New Zealand Fire Service Research Report

Impacts of changes in provision of hand-operated fire-fighting equipment in non-residential buildings

Civic Futures

2015

Hand-operated equipment (fire extinguishers, fire hose reels and fire blankets) are commonly provided in buildings for occupants to use as an immediate first line of defence against smaller fires. This study:

- quantifies the costs and benefits of providing this equipment for various types of non-residential buildings
- examines possible future changes in the level of provision of this equipment under possible regulatory and non-regulatory approaches
- evaluates the impact on fire damage costs and net costs associated with those changes in provision

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1 Summary

This report examines the changes in total costs and benefits likely to be associated with the changes in requirements for, and correspondingly provision of, hand-operated fire-fighting equipment (HOFFE) in non-residential buildings. HOFFE typically covers fire extinguishers, fire hose reels and fire blankets. These items of equipment are available for fire-fighting by building occupants, immediately after a fire is discovered (if it is safe to do so).

This study follows on from changes made to the fire safety provisions of the New Zealand Building Code that came into force in 2012. These changes might make it less likely that HOFFE will be provided and maintained in the future, given perceptions of the on-going cost of maintenance and training associated with HOFFE and uncertainty over the benefit provided.

The study follows past research on the cost of non-residential fires for the New Zealand Fire Service Commission (the Commission) carried out by Business and Economic Research Ltd (BERL, 2012). Three of the cost areas used in that study are considered likely to change if the level of provision of HOFFE changes:

- Fire protection systems (including the provision and ongoing support for HOFFE)
- The Fire Service Levy (a proxy for the cost of operating the New Zealand Fire Service (NZFS) and supporting infrastructure)
- Fire damage costs (including building damage and associated costs)

Part A of the methodology examines how total costs and benefits associated with non-residential fires are affected by changes in provision of HOFFE. This is based on the difference in damage outcomes between those fire events where HOFFE is recorded as being used and those where it is recorded as not being used, across 10 building types. This analysis estimates that:

- the annual **full-coverage cost** for providing HOFFE is $23.4M
- the annual **benefit** through reduced damage from provision of HOFFE is $48.2M

The net benefit (estimated at $24.8M) is concentrated in Factories and industrial buildings (net benefit of $18M) and Restaurants and taverns (net benefit $3.2M). Some building types have relatively few fire incidents where HOFFE was used. A sensitivity analysis shows that the estimated benefits depend in particular on the behaviour of unreported fires. From this analysis building types are classified as follows:

Could receive net benefits from HOFFE	Very likely to receive net benefits from HOFFE
Farm buildings Hospitals and nursing homes Offices and administration buildings Storage buildings	Education buildings Factories and industrial buildings Hostels, hotels and other accommodation Restaurants and taverns Shops Social, cultural and religious buildings

Part B of the methodology develops a set of scenarios for future provision of HOFFE over the short- to medium-term, informed by data on the current level of provision and the views of those involved in providing HOFFE, obtained from surveys and interviews. The scenarios are:

- Scenario 1: Status quo (continue current approaches) – is estimated to lead to a reduction in HOFFE provision of 10% to 15% across the building types
- Scenario 2: Increased effort in making information available to decision-makers – is estimated to lead to a 5% reduction in HOFFE provision for all building types
- Scenario 3: Specific regulations for HOFFE – is estimated to lead to an increase in HOFFE provision of 5% for all building types

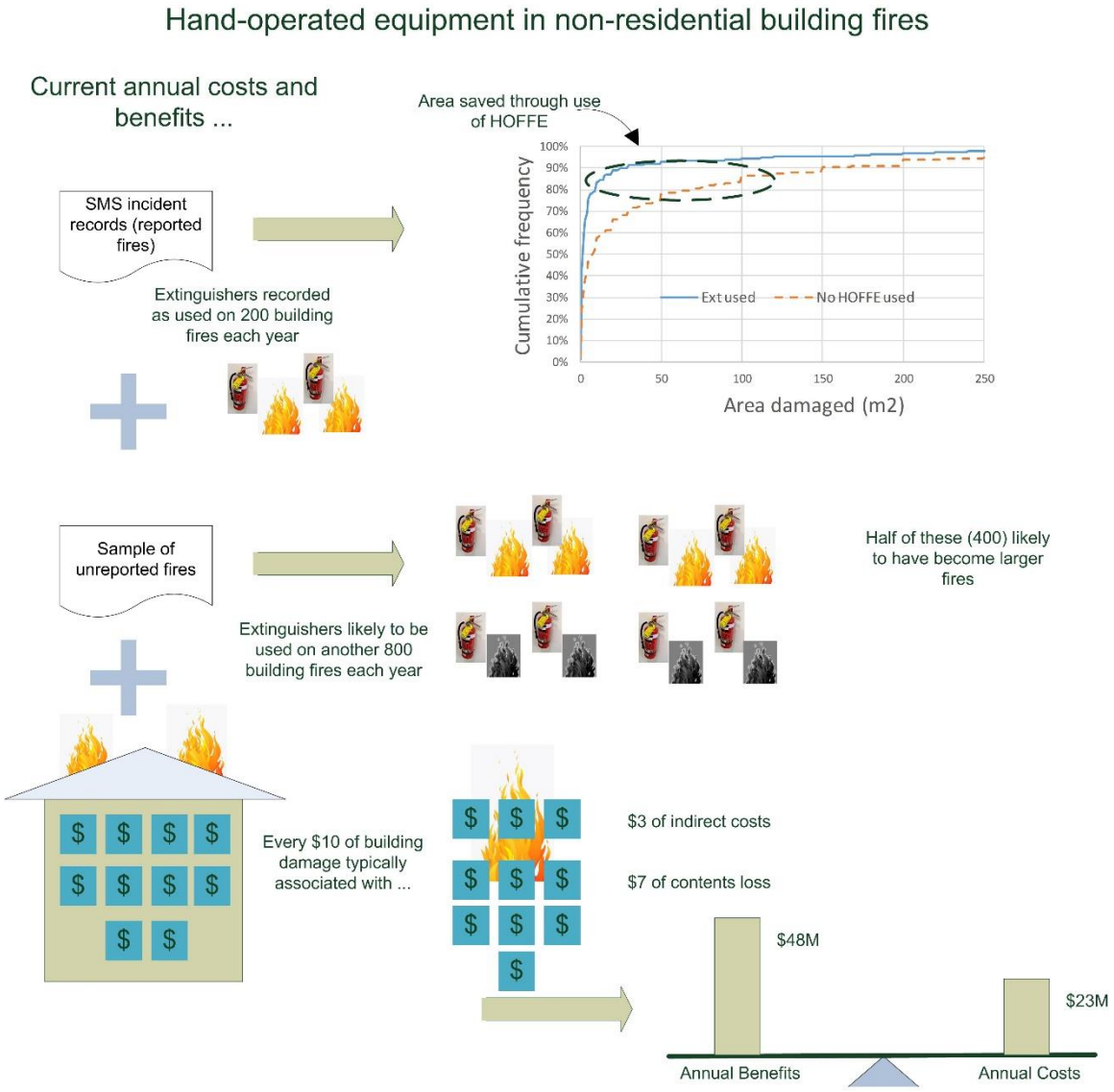
Part C of the methodology then uses the cost model developed for part A to examine the likely changes to fire costs under the future level of provision expected in each of the scenarios. This is expressed as changes to fire damage costs (losses) and to net fire costs (losses offset by provision). The estimated changes to annual fire damage costs are as follows.

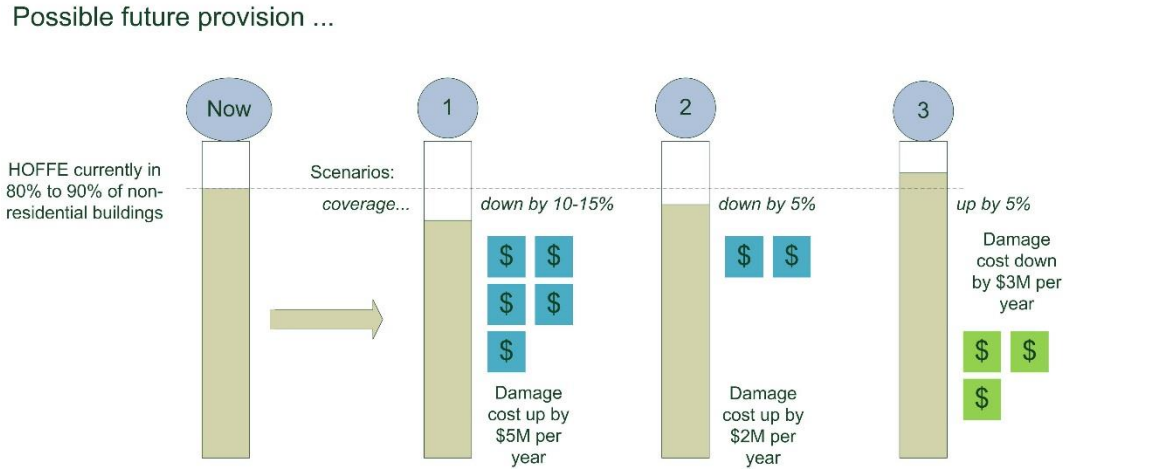
	Change in annual fire damage costs ($M)		
Building type	**Scenario 1**	**Scenario 2**	**Scenario 3**
Education buildings	0.3	0.0	-0.2
Factories and industrial buildings	2.3	0.6	-1.6
Farm buildings	0.2	0.1	-0.1
Hospitals and nursing homes	0.1	0.1	0.0
Hostels, hotels and other accommodation	0.2	0.0	-0.2
Offices and administration buildings	0.4	0.2	-0.1
Restaurants and taverns	1.0	0.6	-0.5
Shops	0.5	0.2	-0.1
Social, cultural and religious buildings	0.2	0.2	-0.2
Storage buildings	0.2	0.1	-0.1
Total	5.4	2.0	-3.0

The increases for scenarios 1 and 2 mean that the Commission's target for non-residential building damage not exceeding $55 million per year could be put at greater risk.

This study suggests that appropriate targeted regulations requiring HOFFE are likely to be economically desirable, and also necessary to obtain some of the net benefits. However, regulations should be pursued carefully and in conjunction with industry bodies. In particular the life-safety message and coverage of existing regulations should be carefully considered and it would also be appropriate to consider the cost for NZFS (or another agency) to operate any HOFFE regulations.

Infographic





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- staff of the New Zealand Fire Service, National Fire Protection Association (USA) and United States Fire Administration that provided information from databases and background on fire regulations and practices

Glossary

Cost avoided	The cost avoided through provision of HOFFE. Damage avoided has a similar meaning. This represents a benefit arising from HOFFE provision.
HOFFE	Hand-operated fire-fighting equipment
Occupant	A person in the vicinity of a fire, who is not a professional or volunteer firefighter. This includes people who work in the building and visitors.
Reported fire	A fire incident that is the subject of an emergency call and that is included within the NZFS SMS incident database
SMS	Station Management System (used by NZFS to record emergency incidents)
Unreported fire	A fire incident that is not the subject of an emergency call and that is not included within the NZFS SMS incident database

2 Introduction

2.1 Purpose and context

This study evaluates how future costs and benefits relating to fires in non-residential buildings are likely to be impacted by changes to requirements for the provision of HOFFE. This is in the context of changes to the New Zealand Building Code in 2012 and the Commission's target to limit fire damage costs for these buildings to $55 million annually. This study will support the Commission in evaluating the appropriateness of seeking regulations relating to this type of equipment, as part of its mission to reduce the incidence and consequences of fire in New Zealand.

A key concept underlying this study is that HOFFE represents equipment provided on site in anticipation of fire. It can therefore be used by building occupants immediately on discovery of a fire (assuming it is safe to do so), before arrival of NZFS personnel.

2.2 HOFFE requirements for non-residential buildings

The current state of regulations on buildings, fire safety, and health and safety, related to providing HOFFE, is outlined below. There are also other non-regulatory drivers for the provision of this type of equipment and these are addressed further in section 4.

The Building Act 2004 and the New Zealand Building Code

The Building Act requires that building work must meet the requirements of the building code[1]. Clauses C1 to C6 of the building code (in effect from 2012) address fire safety for buildings. The objectives of clauses C2 to C6, as set out in clause C1, are to:

> *(a) safeguard people from an unacceptable risk of injury or illness caused by fire,*
>
> *(b) protect other property from damage caused by fire, and*
>
> *(c) facilitate firefighting and rescue operations.*

This objective includes protection of "other property", whereas HOFFE is often seen as protecting the building itself. While HOFFE may support evacuation and life safety, the design of escape routes should ensure evacuation is unlikely to be impeded by fire.

The Building Act 2004 and code also recognise that various specified systems within buildings require ongoing maintenance. This is achieved through the annual certification and building warrant of fitness system. As above, HOFFE is not currently seen as coming within the building warrant of fitness process.

[1] Building Act 2004, s17.

Fire Service Act and Fire safety and evacuation regulations

Sections 21 and 92 of the Fire Service Act 1975 provide for regulations to be made for fire safety purposes, including for the "installation and maintenance of hand-operated firefighting equipment". The Fire Safety and Evacuation of Buildings Regulations 2006 are made under section 92 of the Act. Clause 13 of these regulations applies to most non-residential buildings and states:

> *13 Firefighting equipment for use by building's occupants*
>
> *(1) Any hand-held hose reel or other similar device installed in a building for firefighting by the building's occupants must be maintained under NZS 4503:2005—Hand operated fire-fighting equipment.*
>
> *(2) The National Commander may require an owner or a tenant of a building to install (at specified locations in the building) and maintain portable fire extinguishers—*
>
> *(a) under a code of practice issued under section 21(4)(a)(iv) of the Act; or*
>
> *(b) if there is no code of practice, as the National Commander determines.*

There is currently no code of practice relating to fire extinguishers in force under these regulations, and so no comprehensive mandatory requirement to install this equipment.

Part 2 of the regulations requires evacuation schemes to be provided to the NZFS for many types of non-residential buildings. Evacuation schemes also provide a range of information about the use of the building and fire-fighting equipment within it.

Health and safety legislation

The Health and Safety in Employment Act 1992 requires an employer to take "all practicable steps" to protect the health and safety of people in a workplace (section 6)[2]. Broadly, this requires that employers establish a systematic approach for identifying and evaluating hazards, including fire, and addressing those hazards. This may include provision of equipment and development of procedures for dealing with emergencies.

This legislation does not explicitly require the installation of HOFFE. However, if HOFFE is installed, then this Act does require that appropriate information is provided to employees (section 12) and that adequate training on using it safely is provided (section 13). This act is administered by WorkSafe New Zealand, who provide limited specific guidance on the use of HOFFE related to health and safety.

Hazardous substances regulations

Regulations under the Hazardous Substances and New Organisms Act 1996 specify classes of hazardous substances and requirements for maintaining or restoring safe situations for these. Under the Hazardous Substances (Emergency Management)

[2] This act will be replaced by the Health and Safety at Work Act from early 2016. The new act's requirements affecting HOFFE provision and training are broadly similar to the current act.

Regulations 2001, fire extinguishers must be provided in a place that has more than the specified amounts of flammable substances. Information associated with those substances must also include a description of the preparations for an emergency involving them, any actions to be taken during an emergency, and training and equipment that should be used to deal with such an emergency.

New Zealand Standard 4503:2005 Hand operated fire-fighting equipment

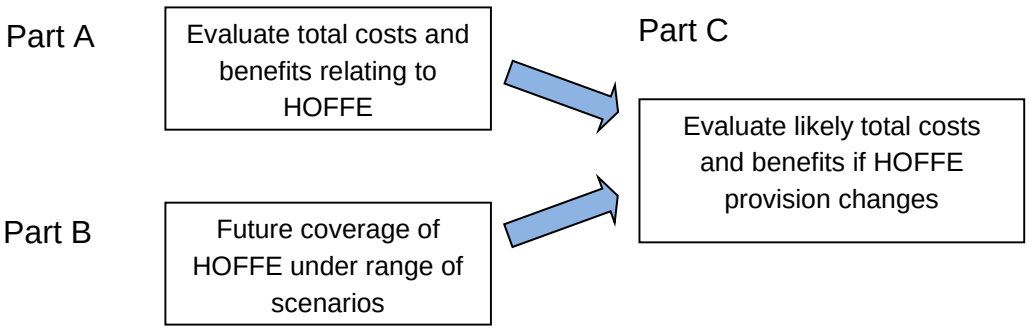
This standard sets out types of fire risks and coverage requirements for equipment that mitigates those risks. It also sets out maintenance requirements for that equipment and notes the need for adequate training on using it. As noted above compliance with this standard (as it refers to maintenance) is required under the Fire Safety and Evacuation of Buildings Regulations 2006.

2.3 Methodology used in this study

This study is based on examining three questions that together address the purpose:

A. How are total costs and benefits associated with non-residential fires affected by changes in provision of HOFFE?
B. What is the likely future level of provision of HOFFE (presented as a range of scenarios)?
C. What are the likely total costs and benefits from those future level of provision scenarios?

Figure 2.1: Outline of methodology



This analysis is based on estimating total costs to society from fire (following BERL 2012 and Hall 2014). It recognises that fire in buildings is a relatively rare event; that most fires start small; and that building damage from a fire can range from very minor to total loss of the structure. The building damage a fire causes can also be associated with other economic losses and with human injury. In New Zealand the majority of the costs associated with fire relate to fire prevention and mitigation, rather than fire damage.

Part A: Impact of HOFFE provision on total costs and benefits associated with non-residential fires

Reducing the provision of HOFFE will mean reduced expenditure for building owners, managers and occupants. It is also likely that this would lead to fires growing larger before they are extinguished, therefore causing more damage. This may also lead to increased costs for the NZFS.

Part A evaluates these based on:

- Costs relating to providing fire protection in the form of HOFFE
- Information from the NZFS Station Management System (SMS) incident database on fires that the NZFS attend, including whether HOFFE was used and the extent of damage from fire
- Information collected by several fire extinguisher service agents on fires that extinguishers were used on (including fires that were not reported to NZFS)
- Estimates of building costs from Rawlinsons (2014)
- Estimates for contents damage and indirect costs
- NZFS operating costs

Part B: Future level of provision of HOFFE

The level of provision of HOFFE is likely to be affected by several factors, including regulation, insurance, risk management and cost considerations. Provision may reduce, in part following the 2012 changes to the building code which clarified that fire extinguishers (in particular) are not required under the building code.

Scenarios for the possible future level of provision of HOFFE have been developed using information on the current level of provision, the balance of these factors and future intentions.

Part C: Total cost from possible future level of provision

Estimates for total fire damage cost and net fire cost under various levels of provision of HOFFE are evaluated. These are based on scenarios for the possible levels of provision (part B), applied to the model developed in part A of total costs and benefits that are likely if provision of HOFFE changes.

Building types used

This study uses 10 non-residential building types, as part of the analysis and to examine possible policy responses. These are derived from the non-residential building types used by Statistics New Zealand to report building consent data, with two changes:

- Hostels & boarding houses and Hotels & other short term accommodation have been combined into a single type (called Hostels, hotels and other accommodation) because they have some similarities and because of low incident numbers in these categories

- Shops, restaurants and taverns have been split into two categories (called Shops and Restaurants & taverns) because of higher incident numbers and differences in fire risk and expected HOFFE provision

Terminology and general approach

Years in this report refer to calendar years (January to December), unless otherwise noted. The analysis considers only non-residential buildings (which includes commercial and short-stay accommodation such as hotels, hostels and boarding houses).

This report relates to hand-operated fire-fighting equipment (HOFFE). This typically includes fire extinguishers, fixed fire hose reels, and fire blankets. The term HOFFE is used to refer to one or more of these generally. In practice, these types of equipment operate differently. Where this difference is important the particular type of HOFFE is referred to. In particular, fire extinguishers are the items most commonly recorded as used in the SMS incident database. Fire extinguishers are also the type of equipment likely to be most affected in the short-term by decisions on provision of HOFFE as they can easily be removed from or added to an existing building.

The expression “the provision of HOFFE” is used to refer to the overall provision of working HOFFE. This includes installation, maintenance, training and signs to ensure people are aware of the location of this equipment.

The term “reported fire” is used to mean a fire for which an emergency call is made, and an incident created within the NZFS SMS database, and “unreported fire” has a corresponding meaning.

2.4 Key information sources

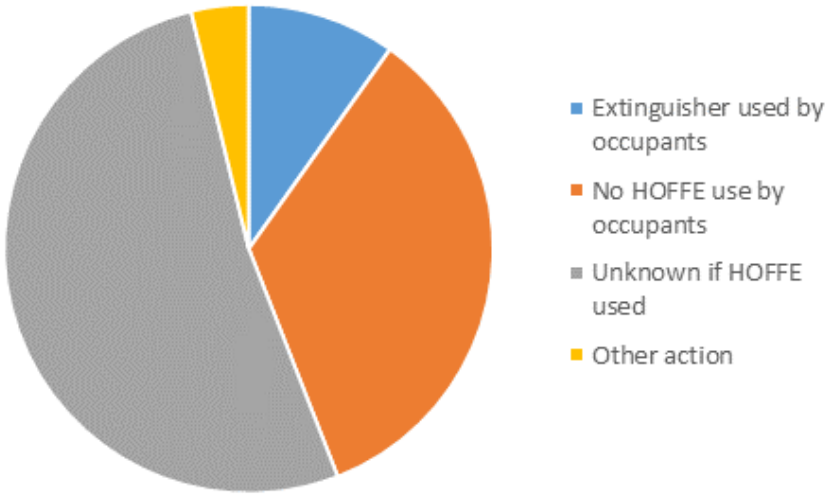
SMS database

Incidents recorded in the NZFS SMS database from January 2011 to December 2014 have been used to identify HOFFE use and outcomes of fires in non-residential buildings.

HOFFE use is based on the actions of occupants, undertaken before the arrival of NZFS personnel and as recorded in the SMS database. Other information recorded includes incident timing, the property use and areas damaged by smoke and flame. Appendix 1 outlines the key fields used in this analysis.

The database records 8228 non-residential fire incidents over this period, as summarised in figure 2.2.

Figure 2.2: HOFFE use from SMS database (2011 to 2014, 8228 incidents)



Extinguisher agent refill data

Several fire extinguisher service agents have kept and provided records of the use of extinguishers that have been refilled over 2014 and 2015, covering around 500 refills. In particular these records indicate the type of fire that each extinguisher was used on, the type of business, effectiveness of the extinguisher, and whether the NZFS was called in relation to each incident.

Information from property managers and insurance industry

Views and information regarding HOFFE have been collated from discussions with property management professionals, and from on-line survey responses from 55 people (covering over 2900 buildings). This has helped with an understanding of attitudes towards HOFFE, and current and possible future provision of this equipment. Discussions and information from the insurance industry has helped inform how insurance requirements can affect this provision.

This information has informed the scenarios of possible changes to the future provision of HOFFE, and in particular the possible impacts of regulatory or non-regulatory approaches.

Evacuation Scheme database

Under the Fire Service Act and the Fire Safety and Evacuation of Buildings Regulations, owners of particular buildings must provide evacuation scheme information to NZFS. These include information on fire-fighting equipment that is provided for the occupants.

The database currently holds 3200 evacuation schemes and has informed the current provision of HOFFE, and evidence of changes over the last four years.

2.5 Outline of this report

Section 3 represents part A of the methodology, and describes the development of a model of the components of costs and benefits associated with fire that are relevant to changes in the provision of HOFFE.

Section 4 represents part B, and examines the current level of provision of HOFFE across New Zealand's non-residential buildings, possible future changes, and possible NZFS policy actions. This results in a set of scenarios for policy responses and associated possible future levels of provision.

Section 5 represents part C, and examines what the total cost of fires might be, for the scenarios prepared in section 4 and using the model described in section 3.

Section 6 presents conclusions and recommendations from this analysis, covering possible approaches to supporting HOFFE provision and possible further work that would improve understanding of the relevant costs, benefits, and provision.

The appendices provide further information on the SMS incident data, building types, and property industry surveys carried out as part of this study.

2.6 Assumptions and limitations

The key data sources for this study are the SMS database and the data collected by fire extinguisher service agents, and both of these rely on post-incident recall of situations where rapid response was required. This data is therefore likely to have some uncertainty and errors.

A sensitivity analysis examines the factors that are considered to be material to the conclusions of this study and particular points of uncertainty are noted accordingly. These may not be exhaustive and so caution is required in wider use of the findings.

This analysis also assumes there will be no relevant change in the short term to:

- Insurance costs or requirements
- Other regulations (including health and safety regulations, noting that the new Health and Safety at Work Act has a broadly similar approach to HOFFE provision as the current legislation)
- The installation or use of other types of fire protection systems
- Activities and behaviours (including activities and behaviours that can increase or reduce fire risk)
- The incidence of fires starting

This study has not sought to quantify the resources or costs needed by NZFS to implement or operate regulations relating to HOFFE.

3 Costs and benefits related to HOFFE use

3.1 Fire cost components

The total cost of non-residential fires was estimated by BERL (2012) for the 2011 year as $656M, using the cost components in table 3.1.

Table 3.1: Economic costs of non-residential fires (2011)

Cost area (non-residential buildings)		Estimated cost (2011 $M)
Fire protection systems	(*)	$273.0
Fire Service Levy	(*)	$151.7
Net fire insurance		$124.0
Fire damage	(*)	$93.2
Human factors		$14.4
Total		$656.3

BERL (2012); Starred items (*) are examined further below.

This table represents “total economic costs”, i.e. the costs of fires to New Zealand society. As BERL note, fire damage costs are substantially outweighed by fire prevention and mitigation costs. This echoes the finding from Hall (2014), who notes that fire damage in the United States represents less than 5 per cent of the total annual cost of fires. The cost of fire protection is seen as having an associated benefit in that damage costs are reduced from the level they would be if that protection was absent.

The current study uses the analysis carried out by BERL as a foundation and considers how these cost components might change if HOFFE provision changes. It does not consider fire-related costs associated with environmental damage or pollution, or associated with irreplaceable cultural or heritage buildings or the sense of community that such buildings can provide.

3.2 HOFFE impact on building fires and fire costs

The majority of fires start as small fires, and past studies have shown that many fires can be extinguished successfully by occupants using a fire extinguisher before those fires pass beyond the incipient stage. Fires can grow very rapidly if they are not extinguished at that stage.

As summarised by Ghosh (2008), a 2002 survey of 2173 fire incidents in the United Kingdom indicated that in 80 per cent of these, portable fire extinguishers successfully extinguished the fire. A parallel study of 2627 incidents across five other countries in Europe also showed successful use of extinguishers in 81 per cent of cases. Results

from a 2006 Swedish study of 1752 incidents where extinguishers were used indicated a lower success rate of 61 per cent.

Importantly, the first two of these studies also showed that for 75 per cent of these fires, the fire service was not called. Such fires are referred to in this study as “unreported fires”. The above figures are consistent with studies carried out in New Zealand, as presented below (see section 3.5).

This indicates that there are two broad ways in which costs associated with non-residential building fires might increase if the provision of HOFFE reduces:

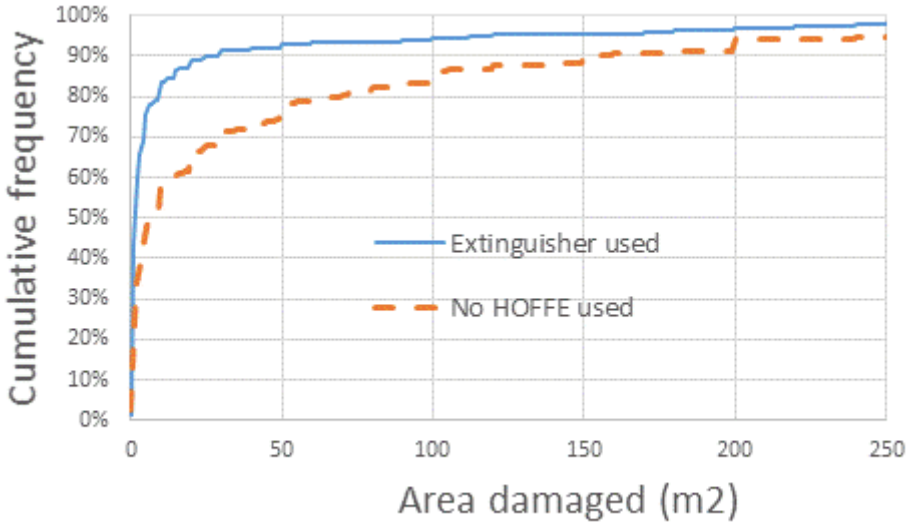
a) Reported fires that are currently fought with HOFFE before emergency services arrive might on average lead to higher damage costs as these fires are likely to become larger before they are finally extinguished.
b) Unreported fires might on average lead to higher costs as these fires are likely to become larger before they are finally extinguished and because some of these fires will become the subject of emergency calls.

The types of costs most important for this study are therefore:

- Fire protection system costs (including the provision and ongoing support for HOFFE)
- The Fire Service Levy (a proxy for the cost of operating the NZFS and supporting infrastructure)
- Fire damage, being costs associated with fire damage to property

Figure 3.1 below shows the cumulative distribution of fire damage in square metres, based on analysis of SMS data. This shows that for 75% of incidents, flame damage is 5m² or less when an extinguisher was used (across all non-residential building types). In contrast, the 75th percentile damage area is 50m² where no HOFFE was used.

Figure 3.1: Distribution of flame damage (No HOFFE vs Extinguisher used)



SMS data: 1685 incidents from 2011 to 2014

The typically lower damage that results from use of extinguishers represents a benefit from this equipment. This benefit is referred to as “damage avoided”, or “cost avoided” when expressed in dollar terms.

Note that this figure compares two cases for intervention by occupants before arrival of the NZFS: use of fire extinguishers; and no use of any form of HOFFE. These two cases are used throughout this analysis as the available data indicates that other forms of intervention (including use of hose reels) are less common (refer figure 2.2).

Figure 3.1 also illustrates that building fires are characterised by many fires that cause relatively small damage and a small number that cause major damage.

3.3 Costs – Fire protection systems and training

The focus of this study is narrower than typical studies on costs related to fire protection, and this means that usual methods of estimating costs for entire fire protection systems (including alarms, sprinklers, material specifications and building design) are not suitable. Accordingly, a high level estimate of the annual expenditure on HOFFE has been prepared based on estimated floor area for each non-residential building type[3], as summarised in table 3.2.

Table 3.2: Estimate of floor area and annual fire extinguisher costs

Building type	Total area (m²)	HOFFE cost ($M)
Education buildings	6,014,000	0.6
Factories and industrial buildings	15,916,000	5.0
Farm buildings	7,084,000	1.9
Hospitals and nursing homes	5,589,000	0.6
Hostels, hotels and other accommodation	2,915,000	0.3
Offices and administration buildings	11,791,000	1.7
Restaurants and taverns	2,609,000	4.4
Shops	8,347,000	0.9
Social, cultural and religious buildings	3,371,000	0.6
Storage buildings	17,075,000	1.9
Total	80,711,000	17.9

[3] As others have noted (e.g. MBIE, 2012), figures on the total number or floor area of non-residential buildings are uncertain. The floor area estimates used here are based on employment data from Statistics New Zealand (one and two level ANZSIC codes) and typical employment density figures, verified against other floor area records at an industry or geographic level.

This estimate is based on these buildings being covered by fire extinguishers to the level required by NZS 4503:2005[4]. It represents a theoretical cost, as some buildings will not be covered in this way and some owners or occupiers will not carry out the maintenance assumed in this estimate.

If fire extinguishers are provided, employees should be trained in how to use them[5]. Information provided by the Fire Protection Association of New Zealand is that this costs around $50 per person and should be repeated every two years. A further cost estimated at $43 per person is included to represent the cost of wages for the 1½ hour training. In practice it is likely that only a small fraction of people (estimated at 5% of employees[6]) will receive this training.

Table 3.3: Estimate of annual fire extinguisher training related costs

Number of employees (1)	2,355,000
Training frequency (yearly)	2
Percentage trained	5%
Trained per year	58,875
Training cost per person	$ 93
Total annual cost ($M)	$ 5.5

Note: (1) Statistics New Zealand, Mar 2015

Summary of annual cost estimate

Based on the above, the total full-coverage cost for providing working HOFFE across non-residential buildings, including training, is estimated at $23.4 million annually.

3.4 Benefits – Building damage (Reported fires)

Influence of HOFFE on levels of building damage

The cost of building damage is likely to be strongly influenced by any reduction in the provision of HOFFE. This influence can be examined through data recorded in the SMS database as summarised in table 3.4.

[4] This is based on all buildings being covered for class A and E fires, and additional class-specific protection for industrial & manufacturing, food preparation, information technology and social & cultural buildings. Costs for Restaurants and taverns are relatively high because of likely higher density of protection, and the higher cost of class F extinguishers.
[5] Refer Health and Safety in Employment Act 1992 ss12, 13.
[6] This estimate is consistent with NZQA data (that indicates an average of 8900 people completing the corresponding unit standard each year) and industry estimates of the ratio of unit standard to non-unit standard training delivered.

Table 3.4: Annual number of SMS non-residential fire incidents (based on 2011-2014)

Building type	Extinguisher used by occupants	No HOFFE use by occupants	Unknown if HOFFE used (1)	Other action (2)	Total
Education buildings	17	64	94	8	183
Factories and industrial buildings	53	92	165	40	350
Farm buildings	14	89	128	2	233
Hospitals and nursing homes	10	68	84	3	165
Hostels, hotels and other accommodation	14	94	96	7	210
Offices and administration buildings	16	87	155	5	262
Restaurants and taverns	23	43	72	2	141
Shops	33	82	134	5	254
Social, cultural and religious buildings	15	59	102	2	178
Storage buildings	9	27	44	3	83
Total	202	705	1073	78	2057

Notes:
(1) This represents incidents where it was not recorded whether or not HOFFE was used; HOFFE might have been used in some of these incidents.
(2) This includes incidents where hose reels, or extinguishers and hose reels together, were used.

This is based on the database showing (for some incidents) whether the occupants of the building used HOFFE to fight the fire, before the arrival of the NZFS. The database also records the extent of damage to the building, in terms of damage from flame, smoke, water or fire control activities.

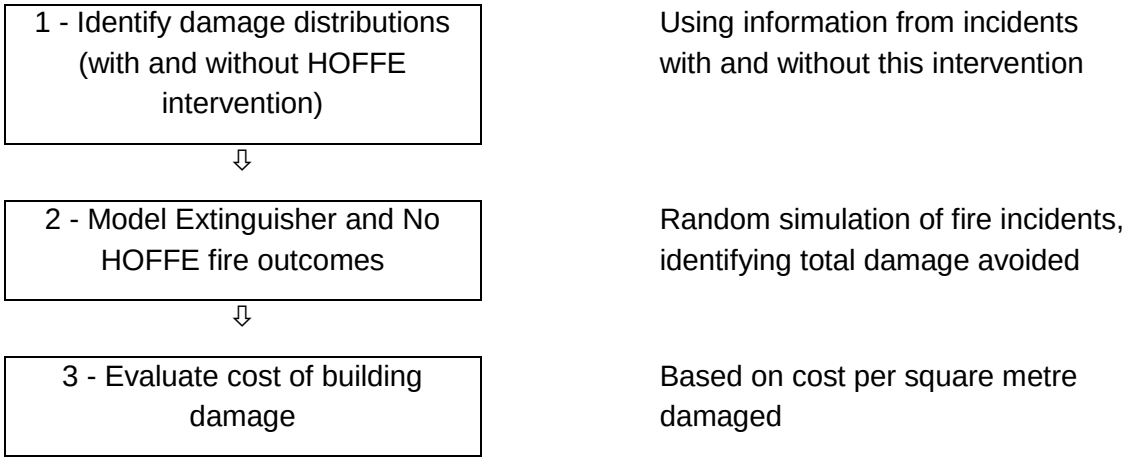
As shown in figure 3.1, the use of HOFFE is associated with reduced flame damage. If HOFFE were not available to be used, it is likely that the distribution of damage across the incidents where HOFFE was used would tend to correspond to the distribution of damage across the incidents where HOFFE was not used (assuming these fires were otherwise similar).

Review of the SMS data indicated that the main factors that affect the level of damage to a building from a fire are:

- The type of activity on the site, as indicated by *General property use.*
- Prior actions by building occupants (including the use of HOFFE).
- Arrival times, where shorter arrival times are associated with less damage and 91 per cent of fires have an arrival time shorter than 15 minutes. Longer arrival times are associated with Rural, Farming or Forest uses.

The estimated increase in building damage from fires that would arise in the complete absence of HOFFE represents a benefit from the provision of HOFFE. This can be estimated as outlined in figure 3.2 and explained in more detail below.

Figure 3.2: Estimating fire costs in the absence of HOFFE (no intervention)



1 - Damage distributions with and without HOFFE intervention

The distribution of flame damage (in square metres) for intervention and non-intervention fires was constructed for all building types. The resulting cumulative distribution is shown in figure 3.1.

These distributions were also constructed for each building type individually. However, several building types have only a small number of incidents where extinguishers were recorded as being used (as shown in table 3.4), and those distributions were not considered robust.

As each building type does have a larger number of “no HOFFE” incidents, the damage distribution curves for each building type were constructed:

- For the No HOFFE case, based on the records for that building type
- For the Extinguisher used case, based on adjusting the Extinguisher used curve for all building types to align with differences between the No HOFFE case for this building type and the No HOFFE case for all building types

2 - Model Extinguisher and No HOFFE fire outcomes

The identified damage distributions for Extinguisher used and No HOFFE used fires were used to evaluate the distribution of damage avoided from use of HOFFE. This was obtained from a random simulation of 50,000 trials for each building type. Each trial

involved sampling from the Extinguisher and No HOFFE damage distributions and determining the corresponding difference in damage outcome.

The distribution of difference in damage area from the simulation is summarised as an area of damage avoided, per fire, for each building type. The cost estimates are therefore based only on the number of fires where extinguishers were recorded as used.

3 - Evaluation of benefit from reduced fire damage

The benefit of the reduced fire damage is based on the area of damage avoided and the per square-metre building cost obtained from Rawlinsons (2014), for the respective building type (see appendix 2). This per-fire cost is calculated as[7]:

{Cost of damage avoided} =

{Per square metre building cost} multiplied by

{Area of flame damage avoided in square metres}

The results of this are summarised in table 3.5 below, by building type.

Table 3.5: Annual damage and benefit - Buildings, reported fires

Building type	Number (annual)	Damage area avoided (m²)	Benefit ($M)
Education buildings	17	283	0.6
Factories and industrial buildings	53	2,414	2.0
Farm buildings	14	769	0.6
Hospitals and nursing homes	10	105	0.3
Hostels, hotels and other accommodation	14	326	0.7
Offices and administration buildings	16	321	0.7
Restaurants and taverns	23	865	1.9
Shops	33	567	0.7
Social, cultural and religious buildings	15	410	1.0
Storage buildings	9	227	0.2
Total	202	6,288	8.7

[7] BERL (2012) use a formula that also accounts for smoke damage, with a 10% weighting. The form above is used here to simplify the modelling and because initial review suggested that including smoke damage made only a minor difference to the cost figures.

Summary

This indicates that HOFFE provides a benefit from reduced building damage of around $8.7 million from reported fires.

3.5 Benefits – Building damage (Unreported fires)

Previous studies have indicated that unreported fires significantly out-number reported fires. Unreported fires tend to be extinguished very quickly (at the incipient stage) and are associated with smaller areas of damage. If levels of HOFFE provision reduce, then there will be two ways in which costs associated with these fires increase:

- Unreported fires that would otherwise have been extinguished by HOFFE will instead become larger fires and cause more damage.
- Some unreported fires will become reported fires, implying greater costs for the NZFS.

Costs associated with building damage are examined below. Costs relating to operations of the NZFS are explored in section 3.8.

Previous New Zealand studies on fire extinguisher use

International studies on the extent to which fires are extinguished by HOFFE at the incipient stage and do not become the subject of a call to the fire service have been noted above. These typically indicate that fewer than 25 per cent of fires are reported to the fire service.

This issue has also been explored through several studies in New Zealand, including two prior studies in 2003-2004 and 2008, and a study carried out in 2014-2015 to support the present study.

As summarised by Ghosh (2008), the 2003-2004 study was carried out alongside the consideration of a code of practice for hand-operated extinguishers. The survey was carried out across members of the Fire Protection Association of New Zealand (FPANZ) and involved members collecting information as they refilled extinguishers that had been used. Data on a total of 395 incidents were collected over eight months. This study was in good alignment with the data reported in the European studies noted earlier, showing that for 83 per cent of incidents the fire extinguisher was effective, and for 90 per of incidents the Fire Service was not called. It was however considered that the sample size was too small and returns inconsistent and uneven, and caution was expressed in relation to using this data to form final conclusions.

The 2008 survey was carried out alongside the study carried out by Ghosh (2008), in conjunction with the University of Canterbury and FPANZ. A similar methodology was adopted, operating over four months (May to August 2008).

A total of 144 incidents was recorded. Extinguishment was successful in 94 per cent of these incidents, and the Fire Service was called in only 11 per cent of the incidents. As

for the earlier study, the low sample size and uneven distribution of returns was noted leading to caution in using these results.

The 2014-2015 study on fire extinguisher use

A similar study has been carried out by NZFS and FPANZ starting in August 2014, with the data below representing 12 months of data. A total of 491 survey responses were received over this period, representing 306 structure fire incidents[8].

Review of these showed that the key parameters are consistent with all previous studies. Fire extinguishers were recorded as effective in extinguishing the fire in 90 per cent of incidents, and the NZFS was recorded as being called in only 20 per cent of incidents.

Total number of fires where extinguishers used

The total number of fires where extinguishers are used can be estimated by combining the percentage of survey incidents where the NZFS was called and the number of incidents within the SMS database where extinguishers were recorded as being used. This calculation is:

Percentage of instances of extinguisher use where NZFS called	20 %	*From extinguisher agent survey*
Number of incidents in SMS database where fire extinguishers recorded as used (per year)	202	*Based on average over 2011 to 2014 calendar years*
Implied number of unreported fires where extinguishers were used	808	

The 306 survey responses therefore represent around 30 per cent of the estimated 1000 fires where extinguishers were used each year. The distribution of the incidents has been compared with the distribution of fire risk across New Zealand, showing a good alignment for most regions[9].

Estimated damage from unreported fires

Not all unreported fires that HOFFE is used on are likely to grow into fires that cause a material level of building damage. To evaluate this, each incident recorded in the extinguisher agent survey was examined. Based on information provided on the scale,

[8] Other incidents include fires not related to buildings, accidental use, responses that did not identify the nature of the fire, or that related to refill of extinguishers that had been used in various incidents over a period of time.
[9] Regions with smaller populations tend to be under-represented or over-represented. This can be expected noting that such regions will be served by a smaller number of agents and may be served less frequently.

cause, setting and objects involved, an assessment was made on whether this incident was likely to have caused material building damage. This showed that around 80% of these fires may have grown and caused such damage.

There is however some uncertainty over this figure, and it acts as a material multiplier of the overall estimate of damage avoided. Accordingly, a lower figure of 50% is adopted, and the damage avoided estimate below is based on an *additional* 404 fires (being 50% of 808). The damage that is likely to have occurred from these fires in the absence of HOFFE is estimated below (see table 3.6), based on the distribution of fires across the extinguisher agent data and the calculations used above for reported fires (table 3.5).

Table 3.6: Annual damage and benefit - Buildings, unreported fires

Building type	Number (annual)	Damage area avoided (m^2)	Benefit ($M)
Education buildings	18	312	0.7
Factories and industrial buildings	248	11,346	9.4
Farm buildings	5	285	0.2
Hospitals and nursing homes	3	29	0.1
Hostels, hotels and other accommodation	9	223	0.5
Offices and administration buildings	16	318	0.7
Restaurants and taverns	38	1,438	3.1
Shops	30	525	0.7
Social, cultural and religious buildings	15	403	1.0
Storage buildings	21	563	0.5
Total	404	15,441	16.7

The bulk of the additional fires and cost avoided relates to Factories and industrial buildings; the 248 fires noted above is an increase of 70% above the current level of 350 fires per year. This arises because data on unreported fires shows that many of these fires arise from industrial processes (including hot work such as welding).

Summary

This indicates that HOFFE provides a benefit from reduced building damage of around $16.7 million from unreported fires.

3.6 Benefits – Contents damage

The fire damage costs evaluated above are based on damaged area and building costs. They do not therefore account for losses to contents of buildings, which can often be greater than building damage costs. Detailed data for this was not able to be sourced for New Zealand, so international sources were obtained.

The NFIRS system operated by many fire services across the United States separately records building and contents damage. Evaluation of information provided for several non-residential building types enabled an estimate of the contents loss, as a fraction of the building loss for each of these types (National Fire Protection Association 2015 and United States Fire Administration 2015), as shown in table 3.7 below. This is based on building damage costs for both reported and unreported fires.

Table 3.7: Estimated contents losses avoided by HOFFE use

Building type	Total building loss ($M)	Contents factor	Contents loss ($M)
Education buildings	1.3	0.50	0.6
Factories and industrial buildings	11.4	1.00	11.4
Farm buildings	0.9	0.75	0.7
Hospitals and nursing homes	0.4	1.00	0.4
Hostels, hotels and other accommodation	1.2	0.40	0.5
Offices and administration buildings	1.3	0.75	1.0
Restaurants and taverns	5.0	0.50	2.5
Shops	1.4	0.75	1.1
Social, cultural and religious buildings	2.0	0.40	0.8
Storage buildings	0.7	1.00	0.7
Total	25.4		19.5

Summary

This indicates that HOFFE provides a benefit from reduced loss to building contents of around $19.5 million from reported fires and unreported fires.

3.7 Benefits – Indirect losses associated with building damage

Damage to buildings is often associated with the potential for indirect costs such as business interruption. For society as a whole, some business interruption costs reflect movement rather than loss, as competitors of a business that is affected by fire may expand.

The prior study by BERL (2012) based these indirect costs associated with fires on figures presented by Hall (2010[10]) as follows:

Indirect damage from fires =

> *65% x {direct damage in reported fires in manufacturing or industrial buildings}*
>
> *plus 25% x {direct damage in reported fires in public assembly, educational, institutional, store, or office buildings}*
>
> *plus 10% x {direct damage in reported fires in storage, or special structures}*
>
> *plus 4 x 2% x {direct damage in reported fires in non-residential buildings excluding storage and special buildings}*

The results of this are summarised in table 3.8.

Table 3.8: Estimated indirect damage avoided by HOFFE use

Building type	Building damage (reported fires, $M)	Indirect factor	Indirect cost ($M)
Education buildings	0.6	25%	0.1
Factories and industrial buildings	2.0	65%	1.3
Farm buildings	0.6	25%	0.2
Hospitals and nursing homes	0.3	25%	0.1
Hostels, hotels and other accommodation	0.7	25%	0.2
Offices and administration buildings	0.7	25%	0.2
Restaurants and taverns	1.9	25%	0.5
Shops	0.7	25%	0.2
Social, cultural and religious buildings	1.0	25%	0.3
Storage buildings	0.2	10%	0.0
Total	8.7		2.9

[10] The same percentages are used in Hall's later (2014) study. Note also that the text of this report (p 3) refers to these factors being applied to both reported and unreported direct losses.

This estimate is based on applying the above factors only to reported fires, as a conservative approach. Further, these factors may not fully reflect the impact of long lead times for delivery of specialised equipment to New Zealand.

Summary

This indicates that HOFFE provides a benefit from reduced indirect losses of around $2.9 million, based on reported fires.

3.8 Benefits – New Zealand Fire Service operations

The NZFS may experience increased costs from reduced HOFFE provision because reported fires may require greater effort, as some of these fires will be larger when the NZFS arrives. Also, some unreported fires that are currently extinguished by fire extinguishers will become the subject of emergency calls. This means that the NZFS is likely to have more call outs.

These costs are estimated as below. The NZFS annual report for the year ending 30 June 2014 indicates that the NZFS attended around 5300 structure fires (of 73,000 incidents), so the potential additional 808 incidents represents an increase of 15 per cent (or 1 per cent of total incidents).

Table 3.9: Estimate of additional NZFS costs (if HOFFE not used)

	Larger reported fires	**Unreported fires**	**Total**
Number of incidents	202	808	
Extra hours per incident	0.6	1.3	
Total extra hours	118	1050	1,168
Cost per hour (two-person unit)	360	360	
Total extra cost ($M)	0.0	0.4	0.4

Summary

This indicates that HOFFE provides a benefit from reduced NZFS operating time of around 1,168 hours and reduced cost of around $0.4 million.

3.9 Summary of HOFFE related costs and benefits

The estimated cost of HOFFE protection can be compared with the range of estimated benefits provided by HOFFE, for each building type. This is summarised in figure 3.3 and table 3.10 below.

Figure 3.3: Comparison of annual HOFFE related costs and benefits ($M)

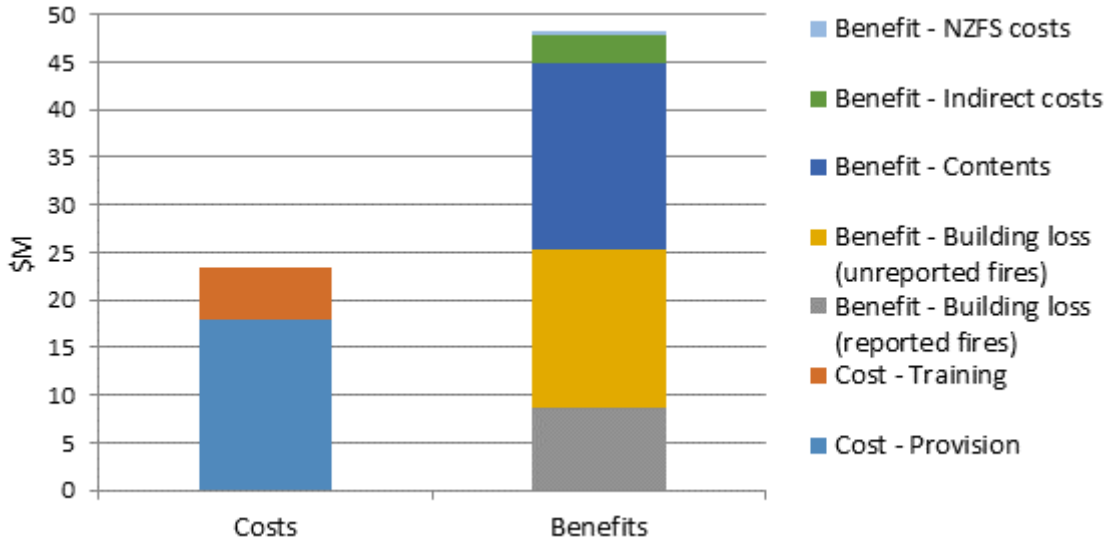


Table 3.10: HOFFE related costs and benefits (Annual $M)

Building type	Provision costs ($M) (1)	Benefit ($M)
Education buildings	1.0	2.1
Factories and industrial buildings	6.1	24.1
Farm buildings	2.2	1.7
Hospitals and nursing homes	1.2	0.8
Hostels, hotels and other accommodation	0.4	1.9
Offices and administration buildings	3.0	2.5
Restaurants and taverns	4.7	7.9
Shops	1.5	2.7
Social, cultural and religious buildings	0.7	3.1
Storage buildings	2.4	1.4
Total	23.4	48.2

Note: (1) This includes purchase / replacement for this equipment, and ongoing costs to building owners / occupiers such as training, maintenance and administration. The estimated annual training cost of $5.5M has been distributed across building types based on employee numbers.

Summary

This analysis estimates an overall net benefit from the provision of HOFFE of $24.8M annually.

3.10 Sensitivity of cost and benefit estimates

The cost figures presented above are based on estimates for several parameters. Those that are most likely to affect the overall results are:

- the current level of coverage of HOFFE
- possible under-counting of fires where HOFFE was used but not recorded
- the distribution of damage avoided through use of HOFFE
- floor area estimates and HOFFE provision estimates including training
- fraction of unreported fires that would grow in the absence of HOFFE
- allowance for contents losses

The level of uncertainty in these factors and the influence of this uncertainty have been reviewed through two further analyses, based on combinations that support lower (case A) and higher (case C) HOFFE benefits, as outlined in table 3.11 below. This table also shows the mid-point estimates used above (case B).

Table 3.11: Variations used in the sensitivity analysis

Factor	Discussion	Analysis range covered (1)
Current HOFFE coverage	Likely that current coverage is around 80% to 85% (see also section 4). Lower figures for current coverage imply that the provision costs should be reduced (as provision costs were estimated based on full coverage).	A) 100% B) 100% C) 90%
Under-counting of HOFFE intervention fires	Highly likely that HOFFE would have been used in some of the fires where HOFFE use is unknown. Increasing the number of fires where HOFFE is used will increase estimated benefits.	A) 0% B) 0% C) +20%
Distribution of damage avoided	Damage distributions are based on adjustments to reflect differences between building types; actual damage will vary from year to year. Higher damage differences mean higher costs avoided by HOFFE.	A) -25% B) 0 C) +20%

Factor	Discussion	Analysis range covered (1)
Building floor area estimates and HOFFE provision costs	Floor area and HOFFE provision figures include use of broad averages. Higher figures for floor area or provision of HOFFE give increases in the costs of HOFFE fire protection.	A) +20% B) 0% C) -10%
Fraction of unreported fires that grow	The fraction of unreported fires likely to grow has been estimated from the limited information about each of these fires. Higher figures for unreported fires that grow mean higher costs avoided by HOFFE.	A) 35% B) 50% C) 60%
Contents loss factors	Contents loss factors are estimates based on limited international data. Higher contents loss factors mean higher costs avoided by HOFFE.	A) -20% B) 0% C) +20%

Note: (1) Figures with + or – are changes from the mid-point case. Figures without + or – represent absolute values.

The results of these analyses are summarised in figure 3.4 and table 3.12.

Figure 3.4: Summary of results of sensitivity analysis

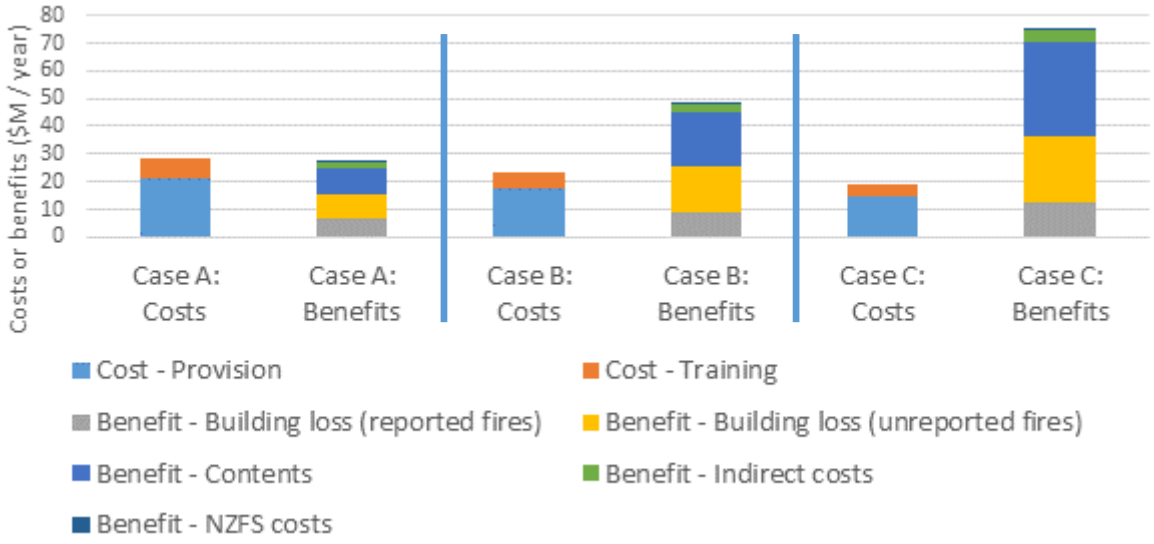


Table 3.12: Summary of results of sensitivity analysis (annual $M)

Building type	Case A: Costs	Case A: Benefits	Case B: Costs	Case B: Benefits	Case C: Costs	Case C: Benefits
Education buildings	1.3	1.2	1.0	2.1	0.8	3.1
Factories and industrial buildings	7.3	12.6	6.1	24.1	4.9	37.9
Farm buildings	2.7	1.1	2.2	1.7	1.8	2.6
Hospitals and nursing homes	1.5	0.5	1.2	0.8	1.0	1.3
Hostels, hotels and other accommodation	0.5	1.2	0.4	1.9	0.3	2.9
Offices and administration buildings	3.7	1.5	3.0	2.5	2.5	3.9
Restaurants and taverns	5.6	4.6	4.7	7.9	3.8	12.1
Shops	1.8	1.6	1.5	2.7	1.2	4.2
Social, cultural and religious buildings	0.9	1.9	0.7	3.1	0.6	4.6
Storage buildings	2.9	0.8	2.4	1.4	2.0	2.2
Total	28.1	27.1	23.4	48.2	18.9	74.8

Based on this sensitivity analysis the likelihood of each building type receiving a net benefit can be summarised as follows:

Could receive net benefits from HOFFE	Very likely to receive net benefits from HOFFE
Farm buildings	Education buildings
Hospitals and nursing homes	Factories and industrial buildings
Offices and administration buildings	Hostels, hotels and other accommodation
Storage buildings	Restaurants and taverns
	Shops
	Social, cultural and religious buildings

Regarding this classification:

- The net benefit is concentrated in Factories and industrial buildings (mid-point net benefit of $18M) and Restaurants and taverns (mid-point net benefit of $3.2M).
- Many unreported fires are in industrial buildings, and may be connected with processes (such as hot work) in those buildings.
- The estimated benefits depend in particular on the behaviour of unreported fires.
- Farm buildings are associated with longer average response times and a higher likelihood of complete loss. Farm extinguisher usage may also be under-represented in the extinguisher refill data. There are relatively few records of extinguisher use for these buildings.
- There are relatively few records of extinguisher use for Hospitals and nursing home buildings. Many of these buildings are used 24 hours a day and covered by sprinklers. They appear to be associated with lower average losses than other building types.
- There are relatively few records of extinguisher use for Hostels, hotels and other accommodation, and Storage buildings.

3.11 Human factors

Other costs related to any change in HOFFE provision could include human costs (from injuries and fatalities). These costs are difficult to estimate, noting that injuries and fatalities are rare for non-residential fires in New Zealand. This report does not make any estimate of potential changes in such costs.

This is also connected with the wider issue of how people behave in emergency situations such as fire. While this is largely outside this study, brief comments are made below.

Occupant fire-fighting on discovery of a fire represents a balance of outcomes:

if extinguishment is rapid and successful, damage and threat to health will be minimal	if extinguishment is attempted and is unsuccessful, threat to health and damage may be increased from the delays in alerting others, evacuation and calling emergency services

Consistent with this, the NZFS and others provide a message of “only fight a fire if safe to do so”, and support training to help people evaluate fire risk better and use HOFFE or other equipment properly.

Human behaviour in fire and similar emergency situations has been investigated in detail in recent decades, and the following points can be made:

- Human behaviour in fire can tend to be logical and if tools are given (such as HOFFE) they will be used.

- Actions taken are heavily dependent on the role of a person and their perception of the situation and associated risks. It is not uncommon (for example) for shoppers in a mall to continue shopping while a fire alarm is sounding. The actions of staff are very important in this situation. Role also applies to any sense of belonging or ownership (whether in a residential or work context).
- It can be difficult for an untrained person to assess the risk associated with fire and the speed it might grow.
- Most people can use a fire extinguisher without training (though operation is typically more confident and effective after training).

4 Possible HOFFE policy responses

4.1 The range of possible policy interventions

Bardach (2011) provides a range of interventions that a public agency might consider for any public policy issue; as adapted for the present problem these can be presented as:

- Do nothing
- Rely on market forces or self-interest
- Work through other government agencies or other regulations
- Support outcomes being delivered through the industry (self-regulation)
- Informing decision-makers (owners / occupiers) directly
- Making specific regulations for the outcomes being sought

These interventions are ordered from the least to the greatest degree of intervention. As a general rule, lower levels of intervention are preferred over higher levels, where lower levels of intervention can deliver equivalent or similar benefits. Regulation should generally be considered alongside identifying whether problems might be adequately addressed through private or non-regulatory arrangements (Treasury 2013).

The risk and potential serious consequences of fire are well known. This means that many businesses are motivated to protect themselves from fire. In particular, firms undertaking higher risk activities (or exposed to higher fire-related costs) may continue to provide fire extinguishers and other forms of HOFFE as part of their approach to risk management or safety even if there was no external requirement or guidance on this. A well-designed regulatory regime with appropriate monitoring and penalties can support high levels of compliance.

4.2 The Commission's role and current approaches

The New Zealand Fire Service Commission is a statutory body, required by the Fire Service Act 1975, as a "matter of prime importance … to take an active and co-ordinating role in the promotion of fire safety in New Zealand". The Commission has a range of explicit functions associated with this, and these cover all of the items noted above.

In relation to HOFFE for non-residential buildings, the Commission already uses a number of policy approaches, though it has not yet sought to put specific regulations in place. These approaches are anchored by clear messages that life safety is paramount and that fire-fighting should be attempted only when it is safe to do so.

The current situation is considered to be composed of:

- no wide-ranging explicit regulatory requirements for HOFFE to be installed within non-residential buildings (though there are targeted explicit regulatory requirements relating to hazardous substances)

- the message from the NZFS and others that fighting a fire should only be attempted when it if safe to do so, and only after other life-protecting actions
- the 2012 changes to clause C of the building code (alongside which HOFFE was clarified as not required under the code or compliance schedule system) that has acted as a catalyst for reconsidering this issue
- pressures for the provision or non-provision of HOFFE arising from consideration of insurance, health and safety, past practice, costs and risk management
- HOFFE currently being installed in many buildings

It is expected that the emphasis on life-safety will be retained, and that the NZFS will continue to influence the provision of HOFFE through its relationships with relevant industries and its public education campaigns.

4.3 Information to inform scenario development

Information from the property management industry

Information from discussions with property industry professionals, and survey responses, indicated that fire protection is a carefully considered issue. The major findings from this are:

- Currently around 80% of buildings have HOFFE installed
- Reductions in HOFFE provision are being considered for around 30% of buildings, and increases for 15%
- The most important factors in decisions about HOFFE are:
    - Health and safety of building occupants
    - Insurance requirements
    - Building regulations
    - Fire safety regulations
    - Risk management
    - Ongoing costs for this equipment (e.g. maintenance, testing, training, administration)

General comments made include:

- Use of extinguishers by untrained staff is inappropriate and risky.
- Other forms of fire protection (including alarms and sprinklers) are common, and considered to reduce the need for HOFFE.
- Life safety is paramount and the NZFS are better placed to fight fires (so employees should be actively discouraged from this).
- Factors against HOFFE provision include: low risk of fire, staff training requirements, staff turnover, difficulties of monitoring portable equipment, and importance of life safety.

It is noted that the above comments are based on discussions with property specialists. Views and coverage may be different in other segments of the non-residential property industry. There are many decision-makers for non-residential buildings. These include

members of professional firms and property-related associations, real estate agents, international companies, government, family trusts and individuals (including individual shop owners).

Insurance industry

The main findings from discussions with insurance industry personnel and review of available documentation are:

- Fire extinguishers and other forms of HOFFE are generally seen as useful and reducing losses; however they are not always an explicit requirement
- Fire losses do not usually dominate insurance losses in New Zealand (apart from major, infrequent, events)
- There is limited publicly available detailed information on costs associated with non-residential fire losses

Evacuation scheme database

The evacuation scheme database has information on over 2400 evacuation schemes that have been entered online since 2012. As relevant to this study, information available for these schemes includes the lodgement date, building use(s), whether it is for an existing or new building, and whether HOFFE is provided.

The main findings from this data are:

- HOFFE is recorded as provided for 82% of buildings. Provision is higher for existing buildings (85%) than new buildings (72%). Around 80% of schemes relate to existing buildings.
- There is no clear pattern of HOFFE provision increasing or decreasing over the 2012 to 2015 period.
- HOFFE provision is higher (90%) for Factories and industrial buildings and Social, cultural and religious buildings. In relation to factories and industrial buildings, this may reflect greater awareness of fire risks associated with industrial processes. Provision is slightly lower (77%) for Education buildings.
- There is no significant variation in the composition of the types of HOFFE over time, with 92% of buildings with HOFFE having extinguishers, 32% having hose reels and 18% having blankets. However, hose reels are much more commonly listed for existing buildings with HOFFE (38%) than for new buildings (6%).

The nature of non-residential buildings

Non-residential buildings have several features that are relevant to this study and identifying possible approaches to HOFFE provision, including the potential for regulation.

In particular, they are typically associated with “in trade” activities; they are already subject to a range of compliance requirements; they often have many occupants

(including the public or visitors); provision of HOFFE is observable; fire-risk is well known and of obvious importance; and fire protection in the form of HOFFE can be readily provided at moderate cost.

This means that the three factors necessary for good regulation and high compliance – knowledge, willingness and ability of the target group (OECD, 2000) – are relatively well satisfied.

4.4 Identifying scenarios for analysis

This discussion above has noted six factors as having a large impact on decisions about providing HOFFE, and identified six broad approaches to improving the provision of HOFFE. The current influence of each of those factors, and an assessment of the potential to change that influence through the identified approaches, is summarised in table 4.1 below.

Table 4.1: Factors, possible approaches and influences

		Ability of approach to influence each factor					
Factor	**Current influence**	**Status Quo**	**Market forces**	**Via other agencies**	**Self-reg**	**Info to owner/occ**	**Specific regs**
Health and safety	=	Low	Low	Med	Low	Med	Med
Insurance	▲	Low	Low	Med	Low	Med	High
Building regulations	▼	Low	Low	Low	Low	Low	Low
Fire safety regulations	▼	Low	Low	Low	Low	Low	High
Risk m/ment	=	Low	Med	Med	Med	Med	Med
Ongoing costs	▼	Low	Low	Low	Low	Low	Med

Based on the above, there are three approaches that appear appropriate for consideration:

1) Status quo
2) Increased effort in providing information direct to decision-makers
3) Specific regulations requiring HOFFE

A “do nothing” option was also initially considered. This could represent the Commission having no public position on HOFFE and ceasing to work with related parties on this topic. This is not included within the analysis as such an approach seems inconsistent

with the Commission's role when taken with the general and specific references to fire safety and to HOFFE within the act and regulations.

The approach of working through other government agencies or other regulations was also initially considered. This could include in particular the departments that manage the building act and code, and health and safety legislation. These are both relevant to fire in buildings and the hazard this represents. However, as noted in section 2.2 there are certain challenges in this. These arise in part because of the structure and purpose of that other legislation and regulation, and is it considered that an approach of working through these other regulations is unlikely to lead to a material difference to the level of HOFFE provision in the short-term.

Current state

Based on available information, the current HOFFE provision for three building types is taken as 90% (these are called the "high provision" building types):

- Factories and industrial buildings
- Restaurants and taverns
- Social, cultural and religious buildings

The current coverage of HOFFE is taken as 80% for other building types.

Scenario (1): Status quo

Under the status quo option, it is expected that there will be minimal change to insurance requirements, being the factor that supports increases in HOFFE provision. In contrast, the factors that support decreases in provision (impact of building and fire safety regulations, and ongoing costs) are likely to be more influential over time.

This is because some building owners and occupiers are likely to seek advice, or make decisions, only when maintenance or training becomes due or leases expire or are entered. Removal and reduction in the short to medium term will therefore be affected by typical equipment lives and commercial lease durations that typically range from three to six years.

HOFFE coverage is therefore expected to decline over the next few years under this scenario. Based on intentions given in the survey (as summarised in section 4.3 above), this scenario is based on coverage reducing by 10% or 15%, i.e.:

- coverage reducing from 90% to 80% for the high provision building types
- coverage reducing from 80% to 65% for other building types

Scenario (2): Increased effort in providing information direct to decision-makers

Under this approach the Commission could develop and promote a good practice guide, or find other ways to raise the profile and value of HOFFE in the minds of relevant decision-makers (typically owners and occupiers of non-residential buildings). This approach would also include seeking to provide stronger messages through the fire

protection industry, including insurance companies and those that provide advice on building protection and risk management such as independently qualified persons (IQPs).

To be effective the message would need to demonstrate the financial benefits (as developed in this analysis), resolve queries on effectiveness and address human factors (including concern over the consequences of improper use of HOFFE in an emergency situation). The survey responses, and other discussions, have highlighted the perceived balance of life-safety, and this appears to be a carefully considered opinion that may take some time to shift (in the absence of prescriptive regulation). Some of the types of decision-makers involved may be difficult to reach.

This scenario is based on coverage reducing by 5%, i.e.:

- coverage reducing from 90% to 85% for the high provision building types
- coverage reducing from 80% to 75% for other building types

Scenario (3): Specific regulations requiring HOFFE

Under this approach the Commission would use the regulation-making powers relating to HOFFE generally (Fire Service Act, s21) or portable fire extinguishers specifically (Fire Safety and Evacuation of Buildings Regulations, clause 13)[11]. It is expected that the resulting codes of practice or standards could set some minimum requirements for the provision of HOFFE that could apply to most buildings (while allowing for special situations and specific risks).

Regulations provide a strong and unambiguous message on what is required. Appropriate regulation can influence several of the factors that influence provision. By creating a mandatory requirement they will alter individual views of the life-safety balance and encourage a stronger risk management focus.

Regulations can also effectively be promoted through others' requirements, e.g. insurance, mortgage, leasing or conveyancing requirements, or property management contracts.

This scenario recognises data indicating that HOFFE is currently provided in most buildings, and that the broad requirements for achieving compliance with appropriate regulation are relatively well satisfied (as outlined in section 4.3). It assumes that the collaborations included in scenarios 1 and 2 would also be carried out.

This scenario is based on coverage increasing by 5%, i.e.:

- coverage increasing from 90% to 95% for the high provision building types
- coverage increasing from 80% to 85% for other building types

[11] Regulations (e.g. mandatory codes of practice or standards) are made through the Minister, and are to be sought following appropriate consultation. They must not require any building to achieve performance criteria additional to those in the Building Act 2004 or in the building code.

5 Costs and benefits of scenarios

5.1 Approach to evaluation of scenarios

The outcomes of each scenario have been developed by evaluating changes in the costs and benefits associated with fires as expected under that scenario (as informed by section 3.3 to 3.8), compared to the current situation as a baseline. The baseline uses a level of provision of 90 per cent for the high provision building types (Factories and industrial buildings; Restaurants and taverns; Social, cultural and religious buildings), and a level of 80 per cent for other types of buildings.

The changes in costs and benefits are determined by:

- including within the simulation of annual fire damage a step to account for the probability of HOFFE being used in each random trial, where that probability is based on the level of HOFFE provision
- adjusting the costs of provision to reflect the level of provision

Note that these future scenarios are based on the case B mid-point figures from the sensitivity analysis (apart from using 80% or 90% as the current level of provision).

5.2 Cost and benefit estimates for scenarios

The cost estimates are presented in figure 5.1 and tables 5.1 and 5.2 using two measures:

- The change in **fire damage costs** reflects estimated changes in the cost of damage from fires (including building losses from reported and unreported fires, contents losses and indirect costs).
- The change in **net costs** reflects estimated changes in total fire costs, based on the change in fire damage costs (above) offset by changes in the cost of HOFFE provision.

The annual changes in fire damage costs range from an increase of $5.4M (scenario 1) to a reduction of $3M (scenario 3). The changes in net costs range from an increase of $2.4M (scenario 1) to a reduction of $1.8M (scenario 3).

Figure 5.1: Summary of outcomes from scenarios – Annual costs ($M)

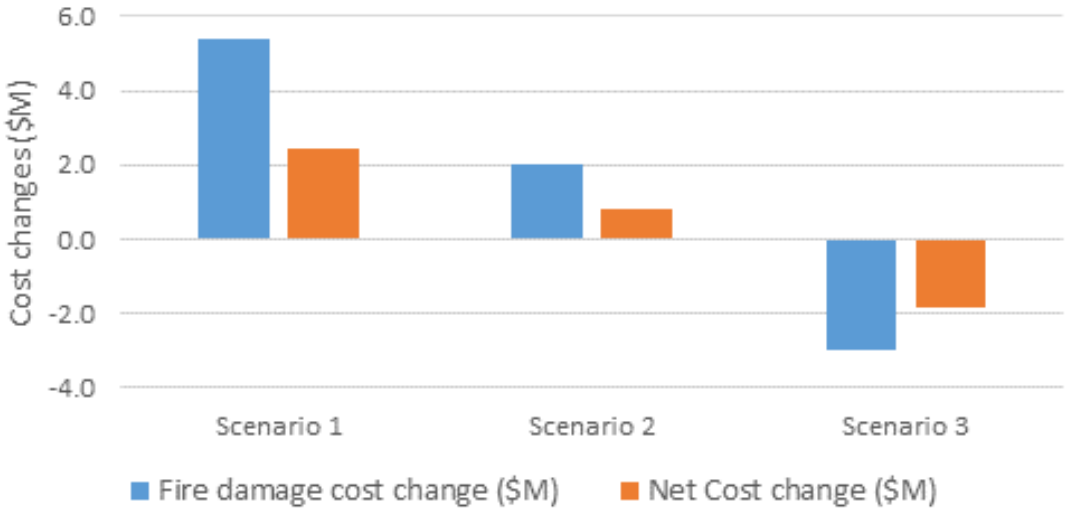


Table 5.1: Summary of outcomes from scenarios – increases in fire damage costs (annual $M)

Building type	Fire damage cost change ($M) Scenario 1	Fire damage cost change ($M) Scenario 2	Fire damage cost change ($M) Scenario 3
Education buildings	0.3	0.0	-0.2
Factories and industrial buildings	2.3	0.6	-1.6
Farm buildings	0.2	0.1	-0.1
Hospitals and nursing homes	0.1	0.1	0.0
Hostels, hotels and other accommodation	0.2	0.0	-0.2
Offices and administration buildings	0.4	0.2	-0.1
Restaurants and taverns	1.0	0.6	-0.5
Shops	0.5	0.2	-0.1
Social, cultural and religious buildings	0.2	0.2	-0.2
Storage buildings	0.2	0.1	-0.1
Total	5.4	2.0	-3.0

Table 5.2: Summary of outcomes from scenarios – increases in net fire costs (annual $M)

Building type	Net fire cost change ($M) Scenario 1	Net fire cost change ($M) Scenario 2	Net fire cost change ($M) Scenario 3
Education buildings	0.1	0.0	-0.1
Factories and industrial buildings	1.7	0.3	-1.3
Farm buildings	-0.1	0.0	0.0
Hospitals and nursing homes	-0.1	0.0	0.0
Hostels, hotels and other accommodation	0.1	0.0	-0.1
Offices and administration buildings	-0.1	0.0	0.0
Restaurants and taverns	0.5	0.4	-0.3
Shops	0.3	0.1	0.0
Social, cultural and religious buildings	0.1	0.1	-0.1
Storage buildings	-0.2	0.0	0.1
Total	2.4	0.8	-1.8

6 Conclusions and recommendations

6.1 Conclusions relating to this study

Net benefits

This study indicates that HOFFE provides significant net benefits across New Zealand's non-residential buildings. A mid-point analysis gives an estimate of annual benefits (through fire damage costs avoided) of $48.2M, compared to an estimated annual cost of provision of $23.4M. For the building types examined in this study:

- Four building types *could* receive net benefits from HOFFE:
  Farm buildings
  Hospitals and nursing homes
  Offices and administration buildings
  Storage buildings
- Six building types are *very likely* to receive net benefits from HOFFE:
  Education buildings
  Factories and industrial buildings
  Hostels, hotels and other accommodation
  Restaurants and taverns
  Shops
  Social, cultural and religious buildings

The net benefit is concentrated in particular to the Factories and industrial building type (net benefit estimated at $18M) and the Restaurants and taverns building type (net benefit $3.2M).

As the benefit of HOFFE (across all building types) outweighs the cost of providing it, total fire costs to building owners and to society are likely to increase if the overall level of provision of HOFFE is reduced.

Actions, future provision of HOFFE and associated costs

The level of HOFFE provision is likely to reduce by between 5% and 15% over the short- to medium-term, if NZFS adopt an approach based either on the status quo (current activities) or enhanced information provision and collaboration. This will be partly due to typically lower levels of provision in new buildings and partly due to the removal of HOFFE from existing buildings. Fire damage costs could increase by between $2.0M and $5.4M annually.

Putting appropriate regulations in place is considered likely to lead to slight increases in HOFFE provision, and could reduce fire damage costs by $3M annually.

This analysis suggests that appropriately targeted regulations are likely to be *economically desirable* (as they will deliver net economic benefits), and *necessary*

(because some of these benefits will not be achieved unless provision is mandatory). This observation is made on the basis that HOFFE is already widely provided, and that the estimate for HOFFE provision includes an estimate for the costs to owners and occupiers for managing this equipment on an ongoing basis.

However, regulations should be pursued carefully and in conjunction with affected industry bodies. Estimated cost changes are small for several building types. Further, the life-safety message should be carefully considered. Any regulations that are developed must accommodate the wide range of unusual situations and specific risks across non-residential buildings, and recognise coverage of existing regulations.

It would also be appropriate to consider the cost for NZFS (or another agency) to operate any HOFFE regulations alongside its existing operations. It is noted that the NZFS already operates a series of databases and an on-line service portal, and has a significant community presence, and so the marginal cost of operating such regulations may be moderate.

NZFS should also continue to monitor information provided through the evacuation scheme database to identify any further trends in HOFFE provision for existing and new buildings.

6.2 Possible further work

Based on work undertaken for this study, the following are suggested for possible later consideration.

- This work has relied on the SMS database, which is a valuable resource. The records do have some gaps, and this increases uncertainty in the analysis. This study may be an opportunity to reinforce the value of this information to its users.
- More information may be needed on human behaviour; this would form part of any information to be provided under scenarios 2 and 3, noting the concerns around life safety.
- Further information could be sought for the building types for which there are relatively few fire incidents where HOFFE was recorded as used (Farm buildings; Hospitals and nursing homes; Hostels, hotels and other accommodation; Storage buildings), to inform a more complete analysis for these building types.
- Future versions of the extinguisher survey could capture more information about the object on fire, and whether the fire is “contained” or likely to grow. This is a key parameter for evaluating the scale of benefits from HOFFE. Documentation associated with the NFIRS (USFA 2015) provides a good discussion of the factors and practicalities associated with this.
- NZFS could approach Statistics New Zealand to explore whether information on unreported fires could be sought through their business frame survey. This would enable a more robust estimate of the scale of these fires.

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Appendices

Appendix 1: SMS incident data

The SMS database extract for 1 January 2011 to 31 December 2014 included 8228 incidents of non-residential fires. The key fields used in this study are indicated below.

Table A1.1: SMS incident database fields

Field	Comments
Incident timing	Alarm, arrival and departure times.
General property use	Used to identify the building type (see below)
Prior actions	Actions of occupants before the arrival of fire service personnel.
Fire damage	Picklist text description of area damaged (eg. “Confined to room of origin”).
Flame damage area	Area in square metres damaged by flame.
Smoke damage area	Area in square metres damaged by smoke.

Table A1.2: General property use mapping to Building type

General property use	Building type
Airport	Offices administration buildings
Church, Cemetery, Religious use	Social cultural and religious buildings
Commercial - not classified above	Offices administration buildings
Communications, Research - not classified above	Social cultural and religious buildings
Community hall	Social cultural and religious buildings
Conservation, Recreation park, Reserve	Non-Building
Construction, Renovation, Demolition site	Non-Building
Defence, Military use	Factories and industrial buildings
Doctors/Dentists emergency clinic, Medical centre	Hospitals and nursing homes
Educational, Health, Institutional - not classified above	Social cultural and religious buildings
Farming, Horticulture, Agricultural use	Farm buildings
Hospital, Hospice, Rest home, Rehabilitation centre	Hospitals and nursing homes
Industrial, Manufacturing	Factories and industrial buildings
Laboratory, Research use	Factories and industrial buildings
Library, Museum, Art gallery, Court etc	Social cultural and religious buildings
Lifestyle block	Farm buildings
Marae, Maori Culture use	Social cultural and religious buildings
Mine, Quarry, Oil well	Factories and industrial buildings
Not Recorded	Non-Building
Office, Bank, Embassy, Fire/Ambulance/Police station	Offices administration buildings

General property use	Building type
Open land	Non-Building
Power station	Factories and industrial buildings
Prison, Correctional institution	Hostels hotels and other accommodation
Public Toilet	Offices administration buildings
Railway property	Non-Building
Recreational use, Theatre, Indoor sports, Pool, Park, Zoo, Aquarium	Social cultural and religious buildings
Recreational, Assembly - not classified above	Social cultural and religious buildings
Restaurant, Pub, Tavern	Restaurants and taverns
Road, Street, Motorway	Non-Building
Rubbish tip, Transfer station, Hazardous waste disposal	Factories and industrial buildings
Rural - not classified above	Farm buildings
School: Pre-school through to Secondary/High	Education buildings
Service/Repair use, Dry cleaner, Laundromat, Mechanical workshop	Factories and industrial buildings
Shop, Shopping mall, Supermarket, Service station, Car yard, Other sales use	Shops
Sports club, Health club	Social cultural and religious buildings
Sportsfield, Stadium	Social cultural and religious buildings
Storage, Warehousing	Storage buildings
Stormwater, Harbour, Lake, River, Beach, Waterfront area	Non-Building
Studio: Radio, TV	Offices administration buildings
Telephone exchange, Communications use, Control room, Data processing	Offices administration buildings
Unable to classify	Non-Building
University, Polytech, Teachers college, Other post-secondary	Education buildings
Vacant building, Section	Non-Building
Passenger terminal	Offices administration buildings
Non existent address	Non-Building
Boarding house, Half-way house, Dormitory, Rooming, Lodging, Home stay, Backpacker	Hostels hotels and other accommodation
Commercial forestry	Non-Building
Hotel, Motel, Lodge, Timeshare	Hostels hotels and other accommodation
Residential - not classified above	Hostels hotels and other accommodation
Construction, Renovation - not classified above	Miscellaneous buildings

Appendix 2: Building data

Building costs were derived by:

- Identifying the range of building categories presented in Rawlinsons (2014) that aligned with each building type, and taking the average (mean) of those, based on the elemental building costs table
- Making a reduction to account for the substructure cost (typically 5% to 15%), as this element will often not be damaged (except for larger fires)
- Using the Factories and industrial building figure for Farm buildings and Storage buildings (as this was a conservative (low) figure and considered an appropriate proxy).

The building costs used are given in table A2.1.

Table A2.1: Building costs for each building type

Building type	Building cost $/m²
Education buildings	2100
Factories and industrial buildings	825
Farm buildings	825
Hospitals and nursing homes	2650
Hostels, hotels and other accommodation	2250
Offices and administration buildings	2050
Restaurants and taverns	2150
Shops	1300
Social, cultural and religious buildings	2450
Storage buildings	825

Source: Rawlinsons 2014.

Appendix 3: Property management surveys

Two surveys of property industry professionals were run as part of this study, with the assistance of the Property Council New Zealand and the Property Institute of New Zealand. The questions in each were similar, as provided below.

A total of 55 responses were provided across these two surveys, relating to over 2900 buildings. This is understood to give a response rate of around 5% and so quantitative results must be used with care. In both cases, respondents included a range of additional qualitative comments and these (together with discussions with property owners and managers) have been used to inform the views and estimates used in this report.

Property Council New Zealand survey questions

Q1 Are you an owner, manager or advisor for non-residential buildings?

Q2 Please provide an estimate of the number of non-residential properties you own, manage or provide advice on.

Q3 What percentage of your non-residential buildings currently have occupant-use firefighting equipment installed?

Q4 Are you intending to change your provision of (or recommendations on) this equipment in the next few years?

Q5 Which of the following have the most influence on your decisions on providing occupant-use fire-fighting equipment?

- Health and safety of building occupants (including for users of this equipment in the event of a fire)
- Insurance requirements
- WorkSafe (previously Department of Labour) requirements
- Building regulations
- Fire safety regulations
- Perceived effectiveness of this type of equipment
- Risk management (overall evaluation or for a specific risk)
- Purchase and installation costs for this equipment
- Ongoing costs for this equipment (e.g. maintenance, testing, training, administration)
- Personal experience of a fire or of using this type of equipment
- Other (please specify)

Q6 Do you have any comments about the above factors or other factors that are important for this decision?

Q7 What type of non-residential buildings do you own, manage or provide advice on? (You may select more than one type)

- Factories / Industrial / Manufacturing
- Commercial offices, administration
- Retail (including shops, malls, restaurants and entertainment)
- Education
- Farming / rural
- Short-term accommodation (including hostels, hotels, hospitals)
- Storage (warehouses, self-storage)
- Social, cultural, religious
- Other (please specify)

Q8 What regions are the non-residential buildings you own, manage or provide advice on in?

Q9 Do you have any other comments on the questions asked in this survey?

Property Institute of New Zealand survey questions

Q1 Are you an owner, manager or advisor for non-residential buildings?

Q2 Please provide an estimate of the number of non-residential buildings you own, manage or provide advice on.

Q3 What type of non-residential buildings do you own, manage or provide advice on? (You may select more than one type)

- Factories / Industrial / Manufacturing
- Commercial offices, administration
- Retail (including shops, malls, restaurants and entertainment)
- Education
- Farming / rural
- Short-term accommodation (including hostels, hotels, hospitals)
- Storage (warehouses, self-storage)
- Social, cultural, religious
- Other (please specify)

Q4 What percentage of your non-residential buildings currently have occupant-use firefighting equipment installed?

Q5 Are you intending to change your provision of (or recommendations on) this type of equipment in the next few years?

Q6 How do each of the following factors influence your decisions about providing (or advising on) this type of equipment?

> Choice for each of: Factor supports reduced provision; Neutral or balanced influence; Factor supports increased provision; Factor not relevant

- Safety of building occupants (including for users of this equipment in the event of a fire)
- Insurance requirements
- WorkSafe (previously Department of Labour) requirements
- Building regulations
- Fire safety regulations
- Perceived effectiveness of this type of equipment
- Risk management (overall evaluation or for a specific risk)
- Purchase and installation costs for this equipment
- On-going costs for this equipment (e.g. maintenance, testing, training, administration)
- Personal experience of a fire or of using this type of equipment
- Other

Q7 Do you have any comments about the above factors or other factors that are important for this decision?