# The Vital Role of Engineers in Urban Search and Rescue

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## SUMMARY

Structural Engineers are a key part of an Urban Search and Rescue (USAR) response. They have a critical role to play in providing technical advice for rescue teams. This includes assessing the overall stability of a partially or wholly collapsed structure, monitoring the structural stability and the development of temporary shoring arrangements. To be fully effective in a rescue situation, engineers must be specifically trained in USAR procedures and techniques, and must have regular involvement with the rescue teams with which they are associated.

This paper summarises the key roles that engineers play in conjunction with a USAR rescue team, and outlines the arrangements currently being established with both the national Task Force teams and local rescue teams in New Zealand. Details of the new Level One and Level Two USAR Engineer training courses currently under development are provided.

## 1. INTRODUCTION

Urban Search and Rescue involves the location, rescue and initial medical stabilisation of victims trapped in confined spaces following a structural collapse. Such incidents can range from single site collapses through to multi-site situations resulting from landslides or earthquakes. Search for the injured and rescue of those trapped are among the most important and urgent post-earthquake activities. Those conducting USAR activities can themselves become victims, as a high level of risk is associated with these activities.

Engineers involved in USAR activities need to be comfortable dealing with high-pressure situations and able to make rapid decisions. A familiarity with disaster environments and the procedures of specialist rescue task forces needs to be developed. This familiarity requires specific prior training and engagement with emergency service agencies.

This paper describes the functions of an engineer in USAR activities, and outlines the contents of engineering training courses currently under development to enable New Zealand engineers to become effective in emergency events that involve USAR.

## 2. ENGINEERS AS A SPECIALIST USAR SKILL CAPABILITY

Engineers are a recognised specific specialist skill grouping in USAR, along with Paramedics and Search Dogs. The organisational structure set up by the New Zealand National USAR Steering Committee includes a Specialist Skills Working Group, the focus of which is the development of training material and operational mechanisms for these three groups.

The focus of the development of a USAR capability in NZ is on developing *regional capability* in terms of local rescue teams in parallel with a *specialist national capability* in the form of three Task Forces (Angus et al, 2003, and www.usar.govt.nz ). The development objectives for the specialist skill groups reflect this approach, and can be summarised as:

- *At regional (local) level*
    - A group of Engineers, Search Dogs & Paramedics familiar with USAR processes (Category 1 – surface search and rescue) and able to assist the initial response

- *At Task Force (national) level*
    - Have at least two Engineers, Search Dogs & Paramedics assigned to each of the Task Forces and capable of operating at Category 2 level (confined space rescue)

The involvement of engineers from disciplines other than structural is also particularly important, as they can play a significant role in different types of collapse situation (for example, geotechnical engineers in landslide situations), and in the operational planning and logistics support areas generally.

## 3. THE OPERATIONAL ROLE OF ENGINEERS IN USAR

The task of regionally trained engineers, first on the scene with local rescue teams, is likely to be structural triage – the setting of rescue priorities with respect to the risk posed by the partially or wholly collapsed structure.

The role of a Task Force engineer is to provide *critical information*, and not to make all the critical decisions (Hammond, 1995). Task Force leaders will consider the advice of the engineer along with others and develop their action plan for the rescue operations accordingly. The opinion of the engineer may not always be adhered to, and some aspects of a rescue will take place without the input of engineering advice.

The scope of the principal inputs required from a Task Force engineer can be summarised as:

- Assist in structural triage
    - *Prioritise which structures should be searched first in a multiple collapse situation; advise on safe routes for approaching the building; advise on building stability for planning and executing Search and Rescue (ie. determine safe staging areas and consider the likely void spaces where victims could be within the collapse)*
- Provide structural engineering advice
    - *Confirm Task Force decisions on shoring, cribbing, breaching and heavy lifting, when needed; specific design of shoring elements as requested.*
- Assist in the reduction of hazards
    - *Identify hazards; assist with the set-up and monitoring of systems for checking stability and hazard control, in support of the Safety Adviser.*

Task Force engineers need to be well prepared to make difficult decisions in an environment that is very different from the orderly design office. The environment during a USAR event is likely to be chaotic, with many uncertainties relating to the safety status of buildings and many traumatised people.

The engineer also needs to be aware of the roles of the other members of the Task Force. Most of the Task Force personnel come from rescue backgrounds and are used to making rapid, high-pressure decisions as part of their normal occupation, and will take a significant risk in order to save a life. Therefore a conflict in focus can arise between engineers and rescue workers – rescuers save victims, whereas engineers focus on rescue safety.

It is emphasised to Task Force technicians that each person is responsible for their own safety when exposed to a variety of hazards (chemical, biological and structural etc.). Task Force technicians need to be carefully instructed on hazard recognition and mitigation. Engineers therefore have an important role in the training and preparation of USAR team members. Structural hazards include the range of typical collapse modes for different types of structures, along with the fundamentals of structural instability (what can a damaged structure do once it has come to rest; what will trigger further collapses; consideration of approaching and working on and in damaged structures) and the estimation of component masses, to list some aspects. Engineers are responsible for establishing sound skills for communicating engineering objectives, between the Task Force engineers and all other team members.

## 4. USAR TRAINING FOR NEW ZEALAND ENGINEERS

Work on creating a framework for training engineers to be able to effectively assist with minor and major building collapse incidents was initiated by research undertaken at the University of Canterbury (McGuigan, 2002). The framework features two components of training engineers in USAR – (i) *familiarity with how emergency services operate*, and (ii) *specialist engineering skills for collapse situations*.

A progressive training system is being developed, with the following key features:

***Level 1 USAR Engineer***

- *Outcome* – a regional (local) resource assisting (or part of) local volunteer rescue teams
- *Focus* - operating on the outer perimeter of building or site

- *Status* – IPENZ Engineers NZ–endorsed CPD course with 12 hours credit
- *Targets* – Graduate engineers and above who have completed *USAR Awareness*

***Level 2 USAR Engineer***

- *Outcome* – capable of operating with USAR Task Force teams
- *Focus* - operating within a structural collapse site (overall structure & element stability)
- *Status* – IPENZ–endorsed CPD course with 12 hours credit
- *Targets* – Chartered Professional engineers who have completed *Level 1 USAR Engineer* and obtained their Orange Card

The basic entry level USAR qualification is obtained from a 2-day unit standard training course *USAR Awareness* (Category 1A). Holders of this unit standard are issued a pocket-based Orange Ticket. For those wishing to become more actively involved, a USAR Responder Orange Card results from the completion of 3 additional courses totalling 5 days (including the First Aid certificate which ideally all engineers should have as a matter of course). The Orange Card features a photograph of the holder, and so provides an appropriate form of identification that addresses the often-raised question of how engineers and other supporting technical resources will obtain access through perimeter cordons around major emergency sites.

The content of the *Level One USAR Engineer* course is shown in Table 1. This course is to be taught over a 24 hour period (an evening and the following day) at regional centres in New Zealand. This course is currently under development, with the aim of being available for delivery during the 2003/ 04 financial year.

The *Level Two USAR Engineer* course builds on material taught during Level One training and intends to give the participating engineer more knowledge to deal with collapsed structures and an understanding of how people perform in a real emergency. It is intended that the advanced USAR engineering course be delivered over the same 24 hour basis as for the Level One course, but taught from the Task Force bases. The course content is shown in Table 2. Task Force Engineers also need to participate in a three-day (72 hour) rescue simulation exercise alongside Task Force technicians before being eligible for selection. The relationship of these courses with the USAR category training system is outlined in a separate paper (Angus et al, 2003).

**Table 1: Level 1 Engineering Course Outline**

| Module | Key Elements |
|---|---|
| **Module 1.1**<br>***The USAR Training & Response Framework*** | USAR organisational structures and Training Framework<br>CIMS introduction/ refresher; Health & Safety context |
| **Module 1.2**<br>***Role of the Engineer; Rescue Team Dynamics*** | Role of the engineer at a USAR operation<br>Understanding rescue team dynamics |
| **Module 1.3**<br>***Site Technical Processes*** | Building Triage<br>Hazard Assessment and Building Marking |
| **Module 1.4**<br>***Building Collapse Patterns*** | Engineering issues in collapsed buildings - safety and stability |
| **Module 1.5**<br>***Scenario: Role Playing/ Process Familiarity*** | Single site collapse scenario |
| **Module 1.6**<br>***Operational Issues*** | Professional Indemnity & Personal Insurances |

**Table 2: USAR Level 2 Engineering Course Outline**

| Module | Key Elements |
|---|---|
| **Module 2.1**<br>***Task Force Reality*** | What does it mean to be part of a Task Force?<br>Response and training expectations |
| **Module 2.2**<br>***Human Response Issues*** | The reality of how people perform in real emergencies |
| **Module 2.3**<br>***Site Technical Processes I*** | The design of shoring & bracing<br>Hazard assessment/ reporting |
| **Module 2.4**<br>***Site Technical Processes II*** | Shoring & cribbing<br>Breaching & cutting |
| **Module 2.5**<br>***Hazard Mitigation***<br>***Safety Equipment*** | Advanced building monitoring techniques<br>Hazard monitoring and gas analysis<br>Use of search cameras and Trapped Person Locator<br>Heavy (specialist) equipment |
| **Module 2.6**<br>***Course Conclusion*** | Recap on key points, next steps<br>Discussion and course closure |

An engineer who participates in Task Force activities needs to have achieved Chartered Professional Engineer status, and will need to possess a number of personal attributes so that they are suitable for actual events. This includes a reasonable level of fitness due to the demanding nature of the exercise and the potential long hours that can be worked. The engineer will need to be adaptable and able to fit in to the structured nature of the Task Force operation. A good understanding of practical construction methods and some experience in construction and demolition related work is also expected.

## 5. USAR TRAINING FOR AUSTRALIAN ENGINEERS

Australia has been developing a USAR capability since the mid-1990's, working co-operatively with NZ. This work is currently being led by the National USAR Working Group (NUSARWG) under the leadership of Emergency Management Australia.

Task Forces including the Training and operational requirements are resourced on a state by state basis with guidance and support from the NUSARWG and the Australasian Fire Authorities Council. New South Wales, Victoria and Queensland have dedicated USAR Task Forces of varying levels of capability, and the other States and Territories are in the process of developing their USAR capacities

NSW are fortunate in having direct access to structural and other engineers employed by the NSW Department of Public Works & Services (DPWS). In a recent development, all civil and structural engineers taking up a position within the NSW DPWS have the requirement in their job description to undertake USAR Category 1 training. The broader NSW DPWS objective is to have two Category 2 engineers in each of their five principal regional offices.

The NSW USAR engineering module is based on four modules - *USAR Operations* (8 hours), *Effective Team Operations* (4 hours) *Remote Living Conditions* (4 hours) and *Practical Field Operations* (12 hours as part of the 48 hour Technician Exercise). This course is essentially an induction course for Task Force members, with a strong operational focus.

Recent feedback from Australian USAR Task Force leaders and engineers in other states suggests that some of the technical modules of the New Zealand courses under development are of interest to them.

## 6. OPERATIONAL ISSUES

There are many professional considerations associated with the operational involvement of engineers in USAR training and actual deployments. These include:

- Training obligations for the engineer
- Mobilisation mechanisms – response expectations
- Professional indemnity and public liability
- Health and safety responsibilities
- Remuneration

A specific agreement between professional engineers and the USAR Task Forces has been prepared to address this and other issues. This agreement is based on the invited individual engineers to be attached to the Task Forces by way of a standing secondment from their practice to the NZ Fire Service. This is seen as a way of creating a defined and renewable relationship between nominated individuals and the Task Forces which doesn't attract undue liability to either the individual or their practice. An honorarium which contributes towards the annual training and engagement time commitments is to be offered with this appointment.

The liability implications for engineers responding as part of local rescue teams or as individuals are still being worked through. While the new Civil Defence and Emergency Management Act provides cover for responders working under the direction of the Controller in a declared emergency, a local structural collapse situation (eg. single site) would however not result in a declared civil defence emergency, and the level of protection afforded to an engineer providing operational advice is unclear. This applies to engineers operating as either individuals (eg. outside working hours) or on behalf of consulting practices.

In any operational situation it is important to note that while the principal role of an engineer is to provide specific safety advice, the overall responsibility for Health and Safety must stay with the rescue team leader.

## 7. CONCLUDING OBSERVATIONS

Professional engineers are required to fulfil a vital role in rescue operations, assisting with critical decisions relating to the safety of operations and determining suitable methods to ensure temporary stability of collapsed structures. Engineers need to be specifically trained so that they can be effective in demanding and dangerous situations that are quite different from their normal working environment.

A two-level USAR training system for New Zealand engineers is being developed with the objective of providing a specialist engineering response capability at both regional and national levels. The training includes specific courses for engineers and courses involving participation with members of the emergency services. Technical modules from these courses are considered to be relevant and applicable to Australian engineers.

During USAR training, engineers will gain first-hand exposure of the nature of rescue operations and the personnel involved. Ongoing training will need to be undertaken to ensure skill levels are maintained. The USAR engineering courses will form a valuable continuing professional development module for practising engineers, by providing an opportunity for engineers to develop leadership skills and promote community awareness of the engineering profession.

While no amount of training can prepare people for the overall effects of a disaster scene, appropriately focused training for specialist skill personnel such as engineers is essential and will go a long way towards giving engineers a better idea of what to expect.

## References

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