tactical Water Purification System (TWPS)** - Fielded 2004

*TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.*
Three Configurations

1. MULTIMEDIA FILTER
   - RAW WATER SOURCE
   - Activated carbon cartridge
   - Ion exchange cartridge

2. Microfiltration
   - RAW WATER SOURCE
   - RO Vessels
   - Activated carbon cartridge
   - Ion exchange cartridge

3. Ultrafiltration
   - RAW WATER SOURCE
   - RO Vessels
   - Activated carbon cartridge
   - Ion exchange cartridge

AMTA Conference 24 Jul 2007
Unclassified/FOUO
600 GPH Reverse Osmosis Water Purification Unit (ROWPU)

- Produce potable water that meets Tri-Service Standards from any available source
- System produces 600 gallons per hour on seawater (35,000 ppm) and 900 gallons per hour on freshwater
- Raw water intake system – strainer and raw water pump
- Clarification system – multi-media filter, cartridge filter, chemical injection pumps
- Purification system – high pressure pump, 8 6-inch reverse osmosis elements
- NBC decontamination system – activated carbon, mixed-bed ion exchange
- Disinfection by Chlorination
### 600 GPH ROWPU Characteristics

- **30 kW Generator (Army only)**
  - 2850 lb
- **5 ton Trailer (Army only)**
  - 5595 lb
- **Skid mounted (USMC and AF)**
  - 9.5 L x 7 W x 5.7 H ft
  - 7300 lb
- **Trailer Mounted with 30Kw generator**
  - 19 L x 8 W x 8 H ft
  - 16,975 lb
- **Three - 3K onion tanks packed w/ROWPU**
  - GAC, IX and chlorination post treatment for NBC removal
  - Chlorination to 2 ppm

- **Feed flow – 30 gpm**
- **Multi-media filtration**
  - 6-7 gal/min/sq. ft
- **5um cartridge filtration**
  - 8 ea - 2.5 inch dia x 40 inch long filters
  - String wound, polypropylene
- **Reverse osmosis**
  - 8 ea – 6 inch dia. X 40 inch long polyamide RO elements
  - Avg salt rejection – 99.4%
  - All elements in series
  - 50% recovery on freshwater and 33% on seawater
3000 GPH ROWPU

- Produce potable water that meets Tri-Service Standards from any available source
- System produces 2000 gallons per hour on seawater (35,000 ppm) and 3000 gallons per hour on freshwater
- Raw water intake system – strainer, raw water pump, and cyclone separator
- Clarification system – multi-media filter, cartridge filter, chemical injection pumps
- Purification system – high pressure pump, 12 8-inch reverse osmosis elements
- NBC decontamination system – activated carbon, mixed-bed ion exchange
- Disinfection by Chlorination
3000 GPH ROWPU

- Contained in a special ISO container with skid mounted external components
- Mounted on a standard 30ft M871 military trailer
- Powered by a 60kw diesel generator also mounted on the trailer
- Dimension & Weight: 20'L x 8'H x 8'W, 15,100lbs (fully packed container/ROWPU only)
- Dimension & Weight: 30'L x 13'H x 8'W, 37,960lbs (fully packed and mounted on trailer w/generator)
- Three - 3K onion tanks packed w/ROWPU, seven additional tanks come with the system for a total of ten at 135lbs each

- Feed flow – 100 gpm
- Multi-media filtration
  12-13 gal/min/sq. ft
- 3um cartridge filtration
  12 ea - 2.5 inch dia x 40 inch long filters
  String wound, polypropylene
- Reverse osmosis
  2 ea – 8 inch dia. X 40 inch long polyamide RO elements
  Avg salt rejection – 99.4%
  2x1x1 array
  50% recovery on freshwater and 33% on seawater
- GAC, IX and chlorination post treatment for NBC removal
- Chlorination to 2 ppm
600-gph and 3,000-gph ROWPUs water flow diagram
1200 gallons per hour on seawater (45,000 ppm)
1500 gallons per hour on freshwater
0.2 micron microfiltration
Ten reverse osmosis elements
Energy recovery device
Compressed Air valves, controls, and MF back flushing every 15 minutes
Sodium bisulfite, anti-scalant, and chlorine addition
6000 gallon storage, one 125 gpm pump
Carbon and ion exchange cartridges
1500 GPH TWPS
Characteristics

- USMC and Army version have the same base skid-mounted system
- Army system is mounted in a ISO flatrack and includes a 60kW TQG and the following kits:
  - Cold Weather
  - Chemical Cleaning Wastewater Storage
  - NBC Water Treatment
  - NBC Survivability
  - Ocean Intake Structure
- USMC orders the kits separately as required
- Dimensions and Weight
  - Army: 8’H X 8’W X 20’L, 23,300 lbs
  - USMC: 6’H X 7.16’ X 13.75’ L 10,000 lbs
- Transportability
  - Army – HEMTT LHS or PLS
  - USMC - MTVR
- Feed flow – 50 gpm
- Product Flow
  - Freshwater – 1800 GPH
  - Brackish/seawater 1500 GPH
- Strainer - 60 micron
- Microfiltration
  - MEMCOR system – 0.2 micron hollow fibers
  - 12 MF modules/outside-in filtration
  - Backflushes every 15 mins for approx 1 min
- Reverse osmosis
  - 10 ea – 8 inch dia. X 40 inch long polyamide RO elements
  - Avg salt rejection – 99.4%
  - 50% recovery on freshwater and 40% on seawater
- GAC, IX and chlorination post treatment for NBC removal
- Chlorination to 2 ppm
Lightweight Water Purifier (LWP)

Support ground, amphibious, Special Operation Forces, air mobile and airborne units operating autonomously.

Purifies up to 125 gph from a fresh water source, 75 gph from salt water and NBC-contaminated sources.

Ultrafiltration pretreatment
Lightweight Water Purifier Characteristics

• Base Unit
  – Pretreatment Module
  – Pump Module
  – Control Module
  – 3 kW generator
  – High Pressure Pump Module
  – RO Module
  – Chemical Injection/Cleaning Module
  – 2 ea 1000 gal onion tanks

• Supplemental Cold Weather Kit

• Transportability
  – M1097 HMMWV
  – UH-60 Helicopter
  – C130
  – Air Droppable

• System Dimensions and Weight
  – 2000 lbs
  – 4.25’L X 2.25’W X 4’ H (HMMWV bed size)

• Feed flow – 5.0 gpm

• Product Flow
  – Freshwater – 125 GPH
  – Brackish/seawater 75 GPH

• Ultrafiltration
  – Koch system – 0.05 micron hollow fibers
  – 3 UF modules/inside-out filtration
  – Backflushes every 15 mins for approx 1 min

• Reverse osmosis
  – 7 ea – 2.5 inch dia. X 40 inch long polyamide RO elements
  – Avg salt rejection – 99.4%
  – 50% recovery on freshwater and 30% on seawater

• GAC, IX and chlorination post treatment for NBC removal

• Chlorination to 2 ppm
LWP and TWPS water flow diagram

- Feed Water Pump
- Strainer
- Ultrafiltration or Microfiltration Membranes
- Turbidit y Meter
- TDS Meter
- RO Vessel
- Brine/Reject Water
- Sequestrant (Scale Inhibitor)
- Calcium Hypochlorite

Diagram:

LWP and TWPS water flow diagram
### Military Water Purification Equipment Summary

Note: Values presented based on Seawater

<table>
<thead>
<tr>
<th></th>
<th>LWP</th>
<th>600 ROWPU</th>
<th>3k ROWPU</th>
<th>Army TWPS</th>
<th>EUWP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Production Rate (gph)</strong></td>
<td>75</td>
<td>600</td>
<td>2,018</td>
<td>1,500</td>
<td>4,170</td>
</tr>
<tr>
<td><strong>Avg RO Flux (gfd)</strong></td>
<td>8.9</td>
<td>12</td>
<td>13.7</td>
<td>7.6</td>
<td>11</td>
</tr>
<tr>
<td><strong>MF/UF Flux (gfd)</strong></td>
<td>25</td>
<td>na</td>
<td>na</td>
<td>25</td>
<td>40</td>
</tr>
<tr>
<td><strong>RO Recovery (%)</strong></td>
<td>30</td>
<td>31</td>
<td>33</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td><strong>Weight (gpd/lb.)</strong></td>
<td>1.09</td>
<td>1.40</td>
<td>1.88</td>
<td>1.26</td>
<td>2.62</td>
</tr>
<tr>
<td><strong>Cube (gpd/cu.ft.)</strong></td>
<td>12.9</td>
<td>31.3</td>
<td>28.8</td>
<td>22.5</td>
<td>38.9</td>
</tr>
<tr>
<td><strong>C-130 Lift (gpd)</strong></td>
<td>na</td>
<td>43,200</td>
<td>48,500</td>
<td>28,800</td>
<td>100,000</td>
</tr>
</tbody>
</table>

- Able to purify any source - lake, river, ocean, NBC contaminated - in sufficient quantities **BUT**
  - Systems have large energy (fuel) requirements
    - 20 to 50 kW-Hr/ Kgal
  - Systems have a large footprint (size/weight)
    - Systems require operational changes for certain contaminants
  - Systems are a logistics burden - large volume of consumables (filters, membranes, chemicals)
• Multiple Barrier Approach
  – source water selection and protection
  – water treatment
  – disinfection
  – proper operation and maintenance of storage and distribution systems, and
  – operational water quality monitoring
Disinfection

“The act of inactivating the larger portion of microorganisms in or on a substance with the probability that all pathogenic organisms are killed by the agent used”

Sterilization

Prevent re-growth

Protect against potential contamination
Disinfectants -

- Chlorine, Iodine, Chlorine Dioxide, UV, Ozone
- Sodium Hypochlorite – bleach (Clorox, 5-10%)
- Calcium Hypochlorite – HTH (70%)
  - Readily Available
  - Relatively safe
  - Effective
Target Disinfectant Residuals (TBMED 577)

- **Point of Production**
  - RO Based treatment – 2 mg/L after 30 min
  - Non-RO Based treatment – 5 mg/L after 30 min
- **Point of Consumption** – 1 mg/L
- **After transport** – 1 mg/L
- < 1 mg/L increase to 2 mg/L – available immediately
- Non-detect, increase to 2 mg/L – wait 30 min
• Multiple Barrier Approach
  – source water selection and protection
  – water treatment
  – disinfection
  – proper operation and maintenance of storage and distribution systems, and
  – operational water quality monitoring
Primary Water Storage & Distribution Equipment

**Distribution**
- **TWDS** - Tactical Water Distro System (10 mi hoseline sets)
- **SMFT** - Semi-Trailer Mounted Fabric Tank (3k and 5k sizes)
- **FAWPSS** - Forward Area Water Point Supply System

**400 Gallon Water Trailer**
- **M149A2 Water Trailer**
- **Camel**
- **800 Gallon Water Trailer**
- **Hippo**
- **2000 Gallon Tank Rack**

**Storage Systems**
- **SDS** - Storage & Distro Systems consist of 50K and 20K bags
- **Onion Bag** - 3,000 gal thin skinned bag for temp storage

**TWDS**—10 miles of hoseline; six 600 GPM pumps; two 20K storage tanks; two 125 gpm pumps

**SMFTs two sizes (3K & 5K)**

**FAWPSS**
- Six 500 gallon drums, one 125 GPM pump, and hoses

**The HIPPO**

**The CAMEL**

**400 Gallon Water Trailer (400 Gal)**

Unclassified/FOUO
• Multiple Barrier Approach
  – source water selection and protection
  – water treatment
  – disinfection
  – proper operation and maintenance of storage and distribution systems, and
  – operational water quality monitoring
Preventive Maintenance Tasks

- **Basic Characterization Testing (BCT)**
  - Tri-Service Field Water Standards (TSFWS)
  - Water Point Reconnaissance
  - *Untreated Source*

- **Basic Potability Testing (BPT)**
  - Tri-Service Field Water Standards (TSFWS)-Must Meet!
  - after the ROWPU is fully operational and before water is dispensed for consumption
  - *Treated Product*

- **Advanced Water Surveillance and Testing**
  - When a water point remains in operation for greater than 7 days
  - Partial Onsite
  - Partial Sampling for Remote Analysis
### Water Quality Standards

**Table C-2. Long-term field water quality standards (less than 1 year)**

<table>
<thead>
<tr>
<th>Physical Properties</th>
<th>U.S. Tri Service (June 1996)</th>
<th>QSTAG 245 (Sep 1985)</th>
<th>STANAG 2136 (Sep 1995)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5 L/Day</td>
<td>15 L/Day</td>
<td>5 L/Day</td>
</tr>
<tr>
<td><strong>Color (Color Unit)</strong></td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td><strong>Odor (TON)</strong></td>
<td>3</td>
<td>3</td>
<td>--</td>
</tr>
<tr>
<td><strong>pH</strong></td>
<td>5 - 9</td>
<td>5 - 9</td>
<td>5 - 9.2</td>
</tr>
<tr>
<td><strong>Temperature (Degrees C)</strong></td>
<td>15 - 22</td>
<td>15 - 22</td>
<td>15 - 22</td>
</tr>
<tr>
<td><strong>TDS (mg/L)</strong></td>
<td>1000</td>
<td>1000</td>
<td>1500</td>
</tr>
<tr>
<td><strong>Turbidity (NTU)</strong></td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Chemical Properties</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Arsenic (mg/L)</strong></td>
<td>0.06</td>
<td>0.02</td>
<td>0.05</td>
</tr>
<tr>
<td><strong>Cyanide (mg/L)</strong></td>
<td>6</td>
<td>2</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Chloride (mg/L)</strong></td>
<td>600</td>
<td>600</td>
<td>600</td>
</tr>
<tr>
<td><strong>Lindane (mg/L)</strong></td>
<td>0.6</td>
<td>0.2</td>
<td>--</td>
</tr>
<tr>
<td><strong>Magnesium (mg/L)</strong></td>
<td>100</td>
<td>30</td>
<td>150</td>
</tr>
<tr>
<td><strong>Sulfate (mg/L)</strong></td>
<td>300</td>
<td>100</td>
<td>400</td>
</tr>
<tr>
<td>Microbiological</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Coliform (#/100 mL)</strong></td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>Virus (#/100 mL)</strong></td>
<td>--</td>
<td>--</td>
<td>1</td>
</tr>
<tr>
<td><strong>Sporos/Cysts (#/100 mL)</strong></td>
<td>--</td>
<td>--</td>
<td>1</td>
</tr>
<tr>
<td><strong>Radiological (µCi/L)</strong></td>
<td>0.1</td>
<td>0.05</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Current EPA Std was reduced to .01 mg/L in Jan. 2006
Questions?

Back up Slides