

APPENDIX A SEARCH CAPABILITIES

INTRODUCTION

- The following is an introduction to search and is based on the FEMA US&R RESPONSE SYSTEM, Operations System Discription, addendum on Search.
- Search and Rescue operations in the urban disaster environment require close interaction of all task force elements for safe and successful victim extrications.
- Search operations will be initiated early in the mission and could continue until stand-down, since as the structure is accessed, parts removed, etc., re-searching will be required.
- There are many methods and types of equipment that can be used in the search.
- All members of the task force need to understand the advantages and disadvantages of each tool in order to enhance the functioning of all operations.
- The following will discuss what is currently available to the task force as a group of elements in it's tool box.

SEARCH STRATEGY & PRIORITIZATION

- In the past the search function has been used, at least partly, to initially prioritize a group of buildings. Since an adequate search may take several hours, it is essential to use some other logical method to prioritize the structures if a large number are involved.
- The current approach, based on Appendix D, FEMA US&R Response System, is to use a simple, common sense, numerical method (Triage) to sort the buildings such that those that have the greatest chance of yielding positive results (most saves in shortest time) will be given highest priority.
- This initial prioritization will probably have taken place prior to the arrival of the task force at a specified area.
- Triage may be performed by the task force if they are assigned to an area that contains many collapsed structures, or may be used to sort the sections of a very large building complex.

TERMINAL OBJECTIVES

- The student shall understand the capabilities of the US&R Task Force Search Team.
- The student shall be prepared to function as the Rescue Specialist member of the Search & Recon Team

ENABLING OBJECTIVES

- Discuss and understand the functions that need to be performed by the Search & Recon Team
- Understand the Advantages and Disadvantages of the various Search Methods and Tools used by a US&R Task Force
- Understand the basics of Search Strategy

INTRODUCTION

- FEMA US&R Response System, OSD , Search Appendix
- Search & Rescue needs close interaction of all Task Force elements
- Search starts early and continues to the end of the incident
- Many tools and methods are available
- Need to understand the advantages and disadvantages of each tool
- *What's In Task Force Search Tool Box*

SEARCH STRATEGY & PRIORITIZATION

- Search used in the past to prioritize
 - Too time consuming
- Use Structure Triage
 - Appendix D - FEMA US&R Response System
- Structure Triage may be done by others or by Task Force

APPENDIX A SEARCH CAPABILITIES

SEARCH & RECONNAISSANCE TEAM

- Once a priority has been established, the task force would deploy one or both of it's 9 person search and recon teams, staffed as follows:
 - **Search Team Manager (1)** - functions as search/reconn team supervisor, sketches and records information, and communicates details and recommendations back to the Task Force Leader.
 - **Canine Search Specialists (2)** - conduct canine search operations and redundant verifications of alerts.
 - **Technical Search Specialist (1)** - conduct electronic search operations including acoustic/seismic listening devices and/or electronic viewing equipment.
 - **Medical Specialist (1)** - provide medical treatment for search/reconn team members and recovered victims..
 - **Structure Specialist (1)** - provides advice regarding building stability, shoring, stabilization, access, victim location, hazard assessment and marking.
 - **Hazardous Materials Specialists (1)** - monitors atmospheres in and around voids and confined spaces. Assesses, identifies and marks hazardous materials dangers. Works with Structural Specialist regarding hazard assessment and marking.
 - **Rescue Specialists (2)** - provide assistance to the search/reconn team including drilling/breaching for electronic viewing equipment and/or deployment of listening arrays.
- The following operations should be conducted by the search and recon team:
 - General area/building search, reconnaissance and evaluations
 - Structure I.D., structure/hazard evaluation and marking, search assessment and marking

SEARCH & RECON OPS

- Area/building search
- Identify bldg., structure/hazards evaluation & marking, search assessment & Marking
- Assess void space atmospheric conditions
- Victim location I D
- Sketch search area and record info
- Communicate findings to T F L

APPENDIX A SEARCH CAPABILITIES

SEARCH & RECONNAISSANCE TEAM (continued)

- Assess general atmospheric conditions in/around confined spaces or voids
 - Victim location identification.
 - This would include canine, electronic and physical search operations.
 - The location of viable victims would be denoted by marking the exact location with International Orange spray paint or orange surveyors tape.
 - Sketch the general search area and note all significant issues
 - Communicate findings and recommend priorities back to the Task Force Leadership.
- Specific equipment and materials are necessary to fully support a deployed search and recon team. This equipment should be segregated and receive priority consideration when a task force cache is being moved to an assigned location. It should be immediately available in order to deploy one or two search and recon teams in a timely manner. The following equipment and supplies are required:
- Electric Hammer-Drills (preferably battery-operated. If not, a small electric generator, fuel + cord are required).
 - Electronic Viewing Equipment (searchcam, fiberoptic)
 - Electronic Listening Devices (acoustic, seismic, etc.)
 - Atmospheric Monitoring Equipment (flammable, toxic, N.B.C., oxygen-deficient).
 - Marking Materials (orange spray paint/surveyors tape and Fire Line tape, etc.)
 - Alerting Devices - bull horn for hailing, aerosol horns for emergency signalling).
 - Medical Pack (physician or paramedic backpack).
 - Structure Evaluation Equip. – Eval. Forms, measuring devices (clinometer, range finder), recording devices.
 - Personal Gear - per person (safety equipment, food, water, etc.)

SEARCH & RECON OPS

- Area/building search
- Identify bldg., structure/hazards evaluation & marking, search assessment & Marking
- Assess void space atmospheric conditions
- Victim location I D
- Sketch search area and record info
- Communicate findings to T F L

SEARCH & RECON TEAM EQUIPMENT

- Electric hammer drills
- Electronic viewing equipment
- Electronic listening equipment
- Atmospheric monitoring equipment
- Marking materials
- Structure Evaluate equip
 - distance, laser range finder
 - height, clinometer
 - recording devices

APPENDIX A SEARCH CAPABILITIES

REVIEW OF SEARCH TOOLS AND TACTICS

- The following outlines the current tactics available for locating trapped victims (usually from collapsed buildings of reinforced concrete construction) and their corresponding **Advantages and Disadvantages**. No single tactic is sufficiently effective on its own to ensure that a complete search has been conducted. The most effective search strategy should blend all viable tactical capabilities into a logical plan of operation.

PHYSICAL VOID SEARCH (visual/vocal)

- In most incidents a basic physical void search has been done by neighbors, passerbys or first responders. To conduct a thorough physical search, the Task Force should be deployed in a grid pattern over the collapse site. They should make separate visual assessments in voids and confined space areas for any indication of victims. They may also be used in a coordinated fashion as an array of listeners. A bull-horn, or hailing device, would be used to provide direction to trapped victims. The area is then quieted and the personnel listen and attempt to pin-point the location of the noise.
- This operation is less exacting then the others and poses a significant risk to the personnel involved in the operation.
- **Advantages - Physical Void Search**
 - Does not necessarily require specialists, canine, or sophisticated electronic equipment. People could quickly be trained to support the effort.
- **Disadvantages**
 - Limited access to all voids in building.
 - Proximity required may be dangerous to search personnel.
 - Will not locate unconscious, physically weak, or a very young victims

SEARCH & RECON TEAM EQUIPMENT

- Bull horn for hailing - air horn for signaling
- Medical pack
- Personal gear
 - water
 - safety equipment
 - canine
- S & Recon equipment needs to be loaded in position to be unloaded among "first off" items

PHYSICAL VOID SEARCH

- **Advantages**
 - No special equipment required
 - People easily trained to support effort



PHYSICAL VOID SEARCH

- **Disadvantages**
 - Limited access to voids
 - May be dangerous
 - Will not locate unconscious, weak, young



APPENDIX A SEARCH CAPABILITIES

AUDIBLE CALL-OUT METHOD (rescue hailing method)

- Since frequently, the voice of the victim can not be heard, a method of calling out to them with a request for knocking may be successful. Again, an array of listeners in a grid pattern can be used to help point the victims location.
- **Advantages**
 - Same as **Physical Void Search**
 - Personnel can inform victim of expected response.
 - This procedure can be modified and used in conjunction with listening devices.
- **Disadvantages**
 - Unconscious, physically weak, or a very young person cannot be detected.
 - Sound of knocking is possibly too weak for audible detection.

USE OF FIBEROPTICS

- Fiberoptic viewing equipment provides another, and more recent capability for the search tool box.
- The flexibility and the small diameter of the fibre optics bundles makes the **Flexible Fiberscopes** very appealing in extremely tight spaces. The technology has been advanced primarily for medical applications where fibre optics systems are used to view the operation and walls of the heart, veins, intestines etc. The picture resolution is limited by the number of fibers in the bundle. Light can be brought in and the picture will return through the same bundle. Eyepieces, camera, light sources, articulation are all available. Most Fiberscopes have four-way articulation of the tip. Diameters range from 2.4 to 13 mm. Long high resolution fiber bundles can become very expensive.
- This equipment, especially when used with conjunction with concrete hammer/drills, is quite effective at pinpointing the exact location of victims. However, it may also be used for general void searches within collapsed buildings. Prior experience has shown success, when rescue personnel have drilled an array or series of holes (in a floor space for example) and an operator(s) subsequently follows with the fiberoptic device(s) to make quick assessments through them.

AUDIBLE CALL-OUT

- **Advantages**
 - No special equipment required
 - People easily trained to support effort
 - Searchers can inform victim of response
 - Can be used with listening device

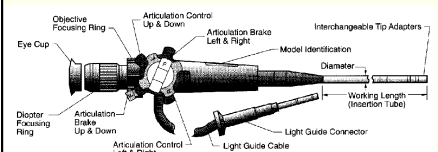


AUDIBLE CALL-OUT

- **Disadvantages**
 - Will not locate unconscious, weak, young
 - Sound of knocking may be too weak for audible detection



FLEXIBLE FIBERSCOPES



APPENDIX A SEARCH CAPABILITIES

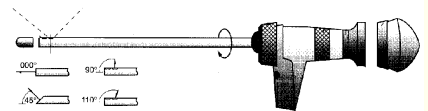
USE OF FIBEROPTICS (continued)

- This equipment is simple to use once personnel are fully trained in its operation. The most difficult aspect to master is the determination of which direction one is viewing when the instrument is inserted into a drill hole or void opening. This requires consistent training. The equipment can also be considered as part of the rescue element's responsibility due to its ease of operation, and used when cutting/breaching near a victim.
- Due to its actual visual indication of a victim, no redundant check is usually required. If the operator is required to move on for subsequent operations, the site should be marked with red tape to indicate a live victim. In addition, the specialist should sketch the general features of the structure/area being searched noting any significant information on the sketch for future reference.
- An available alternate to the flexible fiberscope are **Rigid Borescopes**. These devices have been in use for a long time. As the name implies - they are mainly used to explore, through bored holes, mechanical devices such as aircraft engines, castings, and pipes. These devices consist of straight tubes with lenses, mirrors or prisms on the ends. Because no fibers limit the resolution, picture quality is very high, cost is moderate. Limited articulation is available. Brightness, color and resolution are excellent especially when used with high intensity light sources. Tactics are similar to fiberoptic search.
- **Advantages of Fiberoptics**
 - Provides the general position and condition of the victim.
 - Can be used to verify other search tactics prior to commencing rescue operations.
 - Can be used to monitor victim during rescue operation.
- **Disadvantages**
 - Extended or inaccessible voids (observation holes) cannot be viewed due to the flexible nature of the fiberoptic cable and the limited light source.

FLEXIBLE FIBERSCOPES



RIGID BORESCOPES



FIBERSCOPES & BORESCOPES

- **Advantages**
 - Finds position & condition of victim
 - Useful to verify other search tactics just prior to starting rescue operations
 - Used to monitor victim during rescue
- **Disadvantages**
 - Difficult to use in extended holes due to flexible cable, limited length of rigid scope, and limited light sources

APPENDIX A SEARCH CAPABILITIES

SEARCH CAMERAS

- Recently cameras have been made available designed specifically for search and rescue applications. Tactics used will make use of available holes and openings to look inside voids, or holes can be drilled to allow camera access. This item is a very important tool for close in search that has been added to the tool box.

- **Search Cam™** is a pole mounted, 1.75" diameter camera specifically designed for urban search and rescue. The camera itself is remotely movable over a +/-90° angle. A black and white 7" CRT monitor displays a television like picture in front of the operator. Typically a 2" hole is drilled into a void. The very light sensitive CCD camera is placed into the hole. A built-in light source will illuminate the interior of the void. Turning the telescoping pole and using the articulation allows viewing in all directions. A microphone and speaker permit listening for sound and possibly communications with a victim. Depending on the distance to the objects to be viewed, the light source has to be adjusted carefully, so as not to wash out the picture. Unless there are obstructions that block the view, this is a very useful tool, not only during the search but also during extrication, where it can guide cutting and avoid hurting the victim.

- **SnakeEye™** is a low cost (\$2000) featuring a 1¼" diameter CCD type camera, mounted on lightweight, rigid pole. While the SnakeEyeP has a built-in LED light source it may need additional light.. The display is a small (5") flat , high resolution (960 x 234) rotatable color TFT-LCD. The camera head is mounted with a swivel that allows 90 deg. Vertical articulation, or the camera head may be removed from the wand, mounted on another device, or suspended by it's cable. The camera head is waterproof, and, therefore, may be submerged to the length of the cable (100 ft max.). The display, connected only to the opposite end of the cable, is rugged and portable.

Other Cameras Rescue teams may also have access to other cameras from local resources. A chimney inspection camera can be helpful in exploring shafts, pipes, or other voids, and cameras used in sewer or water pipe inspection may also be usefull. These may all be available locally.

SEARCHCAM

- Original unit
 - Pole mounted 1 3/4" camera
 - 7" BW/CRT
 - Mic/Speaker
 - Built-in light source
- New unit
 - Color Cam
 - Display inside face mask



SnakeEye Search Camera

- Low cost (\$2000)
- Waterproof
- Flexible



With SnakeEye you can see inside inaccessible places quickly, easily and affordably!

APPENDIX A SEARCH CAPABILITIES

SEARCH CAMERAS (continued)

■ Advantages of Cameras

- Easily understood
- Possibility to record picture
- Remote viewing.

■ Disadvantages

- Size, cost, power requirement
- Has only straight line of sight.

INFRARED/THERMAL IMAGING

- A unique way of seeing through smoke and dust is infrared. An infrared imaging system was used successfully in the very smokey environment of the World Trade Center incident.

- These cameras are fairly expensive.
- Some models are helmet mounted with a small TV display right in front of the eyes of the operator.
- Infrared vision also allows one to find hot spots inside of walls and sources of fire in very smokey environments
- Resolution is poorer than on a typical black and white TV picture, but they are useful when maneuvering around in unfamiliar surroundings.

■ Advantages Infra Red Imaging

- Equipment is sometimes readily available with some responding local organizations. Can be used to survey large, open, dark areas.

■ Disadvantages

- Unit cannot detect heat differential through solid mediums. Sources of heat other than persons buried under debris are also indicated which creates confusion in a search application.

SEARCH CAMERAS

- Advantages
 - Easily understood
 - Possibility to record picture
 - Useful to verify other search tactics just prior to starting rescue operations
 - Used to monitor victim during rescue



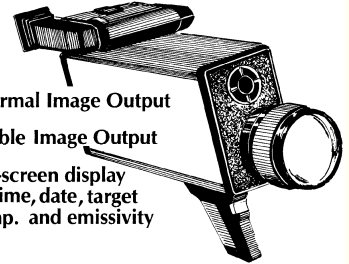
SEARCH CAMERAS

- Disadvantages
 - Size, cost, and power requirements
 - Straight line of sight



INFRARED/THERMAL IMAGING

- Thermal Image Output
- Visible Image Output
- On-screen display of time, date, target temp. and emissivity



INFRARED/THERMAL IMAGING

- Advantages
 - Equipment often locally available
 - Can be used to survey large, open, dark areas
- Disadvantages
 - Cannot detect heat difference through solids
 - Sources other than human can be detected

APPENDIX A SEARCH CAPABILITIES

ELECTRONIC LISTENING DEVICES

- The advent of state-of-the-art electronic listening devices has added a new dimension to the search function. The latest electronic devices can extend the range of the search, (in case where the victim's scent may not reach the surface and therefore be inaccessible to canine) by detecting sounds from the victim. The task force staffing provides for two Technical Search Specialists, who will usually use the electronic acoustic/seismic listening devices as their primary tool. These specialists may also assist with fiberoptic equipment, thermal imaging (if available on site) or other sophisticated equipment as necessary.

- Both of the Technical Search Specialists would usually be deployed early in the mission. After an initial period of operation, one of the two specialists must be rotated into rest cycles for extended operations. Electronic search operations are usually more site-specific and longer in duration than canine search operations. Other task force personnel (preferably rescue personnel) should assist the Technical Search Specialist and also act in the overhead function to ensure overall safety. In addition, the specialist should sketch the general features of the structure/area being searched noting any significant information for future reference.

- The general application of the acoustic/seismic device involves the deployment of an array of two or more pick-up probes around the perimeter of a building or void area. A bull horn or other hailing device should be used to attempt to give direction to any conscious victim trapped within the structure. The victims should be directed to make a repetitive sound (i.e., "knock five times repeatedly"). The general area should be made as quiet as possible during this operation. The repetitive series will provide the operator with an identifiable sound to detect. If detected, the different probes are assessed separately to determine which gives the strongest indication and should theoretically be closest to the source of the sound/victim. If necessary, the array of probes may then be redistributed (around the area of the original probe giving the strongest indication) to more precisely identify the victim's location.

ELECTRONIC LISTENING DEVICES



ELECTRONIC LISTENING DEVICES

- Most Task Forces have these devices
- Listen to acoustic or seismic vibration
- Normally deploy two or more sensors
- Hailing device used to get victim response
- Can determine if live victim is in structure

APPENDIX A SEARCH CAPABILITIES

ELECTRONIC LISTENING DEVICES (continued)

- The distance between probes or sensors will depend on the material of which the structure or rubble pile is made, and in what sections of material the structure-borne sound is expected to travel. Also of influence will be the presence of interfering signals, which may lead to a further reduction in sensor spacing. In any case, the sensor spacing should not exceed 25 feet (8 meters). Typically, a 15' (5 meter) spacing will cover the area well, even under more difficult circumstances.
- For detection, and as part of a hasty search, a single operator using one sensor may suffice. But for safety reasons, the search team should always comprise of at least 2 people.
- Pin-pointing the location of a victim using only one sensor will be difficult, because the signal amplitude and clarity would have to be remembered from sensor location to sensor location. Being able to compare several sensors, and to switch from sensor to sensor quickly, will allow the operator to identify the sensor with the largest and/or clearest signal. As a rule, if a signal is detected, it is advised to leave that sensor in its position and reposition the other sensors around it for more accurate determination of the location. The more sensors available, the larger is the area which can be searched and the quicker a victim location can be pin-pointed.
- Comparison of signals is only meaningful if the sensors are matched in sensitivity and are of the same type and construction, covering the same frequency range. This may not be the case with all listening devices. Some use 2 types of sensors: one for high and one for low (seismic) waves.
- If two sensors are available and a signal is heard, the louder sensor again should be left in place. When the second sensor is moved step by step in a circular fashion around the first sensor, a direction toward the signal source may be obtained, when the movable sensor shows maximum signal.

ELECTRONIC LISTENING DEVICES

- May locate proper layer in pancake collapse
- Takes time to locate victims - move sensors
- Compared signals only good if sensors are matched and anchored in similar materials
- Sensors best in solid/dense materials

ELECTRONIC LISTENING DEVICES

- Can use two sensors to locate victims by keeping strong signal in place and moving other in circle.
- Can use two sensors to locate victim in collapsed structures containing different materials w/different degrees of fracture
- Second operator should be used to confirm

APPENDIX A SEARCH CAPABILITIES

ELECTRONIC LISTENING DEVICES (continued)

- However, it should be kept in mind that the majority of collapsed sites will be made out of different materials: steel, concrete, brick, and wood may be found on one site, with each material having a different sound transmission capability. There will be breaks and fractures, large and small pieces, and overall inhomogeneous materials. It will be more important to access the larger structural parts and to try to place the sensor on similar materials rather than work with theoretical search patterns and assume equal sound distribution and attenuation. The "Stereo Effect" effective if homogenous materials are present. Eventually some type of modified grid search should be used to verify that no section of the site is overlooked.

- In the same manner as in searching with dogs, the second Technical Search Specialist (or other task force member fully skilled in acoustic/seismic devices) should be used to confirm the initial find (certain brands of devices employ two separate headphones for this purpose). Should the second operator provide an indication of a find at the same location, this position should be marked with orange survey tape. This information would then be passed on to the Task Force leadership and the technical search would continue.

- **Advantages of Electronic Search.**
 - Able to cover large search areas and sometimes triangulate on victim position.
 - Capable of picking up faint noises and vibrations.
 - Can be used in conjunction with other search devices to verify find.

- **Disadvantages**
 - Unconscious person cannot be detected.
 - Ambient site noise is intrusive.
 - Victim must create a recognizable sound pattern.
 - Range is limited (acoustic - 25 feet, seismic -75 feet).

ELECTRONIC LISTENING DEVICES

- **Advantages**
 - Able to cover large area
 - Can triangulate on victim position
 - Capable of picking up faint noise/vibration
 - Used in conjunction w/other search tools to verify find

ELECTRONIC LISTENING DEVICES

- **Disadvantages**
 - Unconscious victims not detected
 - Ambient noise level may need to be lowered
 - Victim needs to create noise pattern
 - Limited range (acoustic=25ft, seismic=75ft)

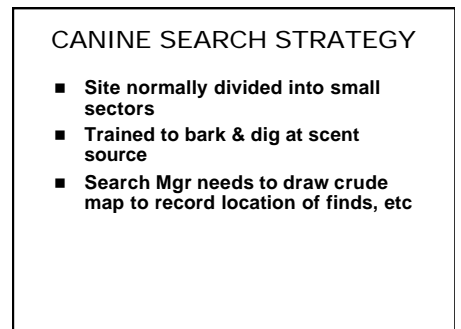
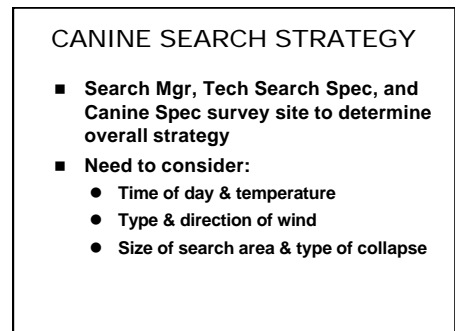
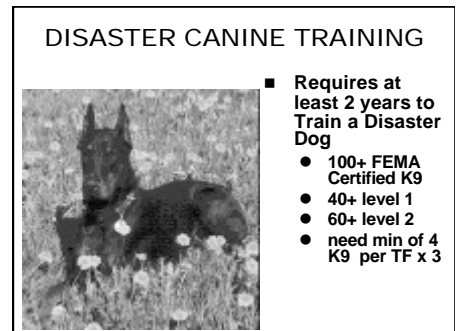
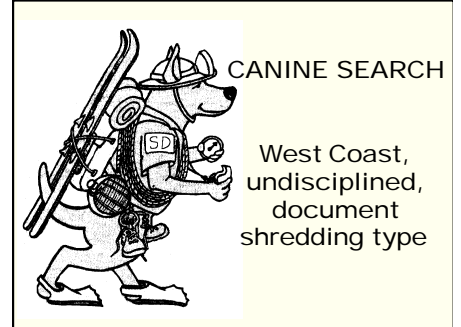
APPENDIX A SEARCH CAPABILITIES

CANINE SEARCH

- A well trained canine search team can search large areas in a relatively short time. The dogs use their keen sense of smell to detect victims buried under the debris. The primary function of the canine is to detect those victims that are alive. However, most canines will give subtle indications of the dead, and when ever possible these areas will be noted for future recovery.
- The search canine will indicate finding the scent of a buried human victim by focused barking at the strongest scent source. The canine may dig at the scent source and try to penetrate to the victim.
- A canine team consists of a canine search specialist and a search canine. Two of these canine search specialist teams, a technical search specialist, and a search team manager will be assigned to search a site. The search team manager monitors handler safety, may be an observer (spotter), keeps track of and maps alerts, and coordinates the search operations.

CANINE SEARCH STRATEGY

- The search team manager, technical search specialist, and the canine search specialists (handlers) will survey the site and decide the best search strategy for the operation.
 - They will factor in the time of day, the temperature, size of area to be searched, and the type of collapse.
 - The site will usually be divided into small search sectors.
 - The search team manager should sketch the general features of the structure/rubble area, labeling each search sector, and noting all significant information (land marks, etc) .on the sketch for future reference.



APPENDIX A SEARCH CAPABILITIES

CANINE SEARCH TACTICS

- The search specialist , from a safe zone will deploy canine #1 to free search the sector. If no alerts or areas of interest are indicated the handler will then direct the canine in a fine grid like search of the sector. While canine #1 is searching, canine #2 is nearby and resting. However, team two handler and possibly the team manager will be observing (spotting) canine #1 search. Each will watch from a different vantage point. These spotters provide the handler with very important information on how well the area has been covered, areas that need to be researched, and any subtle alerts on possible dead bodies, etc.

- If canine #1 detects human scent and alerts, the handler will praise and reward the canine as they leave the area. The area must be noted on the map and no flagging will be placed at this time. Canine #2 will be deployed into the general area of the alert. If the alert is confirmed by canine #2 it will be flagged and the search team manager will inform the task force leader of a find.

- If there are no finds, the canine teams will switch places after approximately 20-30 minutes of searching. Canine #2 will re-search the same sector. If possible, the handler will direct canine #2 to fine grid the sector in a different direction than canine #1 worked, such as north to south or east to west.

- When a search sector has been completely searched by both canines, the next sector will be started, and so on until the entire site has been searched. The canine team should continue to search around rescue operations that may be in progress, providing this doesn't endanger the rescuers.

- Scent channels around the solid slabs, large chunks of concrete, and canines will indicate where scent is emerging, not necessarily exactly where the victim is located. Scent tends to raise /flow relatively evenly thru more broken rubble and lighter types of structures such as light frame, URM rubble with wood floor planes, and badly broken reinforced concrete and precast concrete buildings. Therefore, the canines will tend to indicate a more precise location of the scent source/victim in these lighter, more broken structures

CANINE SEARCH TACTICS

- From safe zone, 1st Canine Search Team deploys to free search sector
- If no alerts, directs canine in fine grid search
- Search Mgr & 2nd Canine Search Team observe from different vantage points
- If 1st Canine Search Team has alerts or not, 2nd Canine Search Team will repeat & verify 1st team's results

CANINE SEARCH TACTICS

- Alert is marked only after confirmation by a 2nd team.
- Remaining sectors are searched & marked until entire area is covered.
- Scent channels around solid slabs, etc & canine will indicate where scent is emerging, not necessarily where victim is precisely located.

APPENDIX A SEARCH CAPABILITIES

CANINE SEARCH TACTICS

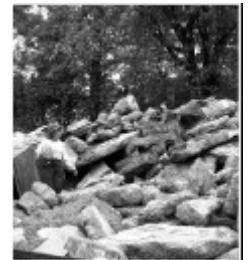
- Continued re-searching of any structure, as it is penetrated by cutting and removal, is important in order to better locate the initial victim and provide information regarding additional victims.
 - This is especially true for concrete structures with solid slabs, since the scent may be traveling back and forth across many solid layers/floor surfaces, and a true direction for victim location may not be indicated until the layers/floor level on which the victim rests is reached.
- **Best Working Conditions**
 - Dawn and dusk when scent is raising
 - Cool weather, light winds (up to 20 MPH)
 - Stable rubble that doesn't slide as canine traverses
 - Light rain
- **Difficult Working Conditions**
 - Hot weather (above 90 degrees)
 - Middle of day when temperatures are above 80 degrees
 - Strong winds/no winds
 - Snow makes surfaces more slippery/hides surface - safe footing unknown
 - Fire fighting foam and other chemicals
- **Advantages in Canine Search**
 - Can search large areas in short period of time.
 - Can traverse or gain access to voids and other opportunity sources.
 - Can detect unconscious victims
- **Disadvantages**
 - Short work period of 20-30 minutes, rest for 20-30 minutes, ready to work, etc.
 - Need two canines to search same area, to check/confirm
 - Performance may vary according to individual handler/canine capabilities.
 - Scarce resource

- Scent tends to raise evenly through broken rubble & lighter structures
- Continued re-searching of structure as it is accessed/uncovered will give best results



WORKING CONDITIONS

- **Best:**
 - dawn, dusk
 - cool weather
 - light winds
 - stable rubble
 - light rain



WORKING CONDITIONS

- **Difficult**
 - hot weather (above 90F)
 - mid-day with temps above 80F
 - strong wind and no wind
 - snow/ice made slippery footing/hides surfaces
 - firefighting foam & other chemicals

CANINE PROS

- **Advantages:**
 - search large area in shortest time
 - can gain access to hidden areas
 - can work in dangerous areas
 - can detect unconscious victims



CANINE CONS

- **Disadvantages:**
 - rest periods
 - use of two to confirm
 - performance may vary
 - uncertified to certified
 - basic to advanced
 - handler to handler
 - scarce resource



APPENDIX A SEARCH CAPABILITIES

ELECTRONIC DEVICES WORKING IN COMBINATION WITH CANINE

- Whenever possible dogs and electronic search should be employed together.
- Canines can and have successfully worked with electronic detection that senses structure borne sound/vibration.
- In Mexico City 1985 Quake, relatively crude seismic sensors were used in the quiet of late night to determine if live/conscious victims were present in pancaked, waffle slab structures. Canine teams were then deployed within the cavities of the building to pinpoint the location of victims, leading to the successful rescue.
- With the more sensitive electronic detection currently available, a more efficient interaction between canine and seismic sensors should be initiated.
- For large, multi-story, pancaked concrete slab structures the electronic detectors could initially indicate, if conscious victims respond, even on which floor level they are trapped. Canine could then be more efficiently directed to search a specific floor area, even thru relatively thin, unsafe voids.
- During hot, day time hours, the electronic devices could be deployed to locate numerous areas where victims are located . These area would then be searched at dusk by canine teams to confirm and pinpoint location.
- In buildings with unconscious victims or poor vibration transmission, characteristic of (badly broken structures of wood, brick, and even precast concrete), the initial search by canines may be the most effective.
- By contrast, in a large concrete and/or steel structures, electronic detection should be the most effective initial search tool.
- When both of these area search tools are available, they should be used to check/verify the finds of the other.

ELECTRONIC & CANINE SEARCH COMBINATION

- Mexico City 1996 Quake had success using crude electronics with K9.
- Most common combo is to use electronics to detect and K9 to locate.
- In large pancake concrete collapse, electronic may be able to indicate which level contains victim, canine to pinpoint on that level.

ELECTRONIC & CANINE SEARCH COMBINATION

- During hot daytime canine do not work well & electronic may be able to direct canine to proper sector, etc.
- For badly broken structures, canine may be most effective for initial search.
- For structures w/large concrete slabs or steel structures, electronics may be most effective.
- If both search tools are available they should be used to confirm each other.

APPENDIX A SEARCH CAPABILITIES

WORK SITE SEARCH PRIORTIZATION

- Depending upon the situation, it may not be necessary to deploy a full search and recon team.
 - Once a viable specific work area (i.e., group of buildings, single building, or separate section within a building) has been determined or assigned, the various search tactics should be determined.
 - In many instances, the canine search can provide the most rapid assessment of a work site area.
 - One search canine team can cover a significant area in short amount of time.
 - This capability might be used first to sweep an area for a general assessment of indications for victims.
 - The redundant check by the other canine should be used to ensure the greatest degree of credibility.
- The electronic search capability may be used effectively, prior to, in conjunction with the ongoing canine search, or afterward.
 - The electronic search by it's nature will usually be slower and more time consuming.
 - The specific selection of an electronic search site could result from the prior indications of the canine search teams or be based upon the types of construction/occupancies affected, as noted earlier.
 - Once again, a redundant check by a second operator should be made after an initial find is identified and should also be marked if necessary.

WORK SITE PRIORITIZATION

- Search tactics will be determined only after assignment is known.
- Type of initial search (canine, electronic, call-out, other) will then be determined:
 - Electronic search is slower but may be more effective than other
 - Canine can cover large areas but need verification & adequate scent
 - Call-out may be most positive

APPENDIX A SEARCH CAPABILITIES

WORK SITE SEARCH PRIORTIZATION (continued)

- Prior to the location of any viable trapped victims, the task force rescue personnel present a significant search resource.
 - They should be used to assist the canine and technical search personnel with safety assessments at collapse sites, gaining access to difficult areas, deploying equipment, etc.
 - They also should conduct physical search operations, either separately, or in conjunction with the canine/electronic search operations.
 - Individual void inspections or combined listening operations can be conducted, as necessary.
 - These operations would be coordinated by the Rescue Team Manager in conjunction with the Rescue Squad Officers.
- Once a reliable indication of the general location of a victim is made, the use of the fiberoptic viewing equipment (in conjunction with the concrete hammer/drills, if necessary) may prove useful in precisely determining the exact location and orientation of the victims.
 - These tools may also prove to be the most effective method of performing a general sweep of a collapse area adjacent to an open, accessible area (such as an intact basement or floor above a collapsed area).
 - An array of inspections holes can be drilled and fiberoptic viewers can be inserted to make a general determination of the collapsed area.

WORK SITE PRIORITIZATION

- In some cases, physical, canine, & electronic search may be conducted in the same, large structure
- Once general area of trapped victims is determined, fiber-optics or video camera viewing may be used:
 - Determine exact position & condition.
 - Cameras may be used for initial victim location by cutting grid of holes thru conc. or wood floor

APPENDIX A SEARCH CAPABILITIES

SUMMARY

- When the task force arrives at an area severely affected by an earthquake, they could possibly be faced with hundreds of persons trapped beneath the rubble. Some may be alive, others dead, and many simple rescues may have already been accomplished by the community.
- The combined use of physical, canine and electronic search tactics will enable the task force to better establish priorities and focus emphasis on the most important rescue activities.
- The task forces will be assigned the most difficult rescue situations. Depending on the complexity of the search and rescue activity, a great amount of time may be spent on each live extrication. The search function must locate viable victims before committing rescue resources to any prolonged operation
- Time should not be wasted in unproductive missions (such as removing bodies or finding trapped animals) while other live victims might still be saved.
- Accordingly, it is essential that all members of the task force understand the advantages and disadvantages of each search tool. The interdependence of the search and rescue function requires mutual respect and confidence, which can be best maintained by understanding that each has significant capability, and limitations.
- Task force supervisors must ensure the close interaction of the Structures Specialists with the search and rescue personnel during search operations. The Structure/Hazards Assessment should include information regarding existing openings, probable victim location, in addition to evaluation of structure stability and hazard identification
- Recurring assessments should be performed throughout the operations, since aftershocks and debris/structure removal can expose new hazards and new search opportunities

SUMMARY

- The search task may require the location of many victims.
- Proper use of all available search tools will enable the most favorable outcome.
- The Task Force will be assigned to the most difficult & time consuming structures.
- The search function must be able to locate viable victims before committing the TF to a prolonged rescue effort.

SUMMARY

- Time should not be spent on the nonproductive.
- All need to understand the limitations & advantages of each search tool.
- Interaction between hazard assessment and search deployment must be close & efficient.
- Assessments should be performed throughout operations since aftershocks & debris/structure removal can expose new hazards & new search opportunities.