

Technical Standard [TS03/14]

# Tsunami Warning Sirens



## **Tsunami Warning Sirens** Technical standard [03/14]

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## Foreword

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The use of sirens for emergency management purposes is a long-established and widespread practice in New Zealand. The ad hoc growth of siren systems across the country has led to significant variances between systems, including the signals used, the meaning of sirens, and the support programmes around their use.

Also, it is important to recognise that sirens are only one component within a wider warning system, and sirens have a number of disadvantages. Many CDEM Groups and territorial authorities already recognise the need to provide extensive public education and awareness programmes alongside the use of sirens, and that these activities can be resource and time intensive. In this context, the absence of continued and prominent public education about sirens will lead to community complacency and subsequent inefficient response to natural warning signs of an impending local source tsunami.



I am pleased to offer this standard as a means of achieving national consistency when sirens are chosen as a public alerting option for tsunami warnings. The standard aims to achieve consistency in siren signals, the meaning of sirens, and in general requirements for their operation. The standard is grounded in widespread consultation with CDEM Groups and territorial authorities, international best practice, independent acoustic testing and the latest research on the use of sirens. While a number of aspects related to the use of sirens are standardised, some aspects remain matters for local decision and advice is also offered in this regard.

It is my hope that this standard leads to consistency in the use of sirens in tsunami warnings across New Zealand, greater public awareness of warnings, and helps to increase the resilience of our communities.

A handwritten signature in black ink, appearing to read 'John Hamilton', with a stylized flourish at the end.

**John Hamilton**  
Director of Civil Defence Emergency Management



# Contents

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<b>Section 1 Introduction.....</b>	<b>1</b>
<b>Section 2 Principles .....</b>	<b>2</b>
<b>Section 3 Siren signal and meaning .....</b>	<b>3</b>
3.1 Siren signal .....	3
3.2 Meaning of sirens .....	4
<b>Section 4 Requirements for using tsunami warning sirens .....</b>	<b>5</b>
4.1 Public education and awareness.....	5
4.2 Tsunami response planning.....	6
4.3 Use of sirens must be hazard and risk based .....	7
4.4 Maintenance and testing of sirens.....	8
4.5 Audibility, installation and review .....	9
<b>Section 5 Important considerations .....</b>	<b>11</b>
<b>Section 6 References .....</b>	<b>14</b>

# Section 1 Introduction

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## Purpose and audience

The **purpose** of this technical standard is to:

- provide for national consistency in the use of sirens for tsunami warnings, and to
- provide guidance on considerations in relation to the use of sirens for tsunami warnings.

The **intended audience** of this technical standard is CDEM Groups and territorial authorities.

## Structure

This technical standard has the following sections:

- Section 1 Introduction (page 1)
- Section 2 Principles (page 2)
- Section 3 Siren signal and meaning (page 3)
- Section 4 Requirements for using tsunami warning sirens (page 5)
- Section 5 Important considerations (page 11), and
- Section 6 References (page 14).

## Application

This standard should be applied by CDEM Groups and territorial authorities for all new siren installations from the date the standard is published.

The signals of existing sirens used for tsunami warnings at the time of publication of this standard should conform to this standard by 30 June 2020; all other aspects of this standard should be applied to existing sirens used for tsunami warnings from the date the standard is published.

## Section 2 Principles

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The following principles emerged as a part of consultation, and provide fundamental guidance to the use of sirens in tsunami warnings:

1. The term 'sirens' refers to a public alerting option only. The ability to detect earthquakes and tsunamis, interpret that data, and trigger public alerting options (e.g. sirens) is a separate concept that should not be confused with activating siren hardware.
2. The use of sirens is a subset of CDEM Group/territorial authority warning systems, and is one public alerting option among many.
3. The use of sirens should be attuned with the national warning system and MCDEM tsunami guidance.
4. The use of sirens must be risk based – that is, based on an understanding of CDEM Group/territorial authority tsunami hazards and risks.
5. Tsunami warning systems will employ the use of multiple alerting channels – one of which may be sirens.
6. Responsibility for activating sirens and the basis for activation must be clarified within CDEM Groups.
7. The use of sirens must be linked to continuous public education programmes and evacuation planning activities.
8. There should be national consistency in the signal and meaning of sirens.
9. Sirens should be used as an all-hazards alerting mechanism, and not only for tsunami warnings.
10. Sirens may be used for distant source tsunami events, and where possible, for regional source tsunami events, depending upon the policies of the CDEM Group and/or territorial authority. Activation of sirens must not be expected for local source tsunami events – the strong earthquake is the only reliable warning.
11. Communities should be involved in awareness raising, testing, and decisions on expanding or de-commissioning siren systems, where possible. Testing must be done on a regular basis.
12. A realistic and achievable programme and budget must be developed for ongoing maintenance and operations.
13. Ongoing consideration of public alerting options by CDEM Groups is recommended – for both reach and cost effectiveness purposes.
14. Ideally, sirens should be public address (PA) capable to allow for direct, event-related messaging to be given.

The use of sirens in tsunami warnings should not be inconsistent with the above principles.

## Section 3 Siren signal and meaning

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### 3.1 Siren signal

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#### Objective

To achieve consistent siren signals for tsunami warning in New Zealand.

#### Policy

The standard siren signal for tsunami warnings is a multiple tone signal that rises repeatedly with time.

*(Note: This signal can only be achieved with electronic sirens. The signal is different to the signals used by emergency services.)*

The standard signal should be used on all fixed signal-only sirens, and prior to public address messages on both fixed and vehicle-mounted public address-capable sirens. Helicopter public address systems may be used with or without the standard signal.

The following policies apply for all sirens (except helicopter public address systems):

- the duration of signals should be at least 10 minutes, and signals may be repeated as required
- the rise and fall signal shall not be used for tsunami warnings, and
- a variance of signals (to indicate different meanings) shall not be used for tsunami warnings.

#### Rationale

Research from the University of Canterbury Acoustics Research Group indicates that a multiple tone signal that rises with time is an effective signal that is fully compliant with international standards.

The large majority of sirens used for tsunami warnings are electronic, and the trend towards the use of electronic sirens in the near future is clear. Electronic sirens are capable of producing the standard siren signal and have advantages over mechanical sirens due to the ability to change signals and to integrate public address messages.

## 3.2 Meaning of sirens

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**Objective** To achieve consistency in the meaning of sirens used for tsunami warnings across New Zealand.

**Policy** The meaning of signal-only sirens used in tsunami warnings is **“seek further information”**. CDEM Groups/territorial authorities must ensure sufficient arrangements exist to be able to provide the “further” information at the local level when sirens have been activated.

Public address (PA) capable sirens will start with the standard signal followed by simple and clear threat information and instructions, with the instructions varying according to the potential threat. A recorded or live message to “seek further information” could be utilised in uncertain situations, but the use of this must not preclude the provision of live or pre-recorded action (e.g. evacuation) messaging.

**Rationale** There is broad agreement across the CDEM sector that “seek further information” is the preferred approach for signal-only sirens. Ascribing a meaning of “evacuate” to signal-only sirens is problematic because by default, this confines the use of signal-only sirens to one hazard only. A meaning of “evacuate” also makes the management of false alarms problematic, as false alarms can create unnecessary anxiety and undermine the public perception of the usefulness of sirens. Management of false alarms with a meaning of “seek further information” for signal-only sirens is far easier, because messaging around the false alarm can be rapidly communicated to the public.

PA capable sirens allow for action information to be provided to at-risk communities, and therefore should utilise the best practice approach of providing the “heads up” and “information” required at the earliest opportunity by including specific information on evacuation, if appropriate.

Consultation and research also suggests that:

- communities find variable (different) signals difficult to understand, especially at times of increased stress such as at the time of warnings, and
- the level of awareness of the meaning of warning signals is variable across New Zealand, and where the level is high, it is associated with extensive ongoing public education programmes.

## Section 4 Requirements for using tsunami warning sirens

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### 4.1 Public education and awareness

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**Objective** To outline the requirements for public education and awareness activities related to the use of sirens in tsunami warnings.

**Policy** Targeted and continuous public education and awareness activities must be undertaken alongside the use of sirens. Public education and awareness related to the use of sirens in tsunami warnings must:

- promote the importance of the recognition of natural warning signs as the core message in relation to local-source tsunami. Sirens should not be expected to be used in these and some regional source events. The consistent message in New Zealand is:

*A tsunami generated by a nearby large earthquake or undersea landslide may not provide sufficient time for an official warning.*

*People in coastal areas who:*

- *experience strong earthquakes (hard to stand up);*
- *experience weak earthquakes lasting for a minute or more;*
- *observe strange sea behaviour such as the sea level suddenly rising and falling, or hear the sea making loud and unusual noises or roaring like a jet engine;*

*should not wait for an official warning. Instead, let the natural signs be the warning. They must take immediate action to evacuate from predetermined evacuation zones, or in the absence of predetermined evacuation zones, go to high ground or go inland.”*

- promote information on:
  - the signal and meaning of sirens
  - public misperceptions about sirens
  - what areas are covered by sirens
  - the limitations of sirens as warning devices, and not to rely on them
  - the importance of taking individual responsibility
- be ongoing programmes
- target visitors to the area as a priority
- have strong links to community response planning, evacuation planning and testing programmes (including the evaluation of effectiveness and the inclusion of culturally and linguistic diverse communities and people with disabilities in planning), and
- include regular ongoing exercises, which are recognised as an effective educational tool as well as being needed for evaluation.

Public education and awareness activities may be aligned with the programmes of other stakeholders - especially emergency services – in order to increase effectiveness.

## Rationale

Public education and awareness is unanimously recognised across the CDEM sector as being the critical component of the effective use of sirens for tsunami warnings. There is evidence pointing towards greater levels of public awareness in areas where targeted ongoing programmes are undertaken.

## 4.2 Tsunami response planning

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### Objective

To ensure that the use of sirens is integrated into tsunami response planning in areas where sirens are used or will be used for tsunami warning.

### Policy

CDEM operational response planning for the use of sirens in tsunami hazard response need to include the following siren activation arrangements:

- carrying out a local threat assessment based on probable area and time of impact, hazard and evacuation zone mapping, available inundation modelling, and local science interpretation and advice
- a decision point on whether sirens will be activated – including responsibility for making the decision to activate
- siren activation and stand-down procedures (personnel and systems). Key considerations include:
  - simple activation systems with redundancy in both personnel and systems
  - preparation and distribution of public information messaging in advance of siren activation
  - notification of key response partners such as emergency services, coastguard, surf lifesaving clubs and harbourmasters
- false activation response and management.

It is important to note that activation procedures need to be developed in advance, drawing on:

- tsunami hazard and inundation mapping and modelling
- evacuation zone mapping and pre-event determination of the most likely events, and
- trigger points for activation.

Clarification of activation procedures needs to drive public education before events and public information management during events.

Other important considerations for siren use in response planning include:

- recognising the value of community response planning in terms of sustainable community response management
- integration of evacuation planning and mapping, community response planning and siren use
- involvement of key stakeholders in planning
- understanding the limitations of sirens, and contingency response arrangements

- ensuring there are strong links between:
  - response planning
  - public education programmes,
  - tsunami hazard and risk information, and
  - siren testing and response exercise programmes.

## Rationale

The importance of coordinated and integrated response planning in relation to the use of sirens is widely recognised. This is especially important where sirens are used for tsunami warnings.

## 4.3 Use of sirens must be hazard and risk based

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### Objective

To ensure that the decision to use sirens is hazard and risk-based.

### Policy

The decision to use of sirens for tsunami warning should be hazard<sup>1</sup> and risk<sup>2</sup> based. Therefore the following elements need to be clarified as a part of decision making on whether or not to use or continue to use sirens:

- the purpose of sirens, and the hazards and risks they will be used for
- the nature of tsunami hazards from local, regional and distant source events, including:
  - travel time - sirens cannot be expected to be activated for local sources and only possibly for regional sources
  - likely extent of inundation (especially land threat)
  - risk relative to other hazards
  - frequency
- the nature of communities at risk:
  - total population
  - population density
  - peak population
  - the social profile of communities – residents, transients, immobility, hearing impaired
  - low-lying coastal areas at risk
  - the absence of evacuation routes and/or road congestion issues for evacuation, and
  - future growth of the population at risk.

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1 Tsunami hazard is the threat of a tsunami event occurring over a given timeframe that will have a negative effect on people, infrastructure and the environment.

2 Tsunami risk not only represents the possibility that a tsunami hazard could occur, but also its likelihood and consequences on people, infrastructure and the environment

## Rationale

Careful consideration of tsunami hazards and risks will help to build confidence in the decision to install sirens, and for continuing their use. In addition, it can be used to support community awareness and understanding of why and how sirens are being used.

There is a perception that in some instances the installation of sirens has been a political response to community pressure – often without a robust assessment of the hazards and risks.

## 4.4 Maintenance and testing of sirens

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### Objective

To provide the requirements for regular maintenance and testing of sirens.

### Policy

CDEM Groups and territorial authorities need to provide a separate and realistic budget for the maintenance of siren systems on an ongoing basis.

While the maintenance requirements for sirens depends upon the age and type of system used, a scheduled preventative maintenance programme covering the following needs to be put in place:

- visual inspections of siren control enclosure, components and connections
- visual inspections of the mountings, alignment, electrical connections and horns (if present)
- cleaning, tightening and/or replacement of components as required
- silent component testing, and
- any other manufacturer's specifications.

The above requirements need to be completed for all sirens within the network at least annually.

Sirens need to be tested on a regular basis as follows:

- the minimum number of publicly notified tests is two per year
- sirens will be publicly tested on or around the change to and from daylight savings each year
- testing may be on a more frequent basis according to the nature of the system and local community requirements
- normally, testing will aim to confirm that the siren is working, is making the right sound, and is loud enough for people to hear in the intended coverage area, and
- integration with response exercises, ideally with communities testing evacuation plans, will further enhance the effectiveness of those plans and be an effective education tool.

It is recommended that CDEM Groups and territorial authorities seek community feedback following siren testing to help determine the effectiveness of the test in terms of audibility, awareness and understanding of the meaning of sirens. Testing may also provide opportunities to gather general information on community resilience.

**Rationale**

Regular ongoing maintenance ensures that both the CDEM sector and communities have confidence in the ability of siren systems to operate for tsunami hazards. The amount of maintenance work required and corresponding costs for siren systems are often greater than anticipated at the time of installation.

Regular testing not only provides confidence in the operability of sirens, but also provides an opportunity for CDEM Groups and territorial authorities to improve public awareness and understanding of systems, and tsunami hazards and risks.

**4.5 Audibility, installation and review**

**Objective**

To provide best practice guidance on the audibility, installation and review of siren systems.

**Policy**

The following standards/guidance should be used to guide the audibility, installation and review aspects of the management of siren systems:

Table 1 Relevant standards

Standard	Description
ISO 7731:2003: Ergonomics – Danger signals for public and work areas – Auditory danger signals.	Specifies the physical principles of design, ergonomic requirements and the corresponding test methods for danger signals for public and work areas in the signal reception area and gives guidelines for the design of the signals.
ISO 9921:2003: Ergonomics – Assessment of speech communication.	Specifies the requirements for the performance of speech communication for verbal alert and danger signals, information messages, and speech communication in general.
ISO 11429:1996: Ergonomics – System of auditory and visual danger and information signals.	Specifies a system of danger and information signals taking into account the different degrees of urgency.
Federal Emergency Management Agency Outdoor Warning Systems Technical Bulletin (2006)	Provides guidance on: <ul style="list-style-type: none"> <li>• principles of sound</li> <li>• fundamentals of outdoor warning systems</li> <li>• planning and design considerations – including layout, siting and audibility/range determination</li> <li>• testing and maintenance.</li> </ul>

The above standards/guidance also cover two important management aspects related to mobile PA systems – recognisability of signal characteristics regardless of movement, and specific guidance for verbal communication.

The University of Canterbury Acoustics Research Group report *An evaluation of the Signals used for Tsunami Warnings in New Zealand*<sup>3</sup> provides a

<sup>3</sup> The report is published on the MCDEM website together with this standard.

detailed explanation of the audibility, installation and review aspects of siren systems. It also covers many other aspects such as spectral and temporal characteristics of signals, perceived loudness, unambiguity, conveyance of urgency, frequency composition and duration. All these considerations are built into the recommended signal, and the recommended duration exceeds all ISO recommendations.

## **Rationale**

In order for sirens to be effective, they need to be audible. Factors such as the audibility of the signal above background noise and changes in the signal level over time are important considerations for effective audibility.

The siting and installation of sirens plays an important role in their audibility and effectiveness, and it is important to consider ambient noise levels, terrain conditions and local climate influences when determining suitable locations for sirens.

Regular reviews of siren systems are required to ensure that changes in background noise levels and other environmental changes are allowed for through time.

## Section 5 Important considerations

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While TAs and CDEM Groups should meet the standards outlined in the previous sections, there are a number of other important considerations that they need to make in relation to the use of sirens for tsunami warnings. These considerations, described below, are at the discretion of the CDEM Group and/or territorial authority, noting that a **consistent** approach to the considerations within a CDEM Group is recommended.

### The Ministry of Civil Defence & Emergency Management position

The MCDEM position on the use of fixed sirens for tsunami warning – as recommended by the Tsunami Working Group – is as follows:

- Sirens (signal-only or PA capable) are not regarded as effective or reliable alerting mechanisms in local source tsunami events (<1 hour travel time). There are numerous examples in such events where sirens could not be triggered in time given the short travel time of the tsunami to the coast. The time it takes to conduct threat assessment and issue official warnings (which in turn would lead to activation of sirens) will very likely be longer than the time it will take for a local source tsunami to reach the coast. It has also been shown that the existence of fixed sirens can create a false sense of comfort with the public in that they expect to be warned by the siren (rather than making a decision to respond to the earthquake itself). In other cases they have contributed to delayed responses among the public due to frequent false alarms. The earthquake damage itself can also have a limiting effect on sirens making them inoperable, while there are also issues with regards to the effectiveness of the sirens through audibility (factors such as wind direction, indoor/outdoor, clarity). All these concerns with regards to sirens were evident in the Japan tsunami of March 2011.
- While sirens can be effective for warnings during regional (1-3 hours travel time) or distant (>3 hours) source events, those events are normally of a lesser threat and the time available to alert the public implies that several other communications means can (and should) be used.
- In view of the above, the use of fixed coastal sirens for tsunami warning is not advised. Where utilised, their appropriate role is as a generic alerting mechanism (alerting the public that something is happening or has happened and that they should listen to the radio to establish what to do). However, as a generic alerting mechanism PA capable sirens have been shown internationally to contribute to more effective response than signal-only sirens.
- The best and most reliable warning system for local source tsunami in New Zealand is the natural warning itself. This is consistent with the official message used for public education in New Zealand (see the message in Section 4.1) and is also internationally accepted as best practice. The focus should be on that message and care should be taken not to create distractions from it.

### Whether to use sirens for tsunami warnings

The following considerations may assist in the decision-making process to use sirens:

- assessment of hazards and risks (see Section 4.3)
- available public alerting options in light of the hazards and risks – including emerging warning technologies (the MCDEM Public Alerting Options Assessment Tool may prove helpful for this process)
- the true costs involved in installing sirens in terms of tangible financial costs such as capital, maintenance and public education/awareness requirements, and intangible costs such as the setting of public expectations around when sirens will be used, and the management of public expectations
- advice from other CDEM Groups/territorial authorities that have similar tsunami hazards and risks, in order to define level of effort involved, and realistic costs and benefits, and
- tsunami hazards and risks – particularly the travel time of tsunami events<sup>4</sup>.

### Coverage, specific design requirements and providers

Coverage refers to the specific communities and areas to be covered by the use of sirens, and the decision-making processes around this. Coverage areas can be influenced by a range of local factors including the nature of the community at risk, environmental factors, cost/benefit, community demand and the willingness of the community to fund siren systems<sup>5</sup>.

Once the coverage areas are confirmed, the preferred approach is to determine specific audibility requirements for covering each community (this may involve advice from an independent acoustics professional). Once the specific audibility requirements are complete, providers may be approached to provide quotes on achieving the desired coverage<sup>6</sup>. There is no “approved provider” of siren systems for use in tsunami warnings in New Zealand.

### What type of sirens to use

There is no “one-size fits all” for the types<sup>7</sup> of sirens to be used in any community, CDEM Group or territorial authority, as each area is unique. Key considerations for TAs and CDEM Groups when considering the types of sirens to use include:

- reliability of the local power supply and telecommunications networks
- availability of alternative systems
- how sirens will be activated
- audibility factors
- useful operating life
- ability of the local community and/or CDEM Groups/territorial authorities to fund sirens
- durability relevant to the local environment (especially salt spray and wind)
- PA capability; pre-recorded vs. live messaging, and
- whether sirens meet the requirements or recommendations within this standard.

<sup>4</sup> Information for the CDEM Sector [IS10/09] and related decision support tool, MCDEM (and any future update)

<sup>5</sup> Refer also to section 4.3 on hazards and risks.

<sup>6</sup> Note that the hazard and risk requirements in section 4.3 should be followed as a closely related part of coverage decisions.

<sup>7</sup> Such as fixed, mobile, PA capable etc.

**TA consent requirements**

Prior to system design and installation, District Plan rules should be checked to determine any potential constraints on siren placement or operation - including environmental noise requirements. CDEM Groups/territorial authorities will need to work within District Plan requirements, or may consider the need for a variation to the Plan in some circumstances.

**Funding mechanisms**

Agreement on appropriate funding mechanisms for siren installation and maintenance is highly desirable prior to installation, and it is recommended that CDEM Groups/territorial authorities seek to confirm these arrangements in advance.

## Section 6      References

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