

**The Third Draft of the Elements of a Model Building Standard or Model Building Protocols for the Construction of Ebola Healthcare Facilities**



**Background and Introduction**

The Ebola epidemic's epicentre is West Africa and is afflicting Guinea, Sierra Leone, Nigeria, Senegal and Liberia and the first case of Ebola being transmitted in Europe was recorded on the 6<sup>th</sup> of October where a nurse contracted Ebola after having cared for a Spanish priest who had returned with the condition from West Africa. Ebola is an exceptionally pernicious disease and highly contagious. It is also known as Ebola Haemorrhagic Fever as it causes major internal organ haemorrhaging.

The first manifestation of Ebola occurred in Zaire in 1976<sup>1</sup>, now called the Democratic Republic of Congo (DRC) near the Ebola River and there have been spasmodic breakouts of Ebola in the last four decades. The current epidemic induced deaths well exceeds the aggregate number of Ebola deaths since 1976. No previous outbreak ever killed more than 280 people. In the past the Ebola outbreaks have tended to be in the more remote regions of parts of Africa such as the Democratic Republic of Congo, but this epidemic is proliferating at an alarming rate in major West African metropolises like Monrovia and Freetown. Because of the high concentration of people living in congested, intimate and destitute conditions, the opportunity for exponential proliferation is much greater.

The disease is spreading exponentially in Sierra Leone and Liberia and has assumed the status of a world health emergency, in light of its potential to kill hundreds of thousands of people in Africa and to spread to other countries unless arrested. Dr Margaret Chan, the Director-General of WHO on the 18th

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of September addressed an emergency session to the UN Security Council concerning Ebola<sup>2</sup>, stating “This virus, this deadly and dreaded Ebola virus, got ahead of us in a fast-moving outbreak...This is likely the greatest peacetime challenge that the United Nations and its agencies have ever faced....None of us experienced in containing outbreaks has ever seen, in our lifetimes, an emergency on this scale, with this degree of suffering, and with this magnitude of cascading consequences....This is not just an outbreak. This is not just a public health crisis. This is a social crisis, a humanitarian crisis, an economic crisis, and a threat to national security well beyond the outbreak zones”.

At a press conference<sup>3</sup> on Tuesday, 2<sup>nd</sup> of September, Dr. Tom Frieden the director of Centers for Disease Control and Prevent (CDC) stated “This isn’t just the countries’ problem, It’s a global problem.”...“The level of outbreak is beyond anything we’ve seen—or even imagined,”....“For every day that this continues to spread in West Africa, the likelihood of someone getting infected and transmitting it elsewhere increases,”...“As long as Ebola is spreading anywhere, all of us need to be concerned.”

On the 2nd of October, Mr Anthony Banbury Head of the UN Mission for Ebola Emergency Response (UNMEER) spoke to reporters in Monrovia, Liberia stating “The objective of UNMEER is very easy: to contribute to the international and national efforts to stop Ebola, to end this crisis, to save lives. That’s what we’re here for,”.... “The only way we will end this crisis is if we end every last case of Ebola so there is no more risk of transmission to anyone...”<sup>4</sup>

### **How is the Disease Transmitted**

In some parts of West Africa there is a propensity on the part of some to eat “bush meat” which can be primate or fruit bat meat and Ebola can be transmitted to human beings via eating, preparing, processing, cooking, or handling these mammals. Transmission may also occur by exposure or close proximity to the areas in which these activities occur. The disease is spread through bodily fluid mediums and agents such as perspiration, saliva, blood, urine, faeces and the handling of people harbouring the infection regardless of whether they are dead or alive. Sometimes called the “caregiver’s disease”, the term was coined because Ebola proliferates quickly amongst family members because it is counterintuitive for them not to hold or maintain close contact with siblings, children or parents afflicted with the condition.

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Ebola has an incubation period of between 2 and 21 days with the average being 8 to 10 days. The corpses of Ebola victims remain highly contagious for many weeks after death.

Although unlikely, it is not inconceivable that if the disease is not halted the rapid mutation capabilities of the disease could in a worst case scenario generate an airborne strain. "Much media speculation has arisen over the possibility of the disease mutating into an airborne variant. The most effective way to prevent this from occurring is the prompt eradication of this outbreak while the virus remains incapable of doing so. The virus is easily aerosolized in the fine particulate matter ejected from a patient's coughing. This is a form of direct transmission and is a completely different vector than airborne transmission".<sup>5</sup>

In developing countries particularly, in areas where there is a high concentration of people with the complement of poor sanitary and intimate living conditions Ebola can proliferate with alarming alacrity. The 2014 outbreaks represents a paradigm shift, whereas in the past, the concentration of Ebola outbreaks was concentrated in remote regions of the Democratic Republic of Congo, the difference with this epidemic is that the highest concentration levels are in West African metropolises.

### **Current statistics as at 5th of October 2014 regarding numbers of death and countries affected**<sup>6</sup>

Liberia: cases – 3,924; deaths – 2,210

Guinea: cases – 1,298; deaths – 768

Sierra Leone: cases – 2,789; deaths – 879

DRC: cases – 70; deaths - 43

Nigeria: cases – 20; deaths – 8

Senegal: cases – 1

United States: cases – 1; deaths - 1

Spain: cases – 3; deaths – 2

Total Recorded Deaths: 3,482

Total Recorded Deaths (10<sup>th</sup> of October): 3,865

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There is widespread speculation that the number of cases will exceed the number of cases officially identified particularly in West Africa where the statistics could be a massive underestimate.

### **Trending Implications:**

In the Centers for Disease Control and Prevention's Morbidity and Mortality Weekly Report released on Tuesday 23<sup>rd</sup> September, it estimated that the number of Ebola cases in West Africa could reach between 550,000 to 1.4 million by the end of January if there is no current change<sup>7</sup>.

Dr Dirk Brockmann of Humboldt University in Berlin, and Dr Dirk Helbing of the Federal Institute of Technology in Zurich, have created a computer model that calculates how a virus may spread geographically stating London's Gatwick and Heathrow airports face a greater risk at a combined 8.5 percent, followed by Brussels. Germany, with its main international airport at Frankfurt, has a lower risk than England and France. The probability of an Ebola patient reach another African country, such as Ghana, is higher<sup>8</sup>.

According to the International Business Times, "Scientists have predicted a 75% that the Ebola virus may reach France by Oct. 24, a 50% chance that it could reach the UK and a 40% chance that it could reach Belgium"<sup>9</sup>.

### **Symptomology**

An Ebola sufferer will encounter a range of symptoms including but not limited to:

- Diarrhoea
- Fevers
- Coughing
- Severe joint pain
- Extreme headaches
- Severe debilitation
- Internal haemorrhaging
- Bleeding from orifices

Dr. Bruce Aylward, Assistant Director-General WHO has recently stated that the current mortality rate in the 2014 outbreak is running at 70%. and it appears that the mortality rates can be influenced to some degree by the level and sophistication of healthcare facilities and the availability of healthcare

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workers that can be deployed in a timely fashion. There is currently no cure for Ebola although some test drugs such as ZMapp harbour promise.

There is an acute shortage of Ebola healthcare facilities and healthcare workers in West Africa and the international community is starting to mobilise to pledge resources to this part of the world. The resource mobilisation consists of the pledging of large sums of money, the provision of healthcare workers (for instance Cuba has pledged 160 healthcare workers), military support and the acceleration of research aimed at finding cures for Ebola. Sadly the mobilization has not happened with the required level of urgency.

Mr Jim Yong Kim, President of the World Bank on the 8<sup>th</sup> of October stated that the response of the international community to the Ebola epidemic was a miserable failure. Mr Kim also stated that there needs to be a 20 billion dollar global health fund made available as a matter of urgency to effect rapid deployment to emergency regions.

### **The Healthcare Facility Construction Standard Imperative**

Mindful of the inadequate and humble healthcare infrastructure in many parts of West Africa, there is a desperate need to build facilities for the treatment of Ebola sufferers. Such facilities will conceivably have unique construction, occupational, health, safety and “facility-in-operation” facets that are sensitive to the peculiarities of Ebola disease transmission. Is it critical that construction method and materials have regard to CDC operational requirements for Ebola healthcare facilities.

There is a need for a set of regulatory elements or protocols that can either find their way into model regulations or an international standard to assist designers, builders, and facility managers with the construction, maintenance and use of Ebola healthcare facilities. This paper and these model elements are currently being evolved and will be a work in progress as expert commentary input is sought as the drafts evolve in a time period of one month.

The Centers for Disease Control and Prevention (CDC) have published a very comprehensive and rigorous prescriptive guidelines with respect to the use and operation of Ebola healthcare facilities. These guidelines can be accessed by logging into the CDC’s Ebola Virus Disease website and in terms of protocols and intricate procedures and guidelines with regards to the use of healthcare facilities, the procedures and protocols enunciated in the CDC’s

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guidelines will take precedence over any of the provisions in this draft standard. Login to the CDC website to view the guidelines at [www.cdc.gov](http://www.cdc.gov)<sup>10</sup>.

The CDC has also provided “Interim Guidance for Specimen Collection, Transport, Testing, and Submission for Persons under Investigation for Ebola Virus Disease in the United States”. The guidelines can be accessed by logging into <http://www.cdc.gov/vhf/ebola/hcp/interim-guidance-specimen-collection-submission-patients-suspected-infection-ebola.html><sup>11</sup>.

As Ebola continues to proliferate at an exponential rate, law makers should give consideration to promulgating parliamentary sanctioned building regulations that have regard to some of the considerations that are identified in this paper, but more importantly, take cognisance of CDC Ebola protocols that should influence the construction methodology, design and materials used for the construction of Ebola healthcare facilities. In Africa in particular, a great many new facilities will need to be built rapidly to deal with the epidemic and legislators could consider promulgating regulations that allow for rapid construction outcomes, but by the same token are sensitive to best practice contagion containment and patient recovery considerations.

### **The Merits in Developing Building Regulations that Adopt Model Standards & Relevant CDC Guidelines**

It is paramount that in formulating standards that can be called up in building regulations have regard to the “international epicentres of expertise”, such as the Centers for Disease Control and Prevention (CDC) and WHO. This document aims to identify some key elements that could find their way into Ebola protocols, which must nevertheless be subordinate to prescriptive protocols that have been published by institutions like the CDC and WHO.

One of the authors<sup>12</sup> of this document has a background in building regulatory law reform and legislative development and is of the view that law makers in Ebola afflicted countries could consider generating new building regulations that specifically deal with construction protocols and methodologies for the erection of Ebola healthcare facilities. Absent uniform regulations that are promulgated by acts of parliament, there could be considerable variation or deviation from best practice international guidelines. Furthermore, if best practice standards find their way into codified building regulations, it is easier for regulators and law enforcers to ensure that the healthcare facilities are built in a manner that has regard to adequate safety holistics.

### **The Objectives of the Elements for the Standard**

1. Ebola healthcare facilities must be constructed in a manner that optimises the opportunity for care and recovery of Ebola patients.
2. Ebola healthcare facilities must be constructed in a manner that optimises the safety of healthcare workers or any other individuals that visit, work in or provide assistance to Ebola sufferers.
3. Ebola healthcare facilities must be constructed in a manner that quarantines the sufferers to ensure that the contagion is contained within the particular facility and cannot be spread through any means of egress or human or animal transmission.
4. The designs and construction methodologies for building Ebola healthcare facilities must be able to be such that the facilities can be built quickly, cost effectively and in a manner that is if at all possible sensitive to environmental sustainability.
5. The standards must have regard to developing protocols and procedures published for the Centers for Disease Control and Prevention (CDC).

### **Key Elements for a Model Standard**

The Key Elements for a Model Standard are outlined in Figure 1. and described further in table 1. The basic primary elements are:

#### **1. Design**

Design needs to cater for the unique internal environment simultaneously managing the balance with the external environment. Space management is essential to plan in advance and needs to work with how material, people and equipment articulate through the facilities. Importantly, finishes are needed that enable the control of pathogenic spread and maintaining a clinically clean environment.

#### **2. Function**

There are several functions that are needed to be facilitated. These are: disease/patient management, waste management, medical protocols, administration, storage, security and staff needs. Stringent security measures and protocols need to be deployed to ensure that harm is not visited upon healthcare workers and patients in the event

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that people living in fear or harbouring misunderstanding become violent. It follows that there has to be access to security personnel.

#### **3. Construction**

Building services, materials and construction methods need to acknowledge and support the various functions and simultaneously deal with delivery and context issues not commonly experienced.

#### **4. Delivery of the Facilities**

Delivery needs to recognise the rapid response nature and requirements for transportability, scalability, and prefabrication.

#### **5. Context**

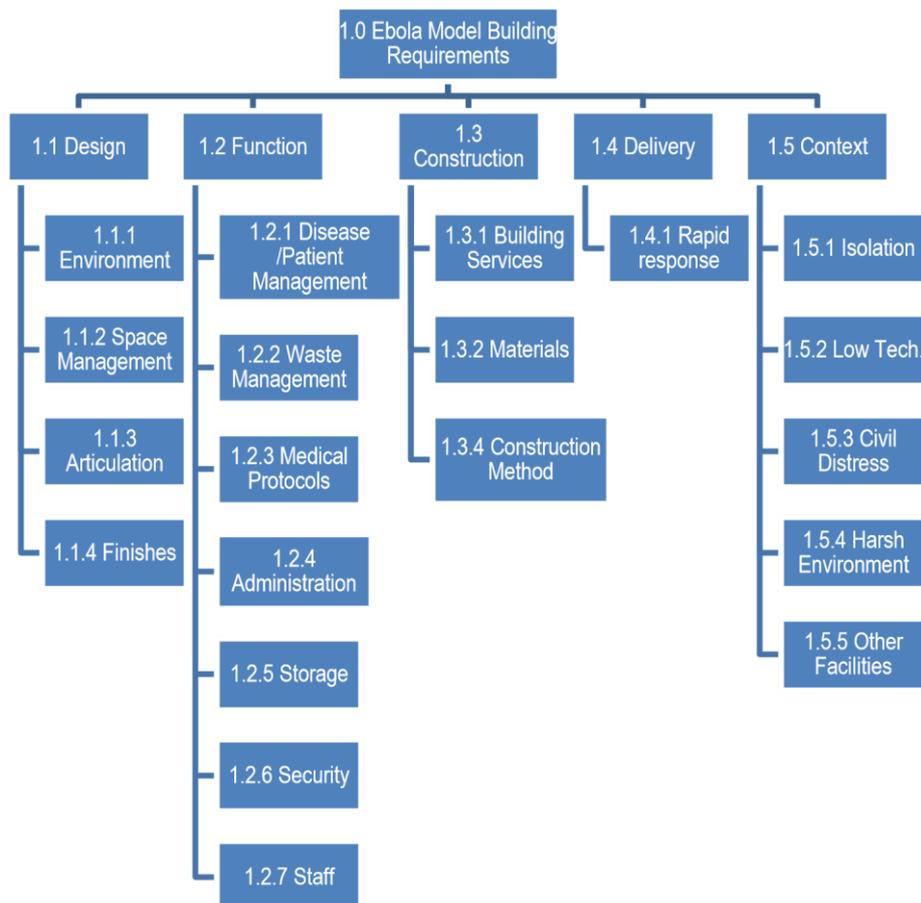
Unique context issues provide the challenge for which the model building standard sits in and needs to address the other key elements.

6. Although at this time Ebola cannot be spread through the air, regard must be had to the fact that in a healthcare facility there will be a higher than normal concentration of airborne droplets thus increasing the potential for disease migration within the facility. Hence regard must be had to ventilation systems that can expel or trap respiratory emissions without posing any threat to uninfected third parties or healthcare workers.

### **Maintenance Manuals**

1. Healthcare facilities must at all times be maintained in a manner that maximises the opportunity for Ebola patients recovery and the health and safety of healthcare workers.
2. Healthcare facilities and patient handling procedures must be managed with the highest level of vigilance. Note that the first case of contraction of Ebola in Europe has occurred in a Spanish containment centre in a hospital. The nurse in question was wearing a protective suit and only attended to the Ebola patient on two separate occasions, yet still managed to contract Ebola.
3. All healthcare workers must be trained and inducted in CDC Ebola healthcare protocols prior to their work being sanctioned. It follows that trained professionals with skills and experience in contagious disease containment need to train inductees.

**Figure 1: Key Elements of the Ebola Model Building**



**Table 1:** Key Element Requirements

Key Element		Requirements
1.1.Design		
	1.1.1 Environment	<u>Internal environment:</u> 1. provides a minimal to “0” risk of being infected with Ebola. 2. allow for frequent sanitisation and application of disinfectants. 3. temperature control systems minimise human perspiration, mindful of the fact that healthcare workers wear protective suits that are conducive to a high level of perspiration particularly in circumstances where there are human resource shortages and intensive and long periods of deployment are required. 4. Temperature control should also be sensitive to the fact that the Ebola virus causes fever and perspiration seeps into bedding and blankets which become saturated with Ebola infested fluids. This being the case, an optimum temperature that is designed to minimise the use of bedding or associated materials is germane.

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		<u>External Environment</u> : Roof and wall elements designed to prevent excessive radiant heat and solar gain, i.e. high insulation values. Where possible allow for balance between internal and external environment to work together in a passive nature.
	1.1.2 Space Management	Spaces created by transportable modules and elements. Scalable for fluctuation in demand. Separate generator and fuel
	1.1.3 Articulation	Patients and public are restricted to open areas. Staff only and isolation areas for staff. Staff are able to articulate easily within facilities. Fire egress for evacuation.
	1.1.4 Finishes	Minimise potential to spread. Anti-pathogenic.
1.2.Function		
	1.2.1 Disease /Patient Management	Patients are able to be segregated, isolated and treated when needed.
	1.2.2 Waste Management	Facilities need to be constructed in a fashion that maximises hygiene and the opportunity for the evacuation of urine and faeces without posing any risk of emanating from spread of the disease through these bodily mediums of fluid exchange . For this to occur there need to be incineration devices that can incinerate Ebola debris.
	1.2.3 Medical Protocols	Medicines and laboratory facilities.
	1.2.4 Administration	Facilitate information management and accurate records. Communication facilities.

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	1.2.5 Storage	Hazardous equipment and material storage to ensure that contaminated materials such as sheets, bed linen, retired gloves, clothing, food, eating and cleaning utensils can be compiled and placed in sanctioned bags and boxes for swift dispatch and supervised destruction.
	1.2.6 Security	Staff need to feel secure from both pathogens and any civil unrest. Keying system with CCTV in sensitive areas.
	1.2.7 Staff	Separate staff facilities for: rest, mess and toilets.
<b>1.3. Construction</b>		
	1.3.1 Building Services	Reliance on energy kept to a minimum. Likely solar and/or generator supplied. Ventilation achieved by passive stack effect. Small local areas conditioned for cooler requirements
	1.3.2 Materials	Light and robust. Limited selection of type. Easy to replace.
	1.3.4 Construction Methods	Need to allow for rapid construction techniques such as prefabrication and minimal foundation and floor work. Able to relocate or to be abandoned and burned to prevent reuse without great cost in materials or labor.
<b>1.4. Delivery</b>		
	1.4.1 Rapid Response	Construction materials and methodologies facilitate construction and deployment of facilities in the swiftest and most cost effective fashion.
	1.4.2 Transportable	Modules, equipment and fit-out all selected for transportability
	1.4.3 Prefabrication	Mass produced in controlled environment and shipped out. US military DepMeds are one potential model for comparison but are themselves too bulky and too heavy
	1.4.4 Scalability	Start with essential modules and add on as needed by scale.
<b>1.5. Context</b>		

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	1.5.1 Isolation	This means basic facilities may be missing requiring the need for further services on site such as laundry, cooking and sleeping facilities. All of which have the potential to facilitate transmission of diseases, so care must be taken and proper supervision provided.
	1.5.2 Low Tech.	Construction skills will be minimal for this type of facility. Needs to enable easy assembly on site and setup. Utilities and ICT needs to be self contained and robust. Any spare parts should be easy to locate and generic.
	1.5.3 Civil Distress	Structure and fabric needs to be robust, and spaces sealable and lockable.
	1.5.4 Harsh Environment	Supplies for water, fuel and food needs to be stored and secured on site.

### Where From Here?

This first draft is for the consideration of experts that may wish to assist with the preparation of the model elements that would make for a model building standard.

A preliminary drafting committee has been established to caucus and develop legal and technical protocols that can be used as guidelines for the construction and maintenance of healthcare facilities with the specific emphasis being correlated with peculiarities of the Ebola disease and its transmission. Until further notice those with whom principal drafting responsibilities will lie are:

- Conjoint Professor [Kim Lovegrove](#) FAIB, President Elect of the Northern Chapter of the New Zealand Institute of Building, partner of Lovegrove Smith & Cotton Lawyers and chairman of [Centre for Best Practice Building Control](#),

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- Mr [Bruce Rogers](#), immediate past Senior Building Controller Whangarei Council, President of the Northern Chapter of the New Zealand Institute of Building.

We urgently require input from experts in contagious disease transmission to provide commentary and input into the development of these protocols. Such contribution however must be pro bono as those currently involved are providing their time and expertise on a pro bono basis.<sup>13 14</sup>

### Where to Send Comment:

Comment can be made on the linked-in sites where this revised standard has been published and also [Kim Lovegrove](#) can be contacted directly through Linked-in mail.

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<sup>1</sup> Dr Roy J. McGroarty, Chairman, Managing Director and CEO at McGroarty International Health Consultants Inc.

<sup>2</sup> <http://reliefweb.int/report/guinea/who-director-general-dr-margaret-chan-speech-ebola-virus-disease-outbreak-delivered>.

<sup>3</sup> <http://www.cdc.gov/media/releases/2014/t0930-ebola-confirmed-case.html>.

<sup>4</sup> <http://www.un.org/apps/news/story.asp?NewsID=48988#.VDSXL2eSySo>.

<sup>5</sup> Mr Sean P. Fay M.S., MA-CEM former military field Hospital Company Commander in the US Army.

<sup>6</sup> WHO update  
[http://apps.who.int/iris/bitstream/10665/136020/1/roadmapsitrep\\_8Oct2014\\_eng.pdf?ua=1](http://apps.who.int/iris/bitstream/10665/136020/1/roadmapsitrep_8Oct2014_eng.pdf?ua=1).

<sup>7</sup> [http://www.cdc.gov/mmwr/preview/mmwrhtml/su6303a1.htm?s\\_cid=su6303a1\\_w](http://www.cdc.gov/mmwr/preview/mmwrhtml/su6303a1.htm?s_cid=su6303a1_w).

<sup>8</sup> Dr Dirk Brockmann, '2014 Ebola Outbreak: Worldwide Air Transportation and Relative Import Risk' Robert Koch-Institute & Humboldt University, Berlin, <http://rocs.hu-berlin.de/D3/ebola/>.

<sup>9</sup> <http://www.ibtimes.com/ebola-virus-could-spread-france-uk-other-european-countries-less-3-weeks-1699639>.

<sup>10</sup> <http://www.cdc.gov/vhf/ebola/about.html>.

<sup>11</sup> <http://www.cdc.gov/vhf/ebola/hcp/interim-guidance-specimen-collection-submission-patients-suspected-infection-ebola.html>.

<sup>12</sup> Conjoint Professor Kim Lovegrove, FAIB, partner of Lovegrove, Smith & Cotton Lawyers, Chairman of the Centre for Best Practice Building Control and President-Elect of the Northern Chapter of the New Zealand Institute of Building

<sup>13</sup> Useful insights and comment has also been proffered by Sean P. Fay M.S., MA-CEM former military field Hospital Company Commander in the US Army.

Conjoint Professor Bob Whittaker AM, Immediate Past President of the Australian Institute of Building, board member of the Centre for Best Practice Building Control, has endorsed the work that the Centre for Best Practice Building Control and the work that the drafting team is undertaking.

The support of this drafting initiative that has been formally volunteered by the New Zealand Institute of Building.