Tab 3  Oxygen Supply Options Developed by Development Center for Operational Medicine, USAF
BRIEFING OUTLINE

• Objectives
• Assumptions
• Basic Systems
• Oxygen Generation Process
• Components--Comparison Matrix
• Options and Comparisons
• Additional Considerations
Objectives

• To provide information about oxygen systems to FEMA for use in emergency mass casualty operations.

• To deliver Oxygen to converted medical facilities such as hotels which would become hospitals

• Provide procurement options
Assumptions

• FEMA Region 8 possesses the following equipment:
  - Respirators
  - Transportation sources
  - Facilities

• FEMA has procedures for:
  - Emergency Response Plans
  - Memorandum of Understanding with Military Medical Organization
  - Procurement/Funding
FEMA REGION 8
serving CO, MT, ND, SD, UT, WY

FEMA Regional Offices

[Map showing regional offices]
Basic Systems

• **Oxygen Generation Systems**
  - Deployable Oxygen Generation System (DOGS)
  - Expeditionary Deployable Oxygen Concentration System (EDOCS)
  - Home Fill Systems

• **Oxygen Storage Systems**
  - Mobile Oxygen Storage Tank (MOST)
  - New Generation Portable Therapeutic Liquid Oxygen (NPTLOX)
  - Hospital Oxygen Backup System (HOBS)

• **Oxygen Distribution Systems**
  - Portable Oxygen Distribution System (PODS)
  - Surgical Oxygen Distribution System (SODS)
Oxygen Generation Process

• Example:
  – On Board Oxygen Generating System (OBOGS)
SIMPLIFIED OBOGS OPERATION

Exhaust Gas

Molecular Sieve Canister - Purge Phase

Exhaust Gas

Engine Bleed Air

Molecular Sieve Canister - Production Phase

Breathing Gas

O₂ 21%
N₂ 78%
Ar 1%

O₂ 93%
N₂ 3%
Ar 4%

DOS (Deployable Oxygen System)
## Components

<table>
<thead>
<tr>
<th>O2 Generation Systems</th>
<th>Oxygen Flow Rate</th>
<th>Power Req</th>
<th>Effectiveness</th>
<th>Cube</th>
<th>Cost</th>
<th>O2 Purity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expeditionary Deployable Oxygen Concentration System (EDOCS) 120</td>
<td>120</td>
<td>8</td>
<td>15</td>
<td>108</td>
<td>131</td>
<td>93 +/- 3</td>
</tr>
<tr>
<td>Portable Therapeutic Oxygen Concentration System (PTOCS)</td>
<td>45</td>
<td>7</td>
<td>6</td>
<td>75</td>
<td>40</td>
<td>93+</td>
</tr>
<tr>
<td>Portable Oxygen Generation System (POGS)</td>
<td>33</td>
<td>12</td>
<td>3</td>
<td>27</td>
<td>35</td>
<td>93-95</td>
</tr>
<tr>
<td>Patient Ventilation Oxygen Concentration System (PVOCS)</td>
<td>20/20</td>
<td>4.3</td>
<td>5</td>
<td>73.5</td>
<td>35</td>
<td>93 +/- 3</td>
</tr>
<tr>
<td>Invocare HomeFill Oxygen Compressor</td>
<td>3</td>
<td>0.2</td>
<td>15</td>
<td>2.8</td>
<td>2.5</td>
<td>93 +/- 3</td>
</tr>
</tbody>
</table>

*provides oxygen and medical grade air  
Oxygen/Air
Generation Systems

- EDOCS
- DOGS
- Home Fill System
DEPLOYABLE OXYGEN GENERATION SYSTEM (DOGS)

Essex Cryogenics
- PTOCS Concentrator
- P/N 60C-0169-0100
## EDOCS vs DOGS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>EDOCS 120</th>
<th>DOGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen Purity</td>
<td>90 – 96%</td>
<td>&gt;93% with potential to meet 95%</td>
</tr>
<tr>
<td>FDA Approval</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Oxygen Outflow control</td>
<td>No information available</td>
<td>0.5 – 15 LPM at each outlet</td>
</tr>
<tr>
<td>System Weight</td>
<td>3800 lbs</td>
<td>870 lbs</td>
</tr>
<tr>
<td>Portability</td>
<td>Forklift</td>
<td>4-person carry on</td>
</tr>
<tr>
<td>Oxygen flow rate</td>
<td>120 LPM</td>
<td>45 LPM</td>
</tr>
<tr>
<td>Oxygen outlets</td>
<td>4 Oxygen Fill Ports to fill H-Tanks (comes with M tanks)</td>
<td>3 oxygen outlets with a minimum flow rate of 11 LPM per outlet at 50 +/- 5 psig</td>
</tr>
<tr>
<td>Cube size</td>
<td>108 cubic feet 2 units can fit on a 463L</td>
<td>43 cubic feet 3 units can fit on a 463L pallet</td>
</tr>
<tr>
<td>Dimensions</td>
<td>94” L X 40”W X 50”H</td>
<td>Air tank module--23 ½” W X 43 ½” L X 27 ½” H Compressor--23 ½” W X 43 ½” L X 27 ½” H Concentrator module--21”W X 30”L X 38” H HP cylinder refill component--34”W X 27”L X 23 ¾”</td>
</tr>
<tr>
<td>Cost</td>
<td>$140K</td>
<td>$33K (POM) (Boost 66 20K) $39K surge estimate</td>
</tr>
<tr>
<td>Power</td>
<td>8 KW (estimated 2-3KW)</td>
<td>6.8 KW</td>
</tr>
</tbody>
</table>
Home Fill System

- 3 liters per min @ 14-21psi
- 110V AC and 200 Watts
- Light weight - 33 lbs
- Approx $2,500
Storage Units

- MOST
- NPTLOX
- HOBS
Mobile Oxygen Storage System (MOST)

- Capacity 11,320 liters @ 2015psi
- 150 lbs
- Non Standard Connections
- Not FDA Certified
- Aluminum Lined
Next Generation Therapeutic Liquid Oxygen (NPTLOX)

- Delivers gaseous oxygen at a rate of 66 LPM at 50 ± 5 psig
- Liquid oxygen storage capacity of 20 liters
- Has 6 oxygen outlets for patient use, supplies 11 lpm maintaining pressures of 50 ± 5 psig
- Weight: 150 lbs when filled to capacity
- Accessory kit for O₂ delivery devices
- Includes a fast-fill interface similar to the current PTLOX.
**HOBS - Hospital Oxygen Backup System**

- Configured bank of eight steel cylinders with manifold connection for large storage needs
- 55,000L capacity
# Storage Units

<table>
<thead>
<tr>
<th>Criteria</th>
<th>PTLOX</th>
<th>NPTLOX</th>
<th>Cylinders</th>
<th>MOST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (lbs)</td>
<td>103 lbs</td>
<td>150 lbs</td>
<td>Variable by type</td>
<td>150 lbs</td>
</tr>
<tr>
<td>Maturity (yes/no)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Proven</td>
<td>In use by AFMS</td>
<td>Not fielded yet, IOC pending $</td>
<td>In use by AFMS</td>
<td>Proven technology, new application &amp; configuration</td>
</tr>
<tr>
<td>Power Requirements</td>
<td>9 volt battery</td>
<td>9 volt battery</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Cube (Ft³)</td>
<td>3.75</td>
<td>7.3</td>
<td>Variable by type and size</td>
<td>9</td>
</tr>
<tr>
<td>Availability</td>
<td>In use</td>
<td>Jun- Jul 03</td>
<td>In use</td>
<td>12-13 weeks</td>
</tr>
<tr>
<td>Cost ($)</td>
<td>$14K</td>
<td>~$25K</td>
<td>~$190-250</td>
<td>~$13K</td>
</tr>
</tbody>
</table>
Distribution Systems

- **PODS - Patient Oxygen Distribution System**
  - Mimics hospital system
  - Off the floor - no tripping hazard

**SODS - Surgical Oxygen Distribution System**
(Operating room equivalent to PODS)
Pressure Drop

• Pressure drops over the length of distribution system
  – Keep hoses as short as possible

• With the storage capacity limitation the distributions will not be too long.
OPTION I

- Expeditionary Deployable Oxygen Concentration System (EDOCS)
- HOBS (8 - cylinder manifold system)
- Mobile Oxygen Storage Tank (MOST)
EMERGENCY OXYGEN GENERATION AND DISTRIBUTION SYSTEM

O₂ Generation System

O₂ Storage System

O₂ Distribution System

Patient rooms
Requirements and Limitations

• EDOCS
  - Supplies 10 patients at 11.0 lpm (respirator) or 55 patients at 2.0 lpm (nasal cannula)
  - Designed to operate 24hrs/day
  - Takes 7 hrs to fill 1 HOBS

• MOST
  - Unique hoses and regulators
  - Less supportable than the standard H Cylinder
OPTION II

• Deployable Oxygen Gas System (DOGS)
  - Requires a Boost 66
• HOBS (8 - cylinder manifold system)
• Mobile Oxygen Storage Tank (MOST)
EMERGENCY OXYGEN GENERATION AND DISTRIBUTION SYSTEM

O₂ Generation System

Boost 66

O₂ Storage System

Patient rooms
Requirements and Limitations

• **DOGS**
  - 3 patient outlets
  - 1 additional fill port

• Requires Boost 66

• 1 HOBS stores 55,000 liters of O₂

• Takes 130 hrs to fill up HOBS to full pressure (without patient use)

• 10 patients per 1 HOBS

• Capable of Operating 24 hrs straight
OPTION III

- LOX Storage
- Filling Tank with NPTLOX
EMERGENCY OXYGEN GENERATION AND DISTRIBUTION SYSTEM

LOX Storage / Filling Tank

LOX Storage System

NPTLOX

Patient rooms

O₂ Distribution System

6 patients per LOX
Requirements and Limitations

- Availability of LOX
- Extensive Training is Required
OPTION IV EMEDS
Requirements and Limitations

• Max 25 Patients per EMED layout
• Extensive activation procedures
• Surgical Capabilities
• Experienced Personnel
OPTION V

• Home Fill Oxygen Compressors
  – Low flow oxygen requirements
  – One per patient (3 lpm) enough for nasal cannula
  – Combinations of 2 or more units increase capabilities
## Comparison

<table>
<thead>
<tr>
<th>Choices</th>
<th>Method</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option I (EDOCS)</td>
<td>Gas</td>
<td>• H Tanks readily available</td>
<td>• Large Unit</td>
</tr>
<tr>
<td>10 patients each</td>
<td></td>
<td>• High yield capability</td>
<td>• Requires additional distribution network</td>
</tr>
<tr>
<td>Option II (DOGS)</td>
<td>Gas</td>
<td>• H Tanks readily available</td>
<td>• Higher power consumption</td>
</tr>
<tr>
<td>3 patients each</td>
<td></td>
<td>• Man Portable</td>
<td></td>
</tr>
<tr>
<td>Option III (NPTLOX)</td>
<td>LOX</td>
<td>• High volume capacity</td>
<td>• Availability of liquid oxygen</td>
</tr>
<tr>
<td>6 patients each</td>
<td></td>
<td></td>
<td>• Training</td>
</tr>
<tr>
<td>Option IV (EMEDS/DEPMEDS)</td>
<td>EMEDS</td>
<td>• Experience and Practice</td>
<td>• Activation Procedures</td>
</tr>
<tr>
<td>25 patients max</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Option V (Home Fill Unit)</td>
<td>Gas</td>
<td>• Small/Portable</td>
<td>• Only for non critical patients (3 lpm)</td>
</tr>
<tr>
<td>1 patient each</td>
<td></td>
<td>• Low power consumption</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Low oxygen yield patients</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Long Shelf-life</td>
<td></td>
</tr>
</tbody>
</table>
### Oxygen Equipment Vendors

<table>
<thead>
<tr>
<th>Product</th>
<th>Vendor</th>
<th>POC</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTOCS NPTLOX</td>
<td>Essex Cryogenics</td>
<td>Timothy Bannister, <a href="http://www.essexind.com">www.essexind.com</a></td>
<td>(314) 832-8077</td>
</tr>
<tr>
<td>EDOCS MOST HOBS</td>
<td>Pacific Consolidated</td>
<td>Lee Smith, <a href="http://www.pci-intl.com">www.pci-intl.com</a></td>
<td>(714) 979-9200</td>
</tr>
<tr>
<td></td>
<td>Industries</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Home Oxygen</td>
<td>OxLife</td>
<td>None, <a href="http://www.oxlifeinc.com">www.oxlifeinc.com</a></td>
<td>1-800-780-2616</td>
</tr>
<tr>
<td>Systems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Home Oxygen</td>
<td>Preferred Healthcare</td>
<td>None, <a href="http://www.phc-online.com">www.phc-online.com</a></td>
<td>1-866-553-5319</td>
</tr>
<tr>
<td>Systems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>POGS</td>
<td>Onsite Gas</td>
<td>None, <a href="http://www.onsitegas.com">www.onsitegas.com</a></td>
<td>(860) 667-8888</td>
</tr>
</tbody>
</table>
Additional Considerations

- Storage
- Transportation
- Maintenance
- Power Demands
Storage Concepts

• Preposition major Oxygen system components within the key cities in Region 8
• Acquire items and use in a mobile medical assemblage to supply remote locations
Transportation

- Components should be palletized for storage and immediate transport
- Systems could be transported from storage site to emergency location via ground transportation
Maintenance

Contract Logistics support should include:

- Training
- Support annual reviews
- Spares
- Repairs and replacement parts
- Warranty
## POWER & OXYGEN REQUIREMENTS

<table>
<thead>
<tr>
<th></th>
<th>Basic</th>
<th>+ 10</th>
<th>+ 25</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MAX POWER DRAW</strong></td>
<td>81 KW</td>
<td>146.4 KW</td>
<td>205.1 KW</td>
</tr>
<tr>
<td><strong>AVAILABLE POWER</strong></td>
<td>100KW</td>
<td>200KW</td>
<td>200KW</td>
</tr>
<tr>
<td><strong>EST O2 USAGE</strong></td>
<td>89 LPM</td>
<td>162 LPM</td>
<td>281 LPM</td>
</tr>
<tr>
<td><strong>EDOCS (120 LPM)</strong></td>
<td>8 KW</td>
<td>(2) 16 KW</td>
<td>(3) 24 KW</td>
</tr>
<tr>
<td><strong>(EST) BOOST 66</strong></td>
<td>2-3 KW</td>
<td>(2) 4-6 KW</td>
<td>(3) 6-9 KW</td>
</tr>
<tr>
<td><strong>O2 FLOW</strong></td>
<td>120 LPM</td>
<td>240 LPM</td>
<td>360 LPM</td>
</tr>
<tr>
<td><strong>EDOCS COST</strong></td>
<td>140K</td>
<td>280K</td>
<td>420K</td>
</tr>
<tr>
<td><strong>W/ BOOST 66 COST</strong></td>
<td>160K</td>
<td>320K</td>
<td>480K</td>
</tr>
<tr>
<td><strong>DOGS (45 LPM)</strong></td>
<td>(2) 13.4 KW</td>
<td>(4) 27.2 KW</td>
<td>(7) 47.4 KW</td>
</tr>
<tr>
<td><strong>O2 FLOW</strong></td>
<td>90 LPM</td>
<td>180 LPM</td>
<td>315 LPM</td>
</tr>
<tr>
<td><strong>REG COST</strong></td>
<td>66K</td>
<td>132K</td>
<td>231K</td>
</tr>
<tr>
<td><strong>SURGE COST</strong></td>
<td>72K</td>
<td>144K</td>
<td>252K</td>
</tr>
</tbody>
</table>
# MAX POWER REQUIREMENTS

<table>
<thead>
<tr>
<th></th>
<th>Basic</th>
<th>+10</th>
<th>+25</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMEDS</td>
<td>64.2 KW</td>
<td>122.7 KW</td>
<td>174.5 KW</td>
</tr>
<tr>
<td>CP-EMEDS</td>
<td>10.5 KW</td>
<td>17.4 KW</td>
<td>24.3 KW</td>
</tr>
<tr>
<td>Water Tent</td>
<td>4 KW</td>
<td>4 KW</td>
<td>4 KW</td>
</tr>
<tr>
<td>CP-Water Tent</td>
<td>2.3 KW</td>
<td>2.3 KW</td>
<td>2.3 KW</td>
</tr>
<tr>
<td>MAX POWER DRAW</td>
<td>81 KW</td>
<td>146.4 KW</td>
<td>205.1 KW</td>
</tr>
<tr>
<td>AVAILABLE POWER</td>
<td>100KW</td>
<td>200KW</td>
<td>200KW</td>
</tr>
<tr>
<td>EDOCS (120 LPM)</td>
<td>8 KW</td>
<td>(2) 16 KW</td>
<td>(3) 24 KW</td>
</tr>
<tr>
<td>(EST) BOOST 66</td>
<td>2-3 KW</td>
<td>(2) 4-6 KW</td>
<td>(3) 6-9 KW</td>
</tr>
</tbody>
</table>
QUESTIONS

• Oxygen Plants in Region 8
• Hotels in contract with FEMA (floor plans/layout)
• Oxygen Equipment in FEMAs inventory (i.e. ventilators, anaesthesia machines, etc)
• Medical Support/Capability of remote Hospital (Concept of Operation)
• What is the O2 Equipment in a CDC Push Pack and how much does it consume?
Credits

• Col Daniel K. Berry, 311 HSW/YAM
• Lt Col Lloyd S. Shackelford, 311 HSW/YAMA
• 2d Lt Clifford A. Hewitt II, 311 HSW/YAMA
• MSgt Ernesto V. Lozares Jr, 311 HSW/YASA
• SSgt Marc C. Paradis, USAFSAM/ATR
• Mr. Gregory J. Iltis, Contractor, 311 HSW/YAMA