90% DRAFT - SUCCESSFUL ACTIVE FIRE PROTECTION MEASURES IN NEW ZEALAND

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Abstract: *This paper reports on research on successful active fire protection systems. The fire incidents with fire alarm activations that were assessed for the purpose of this study are derived from the New Zealand Fire Service (NZFS) web-based incident data reporting system, which is integrated with the overall station management system (SMS) and incident numbers and reports are automatically generated for all incidents that the NZFS attends [1]. The active fire protection systems analysed in this study are automatic and manual fire detection / alarm systems and automatic sprinkler systems, which are elements of the alarm section in the incident reports. A snapshot area has been investigated in detail to assess to what extend the alarm section information from the database can be used for statistical purposes to evaluate successful active fire protection systems in New Zealand.*

1 INTRODUCTION

Active fire protection systems are an integral part of the fire protection of a building and they are characterised by items and/or systems that require a signal and response in order to work (contrary to passive fire protection). A fire detection system is intended to provide sufficient early warning of a fire to permit occupant notification and escape, fire service notification, and in some cases activation of other fire protection features (e. g. smoke management systems). Both the system activation (detection) and notification (alarm) must occur to alert to a fire [2]. The failure of active fire protection systems has been the focus of previous research but it appears that less research has been done to show where these systems have been successful. With the aim to obtain data in New Zealand, which lists the successful operation of various active fire protection, the New Zealand Fire Service (NZFS) web-based incident data reporting system has been found to have the most comprehensive relevant data collection. The SMS Incident System is a dynamic database, which means that emergency incident information can be updated or edited at any time [3]. The reporting period assessed in this study is from the establishment of the database in 2000 to October 2012.

Early in the research, issues with the database information in regard to alarm and detector system activation and performance were identified and a snapshot area investigated in detail. The snapshot area is the Gisborne District, which has been chosen for reasons of accessibility since the buildings are familiar and can be visited by the author. In addition, stakeholders such as local Fire Service staff, alarm contractors and council staff are known to the author and verbal and documented information on existing fire alarm systems in relevant buildings and the fire incidents themselves is accessible.

Every single structure fire incident for the assessed timeframe was investigated and compared with the database information. The result of the Gisborne sample can give an indication to what extent the nationwide fire alarm data from the SMS database can be used to estimate successful active fire protection activations in New Zealand.

Figure 1 depicts two different branches of structure fire incidents, which in this document are described as PFA Premise (Fire Service-monitored) and non-PFA Premise. For premises without an alarm system that is monitored by the FS, the FS is generally called via 111 calls by building occupants, members of the public, or security firms if the system is monitored by a security firm.

PFA premises are premises that have one or several alarm systems that are permanently connected to the New Zealand Fire Service (NZFS). The PFA number has a pre-determined alarm (PDA) associated with it, which is a pre-planned turnout of the relevant fire appliances. Hence the NZFS response to PFAs can be very fast as it only requires the Communications Centre ComCen) operator to click 'OK' and everything happens to a pre-determined plan.

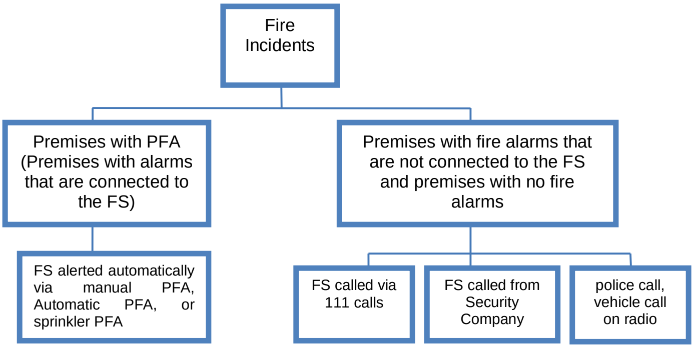


Figure 1: Fire Service-Monitored and Non Fire Service-Monitored Incidents.

There are currently 126 PFAs in Gisborne. The 126 alarm systems are installed in 79 premises. A building and/or a building complex (e. g. hospital, schools can have multiple PFAs. Special cases in the assesses snapshot area are a hospital and a High School, which have several CPNs and can have multiple PFA per individual building/individual CPN.

2 METHODOLOGY

For this study, three data spreadsheets that were extracted from the SMS database and provided by Neil Challands from the NZFS were used and analysed.

- All Gisborne District structure fire incidents for premises that have Fire Service monitored alarm systems (private monitored alarms or PFA) for the reporting period: 2000 (establishment of database) to October 2012. This database is referred to as PFA incidents database throughout this document
- All Gisborne District structure fire incidents for premises that are NOT Fire Service monitored, reporting period: 2000 (establishment of database) to October 2012 – referred to as NON-PFA incidents database throughout this document.
  This includes all structure fires regardless if the buildings have an existing fire alarm system.
- List of all current PFA premises in the Gisborne District

With the support from Gisborne Fire Service staff, the fire alarm system information in the above databases was assessed by following up on every individual structure fire incident in the reporting period. The incident reports for the assessed structure fire incidents were accessed at the local Fire Station.

The data collection methodology included the identification of those structure fire incident premises without a common name and/or with incomplete or no addresses. This was followed by checking all incident addresses against a Compliance Schedule database held at the local council to ascertain which premises had fire alarm systems in place at the time of the fire incident and what systems they were. Other information extracted from the Compliance Schedule database is the responsible alarm servicing agents. It was determined which incidents that were recorded as non-PFA premise incidents but occurred at a PFA premise because the alarm method/how the FS was called was not via a PFA. All incident reports were investigated in order to categorize them as external or internal fires, and to determine if the reports contain any irregularities. The incidents were then categorised and sorted according to their alarm/detection type activation and performance.

3 RESULTS

3.1 Issues Identified with the SMS Database Use and Database Output

Several issues related to the data entry into the database and the interpretation of the database output have been identified in the course of this study that are creating inconsistencies and potentially misleading interpretations.

3.1.1 Varying Definitions and Interpretations

When creating the incident report, the answer selection choices make it obvious that the incident reporter is asked to describe the alarm or detection system that is actually in place in the building / area of fire, rather than describe the alarm or detection system that activated (automatic detection system) or was activated by occupants (manual alarm system) in the fire incident.

The alarm information output from the database in form of the incident report describes the input data as: “Type of alarm initiating call”. This wording is contradictory to the wording used in the actual alarm data entry form as described above. It implies that the alarm or detection system shown is the alarm or detection system having initiated or activated the call to the Fire Service. The contradiction also includes the fact that the reported detector type can be described as not having operated (refer Figure 2).

Alarms

Type of Alarm Initating Call	Heat detector, Thermal detector
Performance of System	Did not operate - detector in room of origin
Failure/Ineffectiveness of system	Unable to classify
Number of sprinkler heads operated	0

Figure 2: Example Alarm Section Output in Incident Report

In the Statistical Report *[3]*, the alarm type selection results are shown in *Table 15* – ‘Type of Detector/Alarm System Activated at Structure Fires’. The ‘non-recorded’ category includes all structure fires where no alarm system was reported as activated (as noted at the bottom of *Table 15 [3])*. The alarm/detector type category information therefore also include all entries where the systems did not operate, which is shown in the example in Figure 2. The ‘Performance of System’ information is entered after the alarm/detector type selection. The performance group and performance code drop-down menus are: ‘fire too small to activate detector’, ‘didn’t operate – detector in/not in room of origin’.

3.1.2 Limitation of Data Entry Options for Special Circumstances

If a premise that has a manual fire alarm system connected to the Fire Service – the manual fire alarm is therefore registered as PFA with the Fire Service – the premise can also have individual detection systems throughout the building complex, such as smoke, heat, flame detection and sprinklers, etc.

This can be the case with older alarm systems that have multiple connection units (MCU) where multiple alarm systems go through a single connector to the Fire Service. This means that the Fire Service receives no information other than that there has been an alarm activation. Such systems have not been installed for the last 20 years and modern systems have a separate connection for each alarm system.

For one particular premise that has been investigated in this research it means that the premise has its own industrial fire brigade and all their alarms are connected to a central control centre for their own brigade. The NZ Fire Service is then called by manual alarm in support of their own brigade. This means that both the detection system and the manual fire alarm have operated and the data selection for can be chosen as either ‘Manual Fire Alarm’ or ‘Smoke/Heat/Flame/etc. Detector System’ as the incident reporting does not allow for multiple alarm entries in one incident. In assessing the structure fire incidents for the premise, it was found that when a detection system activated, the selected entry was the detection type, e. g. heat detection. If no detection system activated, ‘Manual Fire Alarm’ or ‘Unable to Classify’ was selected as ‘Type of Alarm’. In order to be consistent, all incidents, in which the FS was called through the manual PFA, ‘Manual Fire Alarm’ should be the selected type. The set-up of the database entry does not allow for this scenario and there are no options for the data input for the additional activation of the detection system. This is an inconsistency and when counting and comparing the number of successful alarm/detection system activations will lead to inaccurate results.

In case of the snapshot area Gisborne, one particular premise to which the above scenario applies contributes with 40 incidents to the total number of 72 incidents, which can result in incorrect statistical information on the successful fire alarm type activation with an error of over 50%.

3.1.3 Inconsistencies / Contradictions in Incident Reports

The total numbers from the incident database entry ‘alarm type’, which is listed in Table 15 of the SMS Statistics report [3], counts all alarm/detector types entered, regardless if they operated and were effective or not. Would the figures from the SMS Statistics report, Table 15, be used to count the successful activations of the various alarm/detection systems, the figures would not accurately reflect the actual successful activations.

An example for this inconsistency is shown in example incident report W705875 (Figure 3), which lists heat/thermal detector as type of alarm initiating call but lists the performance, also emphasized in the comments, as not having activated.

Alarms

Type of Alarm Initating Call	Heat detector, Thermal detector
Performance of System	Did not operate - detector in room of origin
Failure/Ineffectiveness of system	Unable to classify
Number of sprinkler heads operated	0

02:30, Tue 28 November 2006 **Reporter Comments**

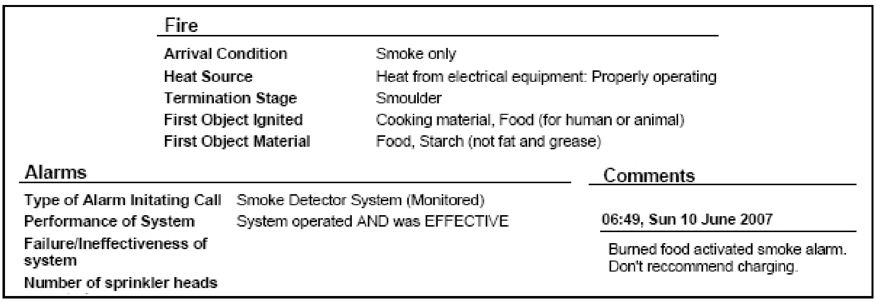
Pot of oil accidentally left on. Damage to extractor unit.
Extinguished by occupants.
Heat detector in room failed to operate. May not have been hot enough.
Have suggested to owner that she get alarm agent to check out head to make sure it is the right type for job.

Figure 3: Excerpt from Example Incident Report W705875

3.1.4 Alarm System Activations Counted as False Alarms

There are alarm activations that may have been be classed as false alarms and have not been assessed in this study as one filter criterion for the data requested from the NZFS was 'structure fire incidents', which by default excludes false alarms'. The most common example are fumes from attended and unattended cooking, which have caused smoke alarms to activate but no fire as such occurred or the fire had been confined to the cooking material. In these cases, the smoke detection system did successfully activate. However, the system did not function as designed.

As informed by NZFS staff while attending the filing of an actual incident report, the border line between classifying an incident as false alarm or not is very subjective. False alarms can incur NZFS call out charges in repeated instances, which may also play a role in classifying a call-out as genuine or false alarm. Figure 4 shows an incident report example for the incident report sections 'Fire', 'Alarm' and 'Comments', which draws attention to the fact that a burnt food incident with fire alarm activation may or may not be classed as false alarm.



Fire

Arrival Condition	Smoke only
Heat Source	Heat from electrical equipment: Properly operating
Termination Stage	Smoulder
First Object Ignited	Cooking material, Food (for human or animal)
First Object Material	Food, Starch (not fat and grease)

Alarms

Type of Alarm Initating Call	Smoke Detector System (Monitored)
Performance of System	System operated AND was EFFECTIVE
Failure/Ineffectiveness of system	
Number of sprinkler heads	

Comments

06:49, Sun 10 June 2007

Burned food activated smoke alarm. Don't reccommend charging.

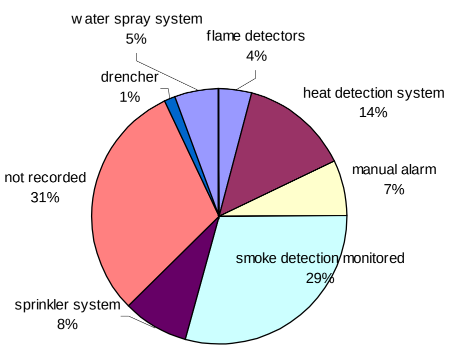
Figure 4: Incident Report Example W759249 (Community Care Premise)

3.2 Analysis of Snapshot Data

Both the PFA and non-PFA premise SMS data for structure fires in the reporting period 2000-2012 were used to count alarm activations considering different aspects.

3.2.1 **PFA Premise Structure Fire Incidents in Gisborne (2000-2012)**

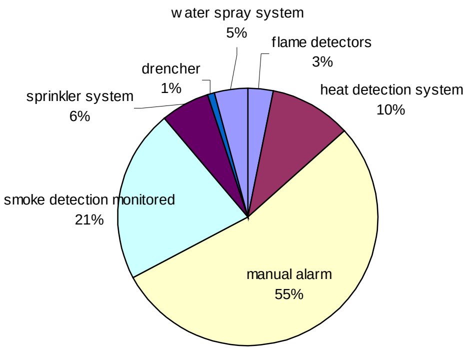
In the period analysed in this study there were 72 incidents, which are listed as PFA structure fire incidents. All of these PFA structure fire incidents were investigated. The distribution of recorded alarm systems is shown in Figure 5. The chart shows the recorded alarm type and the percentage of alarm activations from the PFA SMS database provided by the NZFS.



Type of Alarm/Detector System	**Distribution in the 72 incidents**	
	Number	%
Drencher	1	1%
Flame detector	3	4%
Heat/thermal detector	10	14%
Manual fire alarm	5	7%
Not recorded	22	31%
Smoke detector	21	29%
Sprinkler	6	8%
Water spray projection	4	6%
total	**∑72**	**100%**

Figure 5: SMS Recored Alarm Type Distribution for all PFA Structure Fire Incidents (2000-2012) in Gisborne

The actual alarm activation figures are shown in Figure 6. They were generated by counting the manual, automatic or sprinkler alarm that called the NZFS, counting additional detection systems such as flame, heat, smoke detectors, etc; and adding alarm activations where no activations were recorded in the alarm section but the incident report message log/further investigations confirm alarm activations



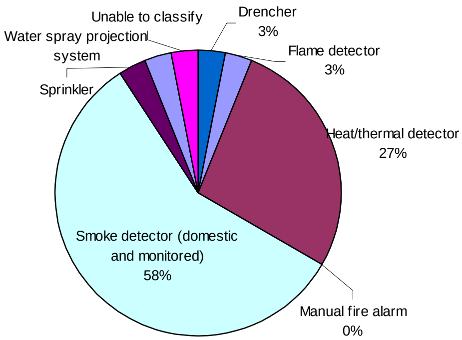
Type of Alarm/Detector System	Actual alarm activations in the 72 incidents	
	Number	%
Drencher	1	1%
Flame detector	3	3%
Heat/thermal detector	10	10%
Manual fire alarm	53	54%
Smoke detector	21	21%
Sprinkler	6	6%
Water spray projection	4	4%
total	**∑98**	**100%**

Figure 6: Actual Activated Alarm Type Distribution for all PFA Structure Fire Incidents (2000-2012) in Gisborne

3.2.2 **Non-PFA Premise Structure Fire Incidents in Gisborne (2000-2012)**

The non-PFA structure fire incident list received from the NZFS comprises 160 incidents. The incidents were filtered to separate the incidents in buildings or building complexes that had alarm systems installed at the time of the fire from those without alarm systems installed.

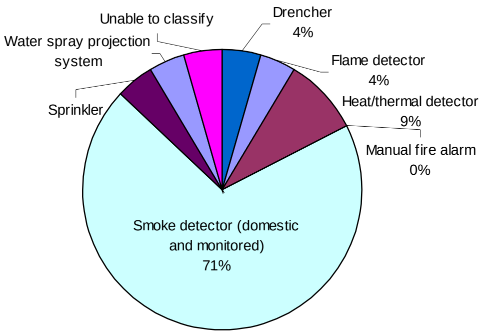
Out of 160 incidents, 52 incidents occurred in buildings or building complexes with existing alarm systems. From these 52 incidents in buildings with alarm systems, 33 incidents had alarm information recorded in the incident reports. 21 of these incidents were recorded with identified alarm/detection system that operated/activated, two of these incidents were not recorded in the SMS database but the information retrieved from the message log. For 12 of these incidents the alarm types were recorded but the detector performance groups and codes were recorded as not operating/activating for various reasons.



Type of Alarm/Detector System	SMS Database Statistic (33 entries)	
	Number	%
Drencher	1	3%
Flame detector	1	3%
Heat/thermal detector	9	27%
Manual fire alarm	0	0%
Smoke detector	19	58%
Sprinkler	1	3%
Water spray projection system	1	3%
Unable to classify	1	3%
total	**∑33**	**100%**

Figure 7: SMS Recorded Alarm Type Distribution from the Non-PFA Structure Fire Incidents List (2000-2012) in Gisborne

Figure 7 and Figure 8 show the SMS database recorded alarm/detector type distribution and the actual activated alarm/detector type distribution respectively. These figures are based on the entries of the non-PFA premises list.

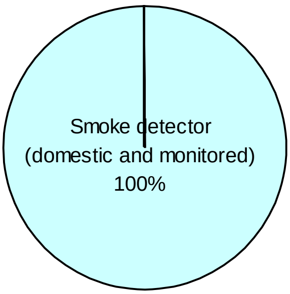


Type of Alarm/Detector System	Actual alarm activations in 23 incidents	
	Number	%
Drencher	1	4%
Flame detector	1	4%
Heat/thermal detector	2	9%
Manual fire alarm	0	0%
Smoke detector	16	70%
Sprinkler	1	4%
Water spray projection system	1	4%
Unable to classify	1	4%
total	**∑23**	**100%**

Figure 8: Actual Activated Alarm Type Distribution from the Non-PFA Structure Fire Incidents List (2000-2012) in Gisborne

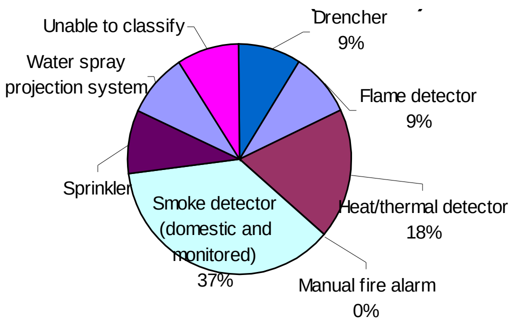
However, the above actual alarm activation figures shown in Figure 8 include incidents that were listed as non-PFA premise incidents but occurred at a PFA premise because the alarm method/how the FS was called was not via a PFA. From the 23 actual alarm activations, 11 occurred at PFA premises, leaving 12 alarm activations at non-PFA premises.

Figure 9 and Figure 10 show the actual alarm activation distribution for both the non-PFA and the PFA premises from the non-PFA premises list.



Type of Alarm/Detector System	Actual alarm activations in 23 incidents	
	Number	%
Drencher	0	0%
Flame detector	0	0%
Heat/thermal detector	0	0%
Manual fire alarm	0	0%
Smoke detector	12	100%
Sprinkler	0	0%
Water spray projection system	0	0%
Unable to classify	0	0%
total	**∑12**	**100%**

Figure 9: Actual Activated Alarm Type Distribution ONLY Non-PFA Premises from Non-PFA Structure Fire Incidents (2000-2012) in Gisborne



Type of Alarm/Detector System	Actual alarm activations in 23 incidents	
	Number	%
Drencher	1	9%
Flame detector	1	9%
Heat/thermal detector	2	18%
Manual fire alarm	0	0%
Smoke detector	4	136%
Sprinkler	1	9%
Water spray projection system	1	9%
Unable to classify	1	9%
total	**∑11**	**100%**

Figure 10: Actual Activated Alarm Type Distribution ONLY -PFA Premises from Non-PFA Structure Fire Incidents (2000-2012) in Gisborne

3.2.3 **Comparison PFA and non-PFA Callouts in Gisborne to New Zealand Wide**

The number of PFA callouts for structure fires in Gisborne may differ considerably compared to the average New Zealand wide figure due to the high number of call outs from one particular PFA premise, which contributes with 40 callouts to the total of 72 callouts. The PFA callouts in Gisborne for the period 2000-2012 is 31% based on 72 PFA callouts and 160 non-PFA callouts. The result of this balance is the high number of actual manual alarm system activations in Gisborne as shown above in Figure 6.

4 DISCUSSION

The evaluation of the SMS database information as a suitable source to systematically analyse successful active fire protection systems has found that the database is potentially very useful. It provides a complete list of all fire incidents the New Zealand Fire Service has attended and therefore provides the basis for a list of premises that potentially had successful active fire protection activations. The incident reports also mostly provide other useful information such as people involved, message logs and comments, which can be helpful when following up on individual incidents. However, there are issues associated with the database that require processing and screening of the output information to a certain extent before it can be systematically analysed. A significant issue is to filter the alarm type data to exclude incidents where the alarm/detection systems did not actually activate for various reasons.

The evaluation of manual PFA premises has shown that only in very few cases the manual call point activation that summoned the NZFS was recorded as successful alarm activation. In order to obtain the actual detection and alarm activation figures for those structure fire incidents, additional assessment steps are required and manual alarm activation and eventual detection system activation must be considered in addition to the data provided by the SMS figures. In the Gisborne PFA premises analysis, the successful manual alarm activations increases from 7% to 55 % once the manual callpoint activations that were used to call the NZSF are added to the successful activations.

No manual alarm systems are recorded as activated in the non-PFA premises. This may be because manual call points are activated to alert occupants of an emergency but not recorded by the NZFS incident reporter or they may in fact not be used. Further investigations are required to clarify this issue. The information to investigate this point further cannot be found in the SMS database information and most likely requires detailed follow-ups of structure fire incidents at premises that have manual call points installed that are not connected to the NZFS.

The predominant successful alarm and detection systems are smoke detector systems in those premises that are not connected to the NZFS. Due to the small sample size, the smoke detector category has not been separated into domestic smoke detectors, automatic smoke detection system or smoke detectors monitored by a security or monitoring firm. The SMS data show 58% smoke detection and 27% heat/thermal detection. After considering the SMS alarm performance group and performance code information and eliminating the alarms that did not actually activate, smoke detection increased to 71% and heat detection decreased to 9%. This confirms that the heat detection systems were less likely to activate than the smoke detection systems.

A further elimination of the structure fire incidents that occurred in PFA premises but were not recorded as such because the method by which the NZFS was called was not via the PFA showed that the activated systems were 100% smoke detection systems. In particular for the Gisborne sample the results show that all successful activations of systems other that smoke detection systems occurred at PFA premises.

In general, the Gisborne structure fire sample consisted of 31% PFA premises, of which one single premise accounted for 57% of the successful alarm/detection activations. This is not including the activations of that particular premise that are counted as non-PFA structure fire, which will show an even influence on the overall activation figures based on the single premise.

For the reason of the overrepresentation of activations from one single premise with large activation numbers and a due to a generally small sample size, the Gisborne sample is not considered to be representative for New Zealand. However, the results of the detailed investigation of this sample, that trends are visible and issues with the available data from the SMS database have been identified.

5 CONCLUSION

The detailed study of the available data for a snapshot area has shown that the alarm/detector type figures from the SMS database is the best source of information for NZ wide investigations on successful active fire protection activations. However, the data must be used carefully. In order to use the available information to conduct a systematic analysis for successful active fire protection systems in New Zealand, the information must be prepared in similar ways to the analysis carried out in this study. Issues with the SMS database content lies not so much with the data entry by incident reporters, but rather with the design of the database in regard to alarm system information.

The trend that has emerged from this study is that manual fire alarms play a small role in the premises that are not connected to the NZFS and that various forms of smoke detection are the predominant form of fire detection and alarm system activation.

It would be interesting to find out if the trend shown in the Gisborne sample holds true for the NZ wide successful active fire protection systems.

REFERENCES

[1] K. Frank, M. Spearpoint, N. Challands, *Uncertainty in Estimating the Fire Control Effectiveness of Sprinklers from New Zealand Incident Reports*, Fire Technology manuscript No. ?, date? Unpublished (Handout 13 from Fire Safety Systems seminar on 09 May 2012

[2] R. W. Bukowski, E. K. Budnik, *Estimates of the Operational Reliability of Fire protection Systems*, MST Building and Fire Research Laboratort, Gaithersburg, MD 20899-8642 USA, undated

[3] New Zealand Fire Service, *The New Zealand Fire Service Emergency Incident Statistics 2009-2010, 2010*, Wellington, New Zealand, ISSN 1171-638X