Improving the Post-Earthquake Response of Hospitals: The Implementation of Priority Response Agreements

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ABSTRACT

It is vital that decisions on which hospital buildings can continue to be used following damaging earthquakes are made quickly. A key component of the decision-making process is timely input from experienced engineers that are familiar with the buildings.

A Priority Response Agreement between engineering practices and operators of critical facilities documents the understanding that nominated locally-based engineers familiar with the buildings will give operators their priority as they respond following a major earthquake. They are typically annually renewable set of arrangements that defines the expectations and responsibilities of both parties following a major earthquake. Priority Response Agreements were first promoted by NZSEE in 2005 and have been adopted by a number of organisations responsible for delivering essential services. However while many of the former District Health Boards have close working relationships with engineering practices, a review in 2022 highlighted that very few specific arrangements were in place across the hospital sector.

After the establishment of Te Whatu Ora – Health New Zealand in 2022, the new national agency established a Seismic Work Programme to address identified gaps and issues. One of the first priorities of this programme was to create Priority Response Agreements for all major hospitals. This paper provides the background to Priority Response Agreements generally, and outlines the process by which they are being put in place for New Zealand hospitals. Linkages with seismic instrumentation and MBIE's wider Rapid Building Assessment programme are also highlighted.

1 INTRODUCTION

A Priority Response Agreement between engineering practices and operators of critical facilities documents the understanding that nominated locally-based engineers familiar with the buildings will give those facilities their priority as they respond following a major earthquake. They are typically annually renewable set of arrangements that defines the expectations and responsibilities of both parties in a post-earthquake situation.

Many critical facilities operators have well-established relationships with consulting engineering practices for the supply of a range of professional engineering services. Some of these agreements include provision for post-disaster response, but where this aspect is included, it is typically only at the practice level rather than with individual engineers. Furthermore, specific expectations and arrangements are only rarely addressed.

This paper provides background to Priority Response Agreements and their development in New Zealand. The development of agreements for all major hospitals across New Zealand is one of the priority workstreams of the Seismic Work Programme established by Te Whatu Ora in 2022, and the approach taken and progress made is described. Linkages with seismic instrumentation and MBIE's wider Rapid Building Assessment programme are also outlined.

2 BACKGROUND TO PRIORITY RESPONSE AGREEMENTS

2.1 What are Priority Response Agreements?

It is essential that the operators of any facility that is intended to be operational following a significant earthquake or other natural hazard should have specific arrangements in place for structural engineers to rapidly evaluate any damage. The objective of this evaluation is to establish the significance of any damage observed, and whether or not the building is able to function and be occupied.

Priority Response Agreements (PRAs) define the expectations and arrangements for those who own and operate critical facilities (hence the reference to Priority), and the engineers who will be carrying out the post-earthquake assessment.

The key philosophies that should underpin a Priority Response Agreement are:

- A clear commitment on the part of the consultant to respond as quickly as they are able to the facility, and ahead of other client commitments
- Acknowledgement by the operational agency or building owner that it is a 'best endeavours' agreement, but one that is backed up with more than one listed engineer who is reasonably confident of being able to attend the site following a major event;
- The engineers are familiar with the building (either as designers or having undertaken a seismic assessment of the building or reviewed a recent assessment); and
- The engineers have prepared a specific post-earthquake assessment plan – essentially a method statement for the process they will follow, covering how they will respond, how they will

physically evaluate the buildings (including where they may wish to expose structural elements), and all relevant contact details.

For an existing building, the process of familiarising themselves with the building will involve reviewing all previous design documentation and seismic assessments. The engineers may wish to undertake a partial or full seismic assessment for themselves if they have not already done so.

2.2 The Origins of PRAs

The concept of Priority Response Agreements was first introduced by NZSEE in the early 2000s as part of activities undertaken by the Society's Working Party on Integrated Response Planning (NZSEE 2005). PRAs were subsequently developed prior to the Canterbury earthquakes between some national engineering consultancies and key lifeline utility organisations, and other sectors such as commercial real estate agencies. They were however not widespread in nature, as many infrastructure organisations already had well-developed relationships with local engineering consultancies. This situation was predominantly the case for hospitals with the then District Health Boards. Procurement considerations also made the establishment of what can be described as retainer-based agreements problematic for some organisations.

Perhaps of greater relevance to the general lack of such agreements was the prolonged period of more than half a century that New Zealand had enjoyed without damaging urban earthquakes prior to the Canterbury Earthquake Sequence. The need to have such arrangements in place was neither apparent to nor at the forefront of thinking for many critical facilities operators.

2.3 Following the Canterbury Earthquakes

Following the September 2010 Darfield earthquake, most building owners in Greater Christchurch developed close working relationships with consulting engineering practices. The focus was on establishing the extent of damage for insurance and regulatory purposes, and extended beyond critical services providers. However as the Canterbury Earthquake Sequence progressed, key lifeline utilities such as Christchurch International Airport and Orion Energy worked closely with their engineers to develop formal aftershock response protocols. Following the February 2011 Christchurch Earthquake and as the series of significant aftershocks continued, a wide range of businesses had arrangements in place with engineers to enable them with a means of promptly re-assuring staff that their premises had not received damage and were 'safe' to continue occupying.

These evolved arrangements were by their nature forms of Priority Response Agreements.

These relationships with engineering practices continued in Greater Christchurch due to the need for many owners to provide engineering evaluations to the Canterbury Earthquake Recovery Agency (CERA) under the requirements of the CER Act. The subsequent demand by building owners throughout New Zealand for seismic assessments in the wake of the Canterbury Earthquakes for regulatory and risk purposes led to a decade of close relationships between owners and engineering practices.

Work undertaken in 2019/20 for the Bay of Plenty Regional Council and the Bay of Plenty Civil Defence Emergency Management Group highlighted the need for regional Emergency Co-ordination Centres to have PRAs in place with local engineers. This work is summarised in a report for the National Emergency Management Agency (Kestrel Group 2021).

3 THE HOSPITAL CONTEXT

3.1 Overview

The first few hours after a major earthquake involves critical decision-making around which hospital buildings can and can't be used. A decision to either continue to deliver medical services in a damaged building or evacuate to an alternative facility is a significant one that needs to take into account a number of clinical and functional considerations, with compromises inevitably being required. Hospital emergency plans must clearly outline the post-earthquake decision-making and implementation process. This should include nominated alternative facilities with reasonable degrees of resilience and appropriate backup infrastructure. Well-focused and early input from structural engineers that are familiar with the buildings is a key aspect of hospital emergency planning.

It is therefore essential that specific arrangements are in place with engineering consultants to respond to any earthquake event as required. The specific response expectations and mechanisms need to be clearly mapped out, including outline inspection plans and the nature of initial reporting. The response arrangements for the engineers should be integrated within hospital emergency plans, with associated annual 'readiness' activities to ensure that the arrangements are up to date.

The 2022 report by Kestrel Group included the observation that there is a high likelihood of having key hospital facilities rendered unusable due to damage to non-structural and structural elements in earthquakes (Kestrel Group 2022). The report highlighted the limited specific response arrangements in place with engineers, and recommended a stronger focus on alternative facility identification and post-earthquake decision-making in hospital emergency plans, with the following specific recommendations:

1. *Ensure that hospital emergency plans provide greater emphasis and clarity around early post-earthquake decision-making;* and
2. *Establish specific arrangements with engineers for post-earthquake response at each main hospital*

3.2 The February 2023 Turkey earthquakes

The devastating earthquake and subsequent aftershocks that affected a significant part of Turkey and Syria on 6 February 2023 provided further examples of the consequences of major urban hospitals not having direct technical support from local engineers capable of rapid response.

As part of the reconnaissance efforts following the Kahramanmaraş earthquake sequence, the Earthquake Engineering Research Institute (EERI) Buildings Team visited the population centres that were most affected by the earthquakes. 37 hospital buildings in the affected region were visited by the EERI reconnaissance team and the operational status six weeks after the earthquakes was documented (EERI 2023).

The EERI team recorded that hospitals constructed after 2010 were either partially or fully open but nearly all older buildings were closed. There was little evidence of structural damage in buildings less than 20 years old, but where closed this was due to damage to non-structural systems. Emergency generators were critical to continued operations, and failure led to some closures. Elevator restart had to wait for technicians to arrive, even when the elevator system was not actually damaged. Imaging equipment was typically still in the original position but needed recalibration, and this was also subject to the limited availability of technicians.

The EERI report notes that damage to non-structural partitions and cladding made patients and staff afraid to stay or return. Trained structural safety assessors were not available in the first few days for some hospitals. Hospital management made decanting decisions quickly after the earthquake shaking stopped, as they did not know if or when engineers would arrive. The lack of timely evaluations and safety assessments caused some

hospitals to evacuate, which may have been unnecessary in some cases. Transferring patients to other facilities due to structural damage, nonstructural damage, or "cautious" evacuations overwhelmed surrounding hospitals. Many patients did not survive the transfers.

Recommendations in the EERI report included the need to have on-call experienced structural engineers, preferably those familiar with the facility, available by phone/video link for consultation on post-earthquake safety assessments immediately after the event.

4 THE PROCESS FOR THE DEVELOPMENT OF HOSPITAL PRIORITY RESPONSE AGREEMENTS

4.1 The Te Whatu Ora Seismic Work Programme

In 2022 Te Whatu Ora established a seismic work programme to implement the recommendations in the Kestrel Report (Brunsdon and Stannard, 2023). The work programme has a series of workstreams that includes the development of a Seismic Policy and Seismic Risk Management Strategy to guide a uniform approach across all hospital buildings, and the preparation of technical guidance for the design of new hospital buildings, with a focus on continued functionality aspects. Putting in place more specific procedures and arrangements for post-earthquake response, including implementing priority agreements with engineers, is the workstream with the highest priority given the number of hospital buildings that currently only have modest seismic ratings.

The work programme is supported by a Health Engineering Advisory Group (HEAG), established in 2023. The group comprises six engineers with considerable experience in hospital environments from a range of engineering practices, including the first four authors. The fifth author provides technical support and co-ordination to the group.

4.2 Workstream Overview

The scope of the current phase of work to develop PRAs encompasses 17 main urban hospitals. Three other hospitals that already had equivalent PRAs in place with District Health Boards prior to the establishment of Te Whatu Ora in July 2022 will subsequently be incorporated in this programme. Additional hospitals will also be brought into the programme as suitable local engineers are identified.

A two-stage process has been adopted by Te Whatu Ora to develop new hospital PRAs. In June 2023, a generic PRA was adopted, as outlined in the following sub-section. This agreement in its preliminary form was used to form the basis of an engagement with local engineering practices, and is therefore referred to as a relationship agreement. As noted above, in order for a PRA to be fully effective, a specific post-earthquake assessment plan is also required to be developed. Referred to as *Rapid Assessment Plans*, these hospital-specific plans are being developed during 2023/24 to enable full Priority Response Agreements to then be completed.

The focus of this stage of work is on establishing PRAs with structural engineers. Clearly building services engineers also provide critical inputs into determining continued functionality decisions once life safety issues are addressed, and lift technicians represent another key capability given the importance of the vertical transportation of patients. The development of equivalent PRAs for these additional disciplines is envisaged to be a subsequent development.

4.3 Outline Structure of Hospital PRAs

The agreements aim to nominate three engineers who are local to the hospital and specific representatives from the hospital Emergency Planning and Property/ Facilities Management departments. While three is a

somewhat arbitrary number of engineers, it provides reasonable assurance that at least one engineer familiar with the site and buildings will be able to attend within a reasonable period of time, along with the wider backing of the practice. The national set of engineering practices that are party to the centrally-organised set of agreements also provides what is effectively a national support network.

The PRAs are a best endeavours agreement, having due regard to the range of personal situations that the nominated personnel may face after a major earthquake. When able to respond, the nominated locally-based engineers will give the hospital their priority with the full backing of their engineering practice. The engineering consultancies were selected based on their proximity to and familiarity with the hospitals. Some of the larger hospitals have teams from two engineering consultancies named in their PRA.

The general document structure being adopted for hospital PRAs is as follows:

1. General
2. Response Expectations and Arrangements
3. Building Information
4. Familiarisation and Preparation
5. Maintenance of this Agreement
6. Commercial Arrangements
7. Signatures

Appendix A: Priority Buildings at [XYZ] Hospital

A1 List of buildings with Post-earthquake functions and with patients

A2 List of other buildings with operational functions

Appendix B: Contact Details

B1 Te Whatu Ora

B2 Nominated Engineers

Appendix C: Building Information Made Available to Engineers

C1 Structural drawings

C2 Seismic assessments

C3 Other information

4.4 Rapid Assessment Plans

Rapid Assessment Plans are developed for each hospital, and set out the details of:

1. How post-earthquake rapid assessments will be undertaken for key hospital buildings; and
2. How the findings for each building will be conveyed to hospital incident management

The Health Engineering Advisory Group has developed a standard Rapid Assessment Plan template which is structured in two sections:

- **Part A** provides information to help with the preparation and maintenance of the Rapid Assessment Plan. It is intended to assist prior to an earthquake.
- **Part B** is the Rapid Assessment Plan itself. It is intended for use on the ground during and immediately after an earthquake.

  Hospital-specific information is provided under the following sub-headings:

- Safety Information
- Contact Details
- Onsite Communication
- Meeting Point
- Priority Building and Default Inspection Priority
- Building Information
- Available Seismic Instrumentation

Information relating to Response Activation, Response Procedure and Occupancy and Evacuation Decisions is standard across all hospitals.

With respect to activation, the Hospital Rapid Assessment Plans are to be immediately activated in response to any earthquake large enough to cause concern to either the hospital team or the nominated engineers. If in doubt, nominated engineers should begin making their way to the hospital meeting point and call the Duty Service Person on the way. In more moderate earthquakes that result in only nominal damage, there is high value in the reassurance provided by responding engineers. The ability of modest events to serve as a 'live drill' for communication protocols is also considered beneficial.

The contracted local engineering practices are currently working with key hospital personnel to develop hospital-specific Rapid Assessment Plans. This involves input from facilities managers and emergency managers at each hospital, with the latter personnel responsible for ensuring the engineering inputs are appropriately connected into the Incident Management Team.

In practice, the creation of the Rapid Assessment Plans also serves as a catalyst for the consolidation of critical information. Most notably, this involves the collation of existing documentation in a readily accessible form, and agreement within the hospital as to which individuals will serve as the primary interface to the engineering team.

It is emphasised that in an emergency situation, it is the Hospital Incident Controller's role (in consultation with other hospital stakeholders, and considering ongoing technical advice) to make decisions about evacuation or continued occupancy of a building. Input from engineers is inevitably influential, but engineers are not the decision-makers in this situation.

5 THE ROLE OF SEISMIC INSTRUMENTATION

The principal objective of having seismic instrumentation installed in a building is to reduce the time taken by engineers to evaluate the response of the structure to significant earthquake shaking, hence hastening re-occupancy decisions.

In the first instance the responding engineer is looking for and reacting to signs of damage to both structural and non-structural elements throughout the building. Decisions to re-occupy can be most challenging in situations where the visible damage to primary structure is minor (with or without appreciable non-structural damage). Having appropriate seismic instrumentation installed informs the engineer on aspects like the proportion of design loading that the building has actually experienced, and in some cases the amount of structural movement that has occurred. This information can support the damage observations, and give the engineer confidence in making continued occupancy recommendations – or information to support a decision not to re-occupy the building.

Concerns or judgments of the hospital Incident Management Team and the nominated engineers should always take priority over the information obtained from instrumentation.

Some hospital buildings have seismic instrumentation installed, with different systems applying in different hospitals. Further consideration is to be given by the Health Engineering Advisory Group to the future form and extent of instrumentation in hospitals.

6 LINKAGE WITH RAPID BUILDING ASSESSMENT PROCESSES AND TRAINING

Once the immediate operational decisions around which hospital buildings can continue to be occupied and used are made, it is intended that the responding engineers would undertake more structured Rapid Building Assessments in accordance with the MBIE procedures. This would lead to Te Whatu Ora being able to report on and placard their own buildings, with the support of the territorial authority. In effect the PRA engineer would become the event engineer on behalf of both Te Whatu Ora and the territorial authority.

This requires that the engineers nominated under hospital PRAs have undertaken MBIE's Rapid Building Assessment training. The majority of those engineers are already on MBIE's list of accredited Tier 2 rapid assessors, and others are being given a twelve-month period to attend training and attain this status.

An accompanying conference paper summarises recent enhancements to the Rapid Building Assessment process (Campbell et al 2024).

7 SUMMARY

A key component of the post-earthquake decision-making process for critical facilities operators is timely input from experienced engineers that are familiar with the buildings. This is particularly the case for hospital buildings, where decisions to continue to deliver medical services in a damaged building or evacuate to an alternative facility are significant ones. Major earthquakes around the world continue to highlight the life safety risks associated with transferring patients in such situations.

Many critical facilities operators have well-established relationships with consulting engineering practices for the supply of various professional engineering services. Some of these agreements include provision for post-disaster response, but where this aspect is included, it is typically only at the practice level rather than with individual engineers. Furthermore, specific expectations and response arrangements are only rarely addressed.

A two-stage process has been adopted by Te Whatu Ora to developing new hospital Priority Response Arrangements. Te Whatu Ora currently has outline Priority Response Agreements in place between hospitals and local engineers for 20 hospitals. These are generic agreement, and more specific post-earthquake *Rapid Assessment Plans* are currently being developed which will enable full Priority Response Agreements to then be completed.

These agreements are focused on structural engineers, but it is acknowledged that similar agreements should also be put in place for other critical services such as building services engineers and lift technicians in future phases of this work.

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