Structural Collapse Search and Rescue Procedures

PURPOSE

To provide guidelines for search and rescue operations at structural collapse incidents.

TCESD#1 shall assume command and control of any incident involving structural collapse or structural damage within its jurisdiction until the emergency has been mitigated. See Command Procedures, Tactical Guidelines, MayDay, RIC, 2in2out, and EMS SOGs for further details.

INCIDENT PRIORITIES

The following priorities will guide decision making during the incident:

- Life Safety
- Incident Stabilization
- Property Conservation

ASSESSMENT

The officer assigned to the operations section should determine the following:

1. Are the risks worth the rewards utilizing the Tactical Guidelines SOG Risk Assessment?
2. Is the Building:
   a. **UNFRAMED**: Structures in which the weight of the floor and roof are supported by bearing walls.
   b. **FRAMED**: Structures that are erected by constructing structural steel or reinforced concrete skeleton made of horizontal beams and vertical columns.
3. Is There a Potential for Secondary Collapse:
   a. **WALLS OUT OF PLUMB**: Walls that have large bows in the middle, are leaning or separated from the floor.
   b. **SMOKE OR WATER MOVEMENT THROUGH BRICKS**: At the scene of fire ground collapses.
c. **BEAMS PULLING AWAY**: Be alert for the separation of support beams from the walls to which they are attached.

d. **BUCKLED STEEL BEAMS**: After heavy fire loads, look for beams that sag or are distorted.

e. **LARGE CRACKS, PLASTER FALLING**: Large cracks that appear in walls, roofs, floors or other structural components.

f. **NO RUN OFF OR SOGGY FLOORS**: As a result of firefighting operations or as a result of weather.

-g. **OVERLOADING OR AGE**: Look for sagging roofs, floors, or spans that creep.

h. **NOISE**: Listen for buildings that creak, moan, groan, snap, crackle or pop.

4. **Control All Utilities Quickly**

   a. Gas
   b. Water
   c. Electrical
   d. Sewer

**VOID DETECTION**

Voids may be formed for a variety of reasons and in a variety of forms. During the search phase, survivors are most likely going to be found inside of voids. These voids may be of different sizes and shapes and are affected by the nature in which the building collapses.

Be able to spot certain types of collapses and identify the following types of voids:

1. **Lean-to-Floor Collapse**: Occurs when one of the supporting walls fails or when floor joists break at one end. This type of collapse usually creates a large void.

2. **Lean-to-Cantilever**: This form occurs when one end of the floor or roof section is still attached to portions of the wall. The other end will hang unsupported. **THIS TYPE OF COLLAPSE IS EXTREMELY DANGEROUS.**

3. **V-Shape Void**: This occurs when heavy loads cause the floor to collapse at the center.

**OCCUPANTS ABOVE THE TRAPPED FLOOR WILL USUALLY BE FOUND IN THE BOTTOM END OF THE COLLAPSE. VICTIMS BELOW THE COLLAPSE FLOOR WILL BE FOUND IN VOIDS.**

4. **Pancake Collapse**: Is the result of the total bearing wall or column failure of an upper floor causing the upper floors to pancake down on the floors below. Victims may be found between floors or in voids created by household or office furniture which supports the floors.
PROCEDURE

ARRIVE ON-SCENE

A. First arriving company officer should take Command and begin an immediate Size-up of the situation. Provide for a general survey of the area and size up of the damage. Find out the following information:
   a. Building's use
   b. Number of occupants
   c. Number of victims trapped and the probable location
   d. Are rescue operations currently underway
   e. Presence of hazards
      1. Gas and utilities
      2. Flammables
      3. Electrical
      4. Flooding from burst mains
      5. Plumbing and sewer disruption Structural stability of adjoining buildings

B. Positioning Apparatus. The first-in company should position the apparatus in a position that it will not be affected by a secondary collapse of the structure. Consideration should also be given to traffic conditions and if they will be affected.

C. Staging. Command should institute Level 1 and Level 2 staging procedures immediately. The management of emergency and civilian traffic is critical from the onset of structural collapse operations.

D. Assess the need for additional resources. Command should immediately begin to assess the need for additional resources. If additional resources are necessary, Command should put in an early call for them. At that time, Command should identify a Level 2 staging area. If it is later determined that the additional resources are not needed, Command can return those units to service. Command should assess the need for outside heavy equipment early, and request mobile cranes, front-end loaders, etc., with large capacity. (Example: 100-ton crane.

E. Assess the Hazards. Command should do an immediate hazard assessment or should delegate that responsibility to a Safety Officer. Some hazards associated with structural collapse are: potential for secondary collapse, explosion with fire due to broken gas and electrical lines, falling debris, toxic atmosphere, etc.
F. Secure the Hazards. Secure all hazards as soon as possible. This will include shutting off the utilities (i.e., gas, electrical, water). If it is not possible to secure all hazards, Safety (or Command if no Safety Officer is present) should notify all rescue personnel operating on scene of the hazards present.

During Phase I of structural collapse operations, Command must consider the fact that if strong control of the incident is not gained quickly; it could easily escalate into an out-of-control situation. A typical structural collapse operation will have a lot of unorganized, well-intentioned efforts by civilian personnel. This situation may make the entire operation unsafe. Command must focus attention early on building a good strong Command structure that will support a campaign operation.

OPERATIONS

In the event there are known victims following collapse, Incident Command shall immediately advise dispatch over the radio and request an extra alarm and appropriate medical resources.

A. Pre-Rescue Operations
   a. REMOVAL OF SURFACE VICTIMS
      • Initial on scene companies should be directed in rescuing victims that can be seen on the surface. Rescuers must be aware of all the physical hazards present at the scene of a structural collapse.
      • All rescue efforts should be directed to the victims who can be SEEN or HEARD!
      • Rescue efforts should also be directed to reach those victims WHOSE LOCATION IS KNOWN even if you cannot see or hear them.
      • The hailing system (yelling into voids), visual (looking) and TIC may be used to determine victim locations.
   b. ESTABLISH A PERIMETER
      While initial rescue of surface victims is going on, Command should establish a perimeter around the whole collapse site and keep all incoming civilian personnel out of the immediate area.
   c. ESTABLISH TRANSPORTATION CORRIDOR
      During initial stages of a campaign operation, Command should attempt to ensure that there will be roadways into and out of the collapse site. This may include establishing liaison with the Police Department and having them re-route all traffic around the collapse site.
d. **ESTABLISH VICTIM STAGING AREA**

Command should designate Triage, Treatment and Transportation Groups. An area should be established away from the hazards of the collapse to account for, treat, and transport victims.

e. **REMOVE ALL CIVILIAN & NON-ESSENTIAL RESCUE PERSONNEL**

After initial surface victim removal has been completed, Command should ensure that all personnel are removed from the collapse site. This will allow for the removal of all civilians and the re-grouping of rescue personnel so that a specific action plan can be instituted for the search and rescue of the remaining trapped victims. At this time, Command should order a report from Division Officers. Members previously operating in the collapsed structure should be quickly debriefed as to building layout and possible location of victims.

f. **ESTABLISH BUILDING TRIAGE TEAM**

After all personnel have been removed from the collapse site, Command should establish a Building Triage Team. This may include a structural engineer and/or building department personnel that are trained in the recognition of structural collapse. Prior to this team engaging in triage activity, Command shall notify them as to the specific action plan. If there is a possibility of hazardous materials involvement, Command should assign a Haz-Mat Technician to the building triage team.

**B. Rescue Operations**

a. **ESTABLISH ACTION PLAN FOR SEARCH TEAMS**

After all personnel have been removed from the collapse site and all personnel accounted for, Command shall establish a specific action plan for the search and rescue of the remaining victims. This action plan shall be distributed and relayed to all rescue personnel that will be operating at the collapse site.

b. **ESTABLISH ACTION PLAN FOR SEARCH & RESCUE**

Prior to beginning search and rescue operations, Command shall design specific search teams. This may include personnel with technical search equipment (i.e., acoustic, fiber optic, etc.), dog teams, or firefighter using the hailing (call-out) method of searching for victims. After the Building Triage Team has completed evaluations of the building, the
Structural Collapse Search and Rescue Procedures

search teams will conduct searches of the building. Search teams should use standard building marking system after the building has been searched. If the Building Triage Team determines that the building is structurally unstable, search and rescue teams shall not enter until appropriate shoring and stabilization has been accomplished.

c. **ESTABLISH RESCUE TEAMS**

Rescue teams will follow search teams that have searched the previously triaged building. Each rescue team shall consist of at least one (1) trained member of the Technical Rescue Team. If there is a possibility of hazardous materials involvement, each rescue team shall carry air monitoring equipment. Rescue teams are not to attempt rescue in a building that has been determined to be unsafe by the Building Triage Team. Command should assign each rescue team a specific radio designation.

d. **LOCATING VICTIMS**

After the search teams have searched a building and received a "positive" find (i.e., acoustic or fiber optic positive reading), the building should be verified again by another means if possible (i.e., search dogs or hailing system). If the building is known to have live victims trapped, rescue teams shall attempt to locate the victims. If the rescue team must support structural components of the building prior to entry, they shall do so and make the area as safe as possible.

e. **BREACHING WALLS, FLOORS, AND ROOFS**

If at all possible, rescue teams should attempt to gain access vertically. The horizontal breaching of walls should be done only if there is no other means to reach the void space that victims may be trapped in. Horizontal breaching of load bearing walls may precipitate a secondary collapse of the structure. The potential for secondary collapse is less if rescue teams breach structural members from above or below. Prior to breaching a structural load bearing member, a specially trained structural collapse specialist (structural engineer, architect, technical rescue specialist) should approve and oversee the breaching operation. If the atmospheric conditions are not known in the room of desired entry, a "pilot" hole shall be punched to monitor the atmosphere prior to breaching operations.
1. In some instances, victims may be reached by breaching and shoring.
   - Initially try to avoid the breaching of walls. This may undermine the structural integrity of the rest of the building.
   - It is safer to cut holes in floors and use the shaft approach.
   - If you must breach a wall or cut a floor, cut a small hole first to assure that you are not entering a hazardous area.

2. Shoring may be used to support weakening walls or floors.
   a. Shores should not be used to restore the structural elements to their original positions.
   b. An attempt to force beams or walls into place may cause collapse.
   c. If you decide to shore, keep the following in mind:
      - Keep timber shores as short as possible.
      - The maximum length of a shore should be no more than 50 times its width.
      - The strength of a shore is dependent on where it is anchored. If anchored to a floor, it will be dependent on the strength of the floor.
      - SHORING SHOULD BE ATTEMPTED ONLY BY QUALIFIED PERSONNEL.
      - Air-shore may be used in the place of timbers and will provide a stronger shoring system.
      - Shoring should NEVER be removed once placed.

f. CONFINED SPACE ENTRY & RESCUE

After the victim has been located, the rescue team should treat that space the victim is located in as a confined space. Rescue team members should proceed with the rescue, following confined space rescue operation guidelines. The rescue team leader shall designate the proper method of entry into the space and shall ensure the safety of the entry rescuers. All spaces shall be monitored for flammable, toxic, and oxygen deficient atmospheres before entry is made. All members making entry shall be on SCBA and in full personal protective equipment.
Structural Collapse Search and Rescue Procedures

**g. RESCUE AND EXTRICATION OF VICTIMS**

Once the rescue team has located the victim(s) an immediate assessment of the victim shall be done. Rescue teams should consider the effect lifting objects off the victim will have on that victim (i.e. crush syndrome). The rescuer shall determine the safest and most effective method of victim extrication. The rescue team leader shall ensure the safety of the extrication of the victim.

**h. TRANSFER TO TREATMENT GROUP**

Once the victim has been removed to a safe location, he/she shall be transferred to the Treatment Group for ALS assessment.

**i. REMOVAL OF RESCUE TEAMS FROM THE BUILDING**

After all located victims have been removed from the building; the rescue teams should "pull out" of the building and update the marking system. Rescue teams should keep in mind that any cribbing and shoring in place should be left in place. The removal of those systems could precipitate a secondary collapse.

**C. Selected Debris Removal**

**LOCATING VICTIMS**

- If rescue teams have not been able to locate victims through other methods, then they should be located by removing debris. If there is a potential for live victims, rescue teams must be very careful when removing debris so as not to cause a secondary collapse or further injury to the victim(s).

- If a victim location is known, either by family members or previously rescued victims, an attempt should be made to remove debris to reach that victim. In lightweight frame construction buildings, this could be accomplished by cutting and hand removing structural members. If the building is of reinforced concrete, it may require breaking large pieces into smaller and more manageable size pieces. This may also require the use of a crane to pick and move the structural components to reach potential victims.
Structural Collapse Search and Rescue Procedures

- Rescue team members should assist in the break-up and removal of structural components. A safety officer shall oversee all of these operations to ensure site safety for all operating personnel. If structural components are removed from the site, they should be marked in some way so as to I.D. them with the particular building for future investigative purposes.
- As debris is removed, all operations should be stopped periodically to search (acoustic, dog team, hailing) for victims. After enough debris has been removed to reasonably ascertain that there are not any victims, then search and rescue operations can be suspended in that area.

D. General Debris Removal/Termination

- After it has been determined that no victims could be found alive in the building, a general debris removal can begin. If there is a potential for deceased victims to be trapped in the rubble, removal crews should be alert for signs of those deceased victims.
- During general debris removal, if heavy equipment operators spot a sign of a deceased victim(s), a selected debris removal shall be conducted to remove the victim(s) respectfully. Coroner and/or other investigative personnel should be notified to handle the removal of the body(ies).
- As debris is removed, each dump truck load shall be marked as to the general area found and final location of the debris. This will help investigators to complete their investigations and reports.
- Command may elect to turn general debris removal over to the Responsible Party for final disposition of the building. If this is done, the R.P. should be notified of the proper handling of debris for investigative purposes.
- Prior to termination of the incident, Command shall account for all personnel that have been operating at the collapse site. Each Company Officer should ensure crew and equipment accountability before returning to service. If Command has not previously addressed the issue of C.I.S.D. (Critical Incident Stress Debriefing) he/she may consider doing so during the termination phase.
E. Additional Considerations


b. Cold. Consider the effect of hypothermia on victims and rescuers.

c. Ambient Conditions. Consider the effects of rain or snow on the hazard profile.

d. Time of Day. Consider having proper lighting on scene for night time operations.

e. Consider the effect on family and friends; keep family informed.

f. Consider news media; assign a P.I.O.

g. Consider the effect on the rescue personnel; notify CISD Team if needed.

h. Consider appropriate facilities for personnel (food, drinks, bathrooms, rest areas etc.)
BUILDING COLLAPSE SAFETY CHECKLIST

- Assure all water, gas and utilities are secured.
- Provide for sufficient illumination.
- Provide for sufficient ventilation.
- Clear the area of personnel not directly involved in the search and rescue operation.
- Station a safety officer in a position to observe for unsafe conditions and the potential for secondary collapse.
- Keep apparatus and equipment away from the structure.
- Stop all traffic for 200 yards in all directions to avoid vibrations.
- Control spread of fire caused by cutting torches.
- Assure all rescue personnel are properly protected.
- Rescuers should work in pairs, assigned to a team and frequent relief should be planned.
- Coordinate activity when there is more than one operation.
- Check for and control hazardous gases, chemicals, sewage, etc.
- Provide for atmospheric monitoring in all confined spaces.
- Prohibit smoking on site and in the hot zone.
- Watch for overzealous rescuers.
- Avoid unnecessary disturbance of loose debris.
- Do not remove natural shores and supports such as doors and beams which have fallen or are supporting debris.
- Do not cut timbers which support debris.
- Work around heavy obstructions, when possible, instead of cutting through them.
- When working around a victim, remove debris by hand to avoid further injury.
- Utilize three (3) systems to evacuate members if needed (audible, radio, and light).

If this is a large concrete reinforced structure that has collapsed, consider the following:

1. Accept the fact that you will have little control of bystanders and personnel working on the pile for a period of time.
2. Request a heavy police response to control the area.
3. Request a fencing company or the military to fence the entire perimeter of the building with chain link fence, concertina wire or other type fence to control access.
4. Request the power company and have them string temporary poles and lights around the entire perimeter.
5. Once there is adequate police presence, clear the entire rubble pile and collapse site and start from scratch by assigning teams to specific sectors.
COMMAND TACTICAL WORKSHEET STRUCTURAL COLLAPSE OPERATIONS

Primary Assessment

- Secure witness or RP
- Determine location, number and condition of victim(s)
- Determine location and number of buildings involved
- Rescue/recovery mode

Secondary Assessment

- Occupancy type (business, mercantile, assembly)
- Building construction type
- Assess hazards (secondary, collapse, gas, electric) - control hazards
- Assess need for additional personnel (search dogs, Red Cross, structural engineer)
- Assess need for additional equipment (100 ton crane, heavy equipment)
- Assess traffic conditions (establish transportation corridor)

Sectorize

- Safety
- Building triage
- Search (technical) - begin marking system
- Access
- Extrication (technical)
- EMS (treatment, transport)
- Staging
- PIO
- Police Liaison
- Haz Mat
- Operations (technical)
Rescue Operations

- Make general area safe (traffic control)
- Remove surface victims
- Make rescue area safe (secure utilities)
- Establish perimeter (access)
- Establish transportation corridor
- Establish victim staging area (accountability)
- Remove all non-essential personnel from rescue area
- Establish building triage team(s)
- Establish action plan for building search team(s)
- Establish action plan for rescue team(s)
- Personal protective equipment
- Transfer victims to MICU
- Selective debris removal

Termination

- PAR (personnel accountability)
- General debris removal
- Remove equipment
- AAR CISD (Critical Incident Stress Debriefing)

---

**SOG Revision Record**

<table>
<thead>
<tr>
<th>Version Number</th>
<th>Date</th>
<th>Reason for Revision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>07/16/2015</td>
<td>Document Release</td>
</tr>
</tbody>
</table>

---

**DOCUMENT UNCONTROLLED WHEN PRINTED**

SOG D1
Version Date: 07/16/2015
Page 13 of 14