BRITISH COLUMBIA TSUNAMI WARNING METHODS

"A Toolkit for Community Planning"

Peter S. Anderson
Telematics Research Lab
Simon Fraser University
Burnaby, B.C.
Canada

July 2006

TABLE OF CONTENTS

SECTION FOUR: Appendices

EXECUTIVE SUMMARY

The Emergency Program Act of British Columbia requires all local authorities (Municipalities and Regional Districts), to develop emergency plans for their jurisdiction. The Local Authority Emergency Management Regulation within the Act, requires that those local authority emergency plans, *"establish procedures by which those persons who may be harmed or suffer loss are notified of an emergency or impending disaster."* There is not one right solution or strategy for emergency notification that works in all communities equally. The unique features of each community require unique solutions.

The purpose of this toolkit is to provide British Columbia local authorities and communities with information that will allow them to evaluate the many options available to provide notification and warning to the public of a potential or impending Tsunami wave. In general, notification options fall into 2 categories:

A Mass Notification Methods
-common alerting to an area, such as sirens

B Addressable Notification Methods
-targeted alerting such as pagers

While this toolkit was developed specifically with tsunami hazards in mind, it may also be applicable to many other hazards that could impact communities.

Large tsunami waves are incredibly powerful and destructive. Early warning and notification are key to the successes in preventing injury and loss of life. The tsunami event in South Asia in December 2004, created a new awareness worldwide of the potential of tsunami waves. It also led to significant discussion about the need to warn those people who may be at risk from future events.

British Columbia has had a Tsunami Warning System in place for a number of years. Tsunami warnings for Coastal British Columbia are initiated by the West Coast Alaska Tsunami Warning Centre (WCATWC). The B.C. Provincial Emergency Program, upon receipt of a Tsunami warning from WCATWC, notifies local authorities, coastal communities, the media and stakeholders by a combination of warning methods, including telephone, fax, and Internet. Local authorities are then required to implement their warning and alerting plans to advise the public at risk.

This "Toolkit" provides descriptions of notification methods and options, brief discussions of their advantages and disadvantages relative to other methods, implementation considerations and costs. The type of method(s) of notification that each community uses, will be shaped by several factors, including: the physical location and nature of the population (e.g. residents vs. non-residents), time of day, budget, geographic location, available supporting infrastructure, local customs, economic and social activities, etc. To achieve effective warning there should be complete and timely coverage, redundancy, and seamless meshing of new and existing systems.

Regardless of the warning and alerting method(s), it is critical that there be consistency in its application and message, widespread and current public knowledge of the potential local area risks as well as continuous education about the alerts. No matter how expensive or sophisticated, a warning system can never be totally effective without education. Whatever methods are chosen, all groups that are part of the notification process should be involved in the planning, implementation and operation of their systems.

It is important to recognize that a warning is the trigger for all of the subsequent activities that will occur during the emergency period, including response, rescue, relief and recovery. The warning portion (initial alert to the all-clear) may be relatively short or could go on for a prolonged period depending upon the nature of the hazard incident. Investing wisely in flexible, robust, redundant, multi-purpose communication system can yield dividends for all emergency needs.

PREFACE AND ACKNOWLEDGEMENTS

This tool kit was prepared by the Simon Fraser University Telematics Research Lab for the Tsunami Integrated Preparedness Project (TIP) under a contract awarded by the province of British Columbia.

This document is the result of the efforts of many individuals representing several organizations. Special thanks to the following for their review, comments, and contributions:

Irene Ferris, Alberni-Clayoquot Regional District
Chris Duncan, Alberni Communications and Engineering Ltd.
Ian Procyk, BCWARN Amateur Radio Project
Mike Andrews, British Columbia Provincial Emergency Program
Cam Filmer, British Columbia Provincial Emergency Program
Nicola Holdsworth, British Columbia Provincial Emergency Program
Kelli McReynolds, British Columbia Provincial Emergency Program
James Whyte, British Columbia Provincial Emergency Program
Del Mecham, Provincial Highway Conditions Centre, British Columbia Ministry of Transport
Peter Wypkema, Canada Post
David Snider, Canadian Coast Guard
LCdr Al Harrigan, Canadian Forces, Department of National Defence
Rob Johns, City of Victoria
Ross Peterson
Anne McCarthy, Environment Canada
Dan Murphy, First Nations' Emergency Services Society
Fred Stephenson, Canadian Hydrographic Service, Fisheries & Oceans Canada
Dave Burgess, Fraser Health Authority
Ian MacLeod, Indian and Northern Affairs Canada
Ken McDonald, Indian and Northern Affairs Canada
Nigel Bell, Industry Canada
Chuck Lok, Mount Waddington Regional District
Al Muir, Muir Communications Ltd
Garry Rogers, Pacific Geoscience Centre, Natural Resources Canada
Cathie Hickson, Natural Resources Canada
Barry Phillips, Public Safety and Emergency Preparedness Canada
Tim Rurak, Ralph's Radio Ltd.
Dennis Erickson, RCMP E Division, Vancouver
Elizabeth Zook, School of Communication, Simon Fraser University
Robert Scholander, School of Communication, Simon Fraser University
Stephen Braham, Telematics Research Lab, School of Communication, Simon Fraser University
Fred Carey, Telus Mobility
Rick Wilschek, Telus Mobility

Ron Robbins, Wantok Enterprises Ltd.
Ted Buehner, U.S. National Weather Service - Seattle/Tacoma
Paul Whitmore, U.S. National Oceanic and Atmospheric Administration
Tyree Wilde, U.S. National Oceanic and Atmospheric Administration
Dave Squires, City of Steward, Alaska
David Gibbs, Kenai Peninsula Borough, Alaska
Lieutenant Ellis, City of Kodiak, Alaska
David Hawker, Lincoln City, Oregon
Delane Engelstad, Lincoln City, Oregon
Joanne Dickinson, Rockaway Beach, Oregon
Alan Winogradov, Delnorte County, Oregon
Cleve Rooper, Cannon Beach, Oregon
Perry Sherbaugh, Manzanita/Nehalem/Wheeler, Oregon
Stephanie Fritts, Pacific County, Washington
Terry Jeggle, United Nations International Strategy for Disaster Reduction

Peter Anderson
Associate Professor
Director, Telematics Research Lab
School of Communication
Simon Fraser University
March 30, 2006

LIST OF ACRONYMS

AOR	Area of Responsibility
ARES	Amateur Radio Emergency Service (Radio Amateurs of Canada)
BCAA	British Columbia Automobile Association
BCPEP	British Columbia Provincial Emergency Program
BCWARN	British Columbia Wireless Amateur Radio Network
C-ADDESS	Central Automatic Data Editing and Switching System
CANALERT	Canada-wide Public Alerting System
CAP	Common Alerting Protocol
CB	Citizen's Band Radio
CDEM	Ministry of Civil Defence and Emergency Management (New Zealand)
CEMCN	Central Emergency Management Communication Network
CHS	Canadian Hydrographic Service
C.L.C.	Canadian Location Codes
CMBS	Continuous Marine Broadcast Service
CRTC	Canadian Radio-Television and Telecommunications Commission
CVTS	Coordinated Vessel Traffic Services
DCS	Digital Calling Service
DMAC	Deputy Municipal Amateur Radio Coordinator
DSC	Digital Selective Calling
DTMF	Dual Tone Multi-Frequency
EAS	Emergency Alert System (US)
EC	Environment Canada
EDGE	Enhanced Data Rates for Global Evolution
EOA	Emergency Office of Arica (Chile)
EOC	Emergency Operations Centre
EPWS	Alberta Emergency Public Warning System
ERP	Effective Radiated Power
EV-DO	Evolution-Data Optimized
FCC	Federal Communications Commission (US)
FIPS	Federation Information Processing Standards (US)
FRS	Family Radio Service
FSA	Forward Sortation Area
FTP	File Transfer Protocol
GEO	Geostationary Orbit
GIS	Geographic Information Systems
GMDSS	Global Maritime Distress and Safety System
GMRS	General Mobile Radio Service
GPRS	General Packet Radio Service
GPS	Global Positioning Satellite
GRS	General Radio Service
HF	High Frequency
HSe	High Speed Enterprise Service

ICG/PTWS	Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System
IOC	International Oceanographic Commission
IP	Internet Protocol
IRLP	Internet Radio Linking Project
INAC	Ministry of Indian and Northern Affairs (Canada)
ISP	Internet Service Provider
IVR	Interactive Voice Recognition
JMA	Japanese Meteorological Agency
JRCC	Joint Rescue Co-ordination Centre
L-ADESS	Local Automatic Data Editing and Switching System
LAN	Local Area Network
LAP	Local Area Paging
LCW	Letter Carrier Walk
LED	Light Emitting Diode
LEO	Low Earth Orbit Satellite
LOS	Line-of-Sight
MAC	Municipal Amateur Radio Coordinator
MARPAC	Canadian Forces Maritime Forces Pacific Operations Centre
MCTS	Marine Communications and Traffic Services (Canadian Coast Guard)
MECC	Municipal Emergency Communication Coordinator
MMSI	Maritime Mobile Service Identity
MSA	Mobile Service Areas
MSAT	Mobile Satellite System
MSC	Meteorological Service of Canada
MSV	Mobile Satellite Ventures
NAT	Network Address Translation
NAVCAN	Navigation Canada
NAWAS	National Warning System (US)
NOAA	National Oceanic and Atmospheric Association (US)
NTS	National Traffic System
NWS	National Weather Service (US)
NWWS	NOAA Weather Wire System (US)
PBX	Private Branch Exchange
PCS	Personal Communications Service
PDA	Personal Digital Assistant
PEP	Provincial Emergency Program
PECC	Provincial Emergency Coordinator Centre
PERAC	Provincial Emergency Radio Advisory Committee
PERCS	Provincial Emergency Radio Communications Service
PGC	Pacific Geoscience Centre
PSEPC	Public Safety and Emergency Preparedness Canada
PSTN	Public Switched Telephone Network
PTWC	Pacific Tsunami Warning Centre
PWLN	Permanent Water Level Network
QoS	Quality of Service

RARR	Regional Amateur Radio Representative
RMIC	Regional Marine Information Centre
ROC	Restricted Operator’s Certificate (radio)
RSS	Real Simple Syndication
S.A.M.E.	Specific Area Message Encoding
SAWS	Simultaneous Announcement Wireless System
SIP	Session Initiation Protocol
SMS	Short Message Service
TIB	Tsunami Information Bulletin
TTY/TDD	Text Telephone/Telecommunications Device for the Deaf
UDP	User Datagram Protocol
UPS	Uninterrupted Power Supply
UHF	Ultra High Frequency
VECTOR	Vancouver Emergency Community Telecommunications Organization
VHF	Very High Frequency
VLPTV	Very Low Power Television
VLPFM	Very Low Power Frequency
VoIP	Voice-over-Internet-Protocol
WAN	Wide Area Network
WAP	Wide Area Paging
WC/ATWC	West Coast/Alaska Tsunami Warning Centre
WP	Warning Point

INTRODUCTION

Tsunamis are among the most destructive forces in nature and can cause much loss of life, injury, and property damage. The term "tsunami", pronounced, "soo-nah-mee", is a Japanese word that embodies two characters: "tsu" and "nami". The character "tsu" means harbour, and the character "nami" denotes wave. Tsunamis are a series of unusually big waves formed by a large-scale disturbance of the surface of a water body. One of the primary causes of tsunamis are earthquakes, but tsunamis can also be caused by near-shore and underwater landslides, near-shore and underwater volcanoes, human-induced explosions on or underwater, and even by space objects impacting water bodies.

In deep, open-ocean water, these waves are often less than a metre high and can travel at speeds up to 1,000 kilometres per hour. However, as they reach shallow water and approach shorelines the leading edge of the waves begin to slow down, and the wave begins to "pile up" behind causing the wave to grow in height. The crests of these waves can be many metres high by the time they reach the shoreline. Sometimes, however, the crest of the wave isn't the first to arrive, the trough is. In this case, instead of very high water levels, the first sign of a tsunami is what appears to be a very, very low tide exposing unusually wide or unprecedented stretches of the seabed. It is important to note that the largest of the tsunami waves is often the third or fourth wave and there can be anywhere from a few tens of minutes, to more than an hour between wave crests.

Most tsunamis are created in the Pacific Ocean, because the largest number of subduction zones is found there. The effects of a tsunami can be local or distant. In British Columbia there are two main types of tsunami threats. The first threat is from tsunamis that are generated out in the Pacific Ocean. These tsunamis could severely impact B.C.'s outer coastal communities with waves from the north, south or west. The second threat is from tsunamis that are generated in local waters. These local tsunamis can be triggered by earthquakes, landslides and/or underwater slides and can have an impact on other coastal areas of British Columbia. [1]

The last destructive tsunami to significantly affect the west coast of British Columbia was caused by the 1964 Alaskan earthquake. As the tsunami waves moved along the coast, they swept into the inlets of the islands and mainland. Several locations reported damage including Port Alberni, Hot Springs Cove, Gold River, Zeballos, Fair Harbour, Amai Inlet, Winter Harbour, Port Alice and Port McNeil.

Injury and loss of life can be minimized if coastal populations are warned that a tsunami is approaching. Today coastal communities can be notified by the B.C. Provincial Emergency Program by a combination of tsunami warning methods, including telephone, fax, and Internet. In turn, it is possible to notify local residents through a combination of personal, mass outdoor, broadcasting and/or telecommunication methods. In the case of a local tsunami, the warning is usually the earthquake. Further notification by local methods is also needed to reinforce

[1] BC PEP What You Need to Know About Tsunamis

evacuation orders and disseminate follow-up instructions, provided the methods are functional after the earthquake.

Warning methods fall into two basic categories:

Mass Notification Methods which are not individually addressable and generally provide the same alert or message to everyone within a particular geographic area, regardless of level of individual risk. These include:

Outdoor Systems	Sirens Mobile Sirens Electronic Signs
Broadcasting Systems	Conventional Radio and Television Cable Television Low Power Radio

Addressable Notification Methods which can tailor and target alerts and messages only to those at risk or to specific groups (such as emergency responders). Some newer, addressable technologies are also flexible enough to support many of the same functions as traditional mass notification systems. These include:

Broadcasting Systems	Amateur Radio Canadian Coast Guard Radio Weatheradio (Environment Canada)
Telecommunication Systems	Telephone Autotel Paging and Tone-Alert Radio Internet VoIP Cellular text messaging Satellite
Personal Systems	Door-to-Door Residential Route-warning

Each method has benefits and drawbacks, which are discussed in detail in this document.

The type of methods that each area uses will be shaped by several factors, including: the physical location and nature of the population (e.g. residents vs. non-residents), time of day, budget, geographic location, available supporting infrastructure, local customs, economic and social activities, etc. To achieve effective warning there should be complete and timely coverage, redundancy, and seamless meshing of new and existing systems. Regardless of the method, it is critical that there be consistency in its application and message, widespread and current public knowledge of both the potential risks as well as continuous education about the alerts.

A warning system can never be totally effective without education, no matter how expensive or sophisticated. Whatever methods are chosen, all groups that are part of the notification process should be involved in the planning, implementation and operation of their systems.

The main purpose of this tool kit is to provide communities with information on various warning methods and procedures to assist them with planning and developing tsunami warning methods and procedures for their own areas.

Information used in this document was gathered from a variety of sources. A series of Internet and online journal searches were conducted concerning warnings systems, lessons learned and recommended good practices. Provincial and federal programs were reviewed and interviews were undertaken with other jurisdictions especially U.S. National Oceanic and Atmospheric Association (NOAA), state and local governments in California, Oregon, Washington and Alaska who have been active in tsunami warning projects. A B.C. coastal community survey conducted in November, 2005 to identify local tsunami needs and issues. Other information was gathered through participation in PEP, regional and local workshops, planning meetings and exercises, and interviews with communication service providers, vendors and amateur radio organizations. The study was also informed by a major west coast tsunami warning report completed by Simon Fraser University in 2004, post-December 26, 2004 Indian Ocean tsunami impact reports and warning concept papers, and reports on lessons drawn from the June 2005 West Coast tsunami warning event. One of the most helpful sources has been *Tsunami Warning Systems and Procedures: Guidance for Local Officials* document produced by the Oregon Department of Geology and Mineral Industries, parts of which have been adapted with permission for use in this tool kit.

This document is divided into four sections.

Section One Provides a brief overview of tsunami causes and characteristics, how they are detected, and a brief description of the current West Coast Tsunami Warning System and its components.

Section Two Describes various approaches to warning, including concepts, definitions, procedures, planning, and incorporating the experience of communities participating in the U.S. TsunamiReady Program and other regions.

Section Three Describes various warning methods available to B.C. coastal communities in detail, including advantages and disadvantages, design and implementation considerations.

Section Four Contains a series of appendices: descriptions of local tsunami warning systems in selected countries; an expanded description of sirens and their properties; a list of useful Internet web links concerning public warning.

SECTION ONE
Public Tsunami Warning Systems

1.1 BASICS OF PUBLIC WARNING SYSTEMS

Experience has shown that people at risk from disasters, whether natural or human-induced, can take actions that save lives, reduce losses, speed response, and reduce human suffering when they receive and act upon accurate warnings in a timely manner. Scientists and emergency management programs continue to develop more accurate warnings as they deploy better sensors to measure key variables, employ better models, and expand their understanding of the causes of disasters. The result is that warnings are becoming much more useful to society as lead-times and reliability improve, and as society devises ways to respond more effectively.[2]

Warning systems typically involve the installation of a range of instruments and technologies to enable early detection and monitoring of hazards. They also involve scientific and organizational programs for analyzing the collected data to determine the extent of associated risk exposure, probable impacts, and processes for notifying those at risk in a timely fashion. For Pacific tsunamis, these arrangements include the installation of a network of seismometers, sea level gauges and deep sea sensors that provide around-the-clock, real-time data for detecting earthquakes and ocean water movements. Scientists use this data to predict the possibility of tsunami waves and to model their anticipated arrival times and onshore impacts.

Advanced telecommunications networks enable this data to be shared worldwide almost instantaneously and warnings to be transmitted to designated national warning authorities. It is the responsibility of the national authority to determine whether or not to issue a tsunami warning applicable to its own territory and population(s), tailor the content of the warning, target those at risk and disseminate the warning message(s). For Canada's West Coast, this authority is the **British Columbia Provincial Emergency Program (PEP)**. *However, it is the responsibility of communities to issue evacuation orders and ensure that warnings can be accessible to, understood by, and acted upon by local populations under their jurisdictions most directly affected by tsunami threats*.

1.1.1 Warning as a System

Warning, therefore, must be viewed not simply as a technology, but rather as a unified system made up of five critical and inter-related elements:

- Hazard identification, risk assessment and vulnerability analysis
- Detection and monitoring
- Emergency management structure
- Local dissemination
- Public education

[2] National Science and Technology Council. (2000) *Effective Disaster Warning*, p.6.

Further, in addition to warning the public, an effective warning system also must provide information about how to prevent and mitigate against disasters and information and knowledge to aid timely response, relief and recovery efforts.

For public warning to be effective a number of key planning tasks must first be understood and accepted in the local or appropriate political context and completed:[3]

Establish a **tsunami warning planning group** to conduct necessary background research, consult and work with all affected interests and contribute to the development of a tsunami warning plan and system.

Conduct and update over time a **hazard and risk analysis** to identify hazards and to determine coastal areas most at risk from tsunamis.

Complete a **vulnerability analysis** to determine populations and critical facilities that are potentially exposed and likely to be impacted

Develop **Tsunami inundation maps** to identify and designate areas expected to be damaged by flooding or waves.

Identify and map out **evacuation plans and routes** to enable populations to reach higher ground or move inland safely.

Select appropriate **warning methods and selection and installation of appropriate means** to ensure all populations at risk can be alerted and given instruction at any time, regardless of physical location.

Establish **emergency plans and procedures** for when warnings will be issued and how they will be widely disseminated, for initiating evacuations, for establishing and managing shelters, and for coordinating search and rescue and emergency relief operations. These plans and procedures should be tested regularly with public involvement.

Develop an **education program** to ensure the public is knowledgeable about the nature of hazards and their effects, who and what is at risk, how populations will be warned, what the warnings mean and what actions must be taken.

Ensure **regular testing and assessment** of the warning system both to ensure that the system works and that the public understands its purpose and messages.

It is also important to recognize that that communities and conditions change over time so planning needs to be an on-going process.

---

[3] Samarajiva, et al. (2005). National Early Warning System: A Participatory Concept Paper for the Design of an Effective All-Hazard Public Warning System.

1.2 THE BRITISH COLUMBIA TSUNAMI WARNING SYSTEM

British Columbia's Tsunami Warning System comprises three basic subsystems:[4]

1. Detection subsystem
2. Emergency management subsystem
3. Public response subsystem

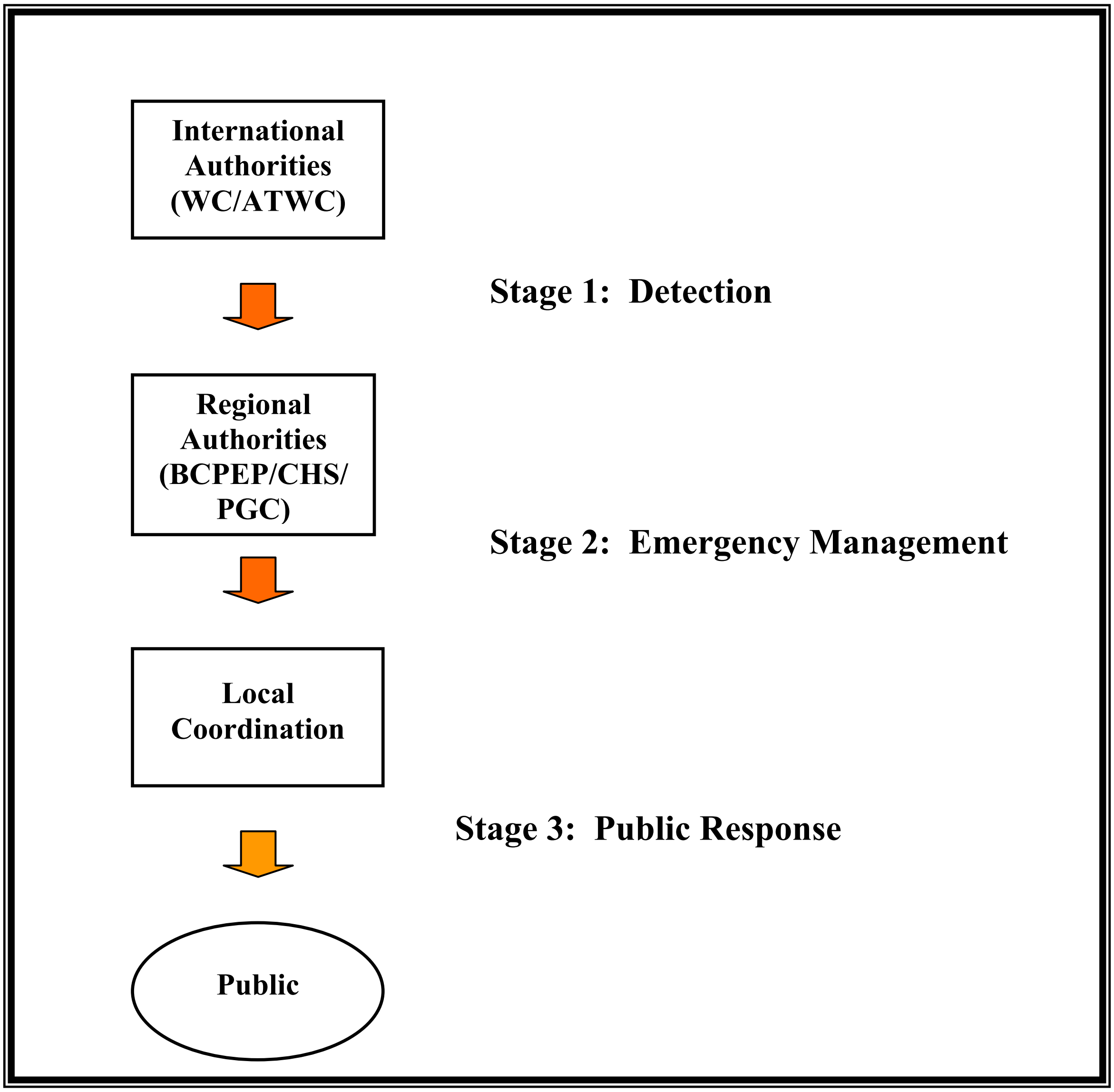


Figure 1: Components of BC Tsunami Warning System

[4] Adapted from: Anderson and Gow (2003) An Assessment of the B.C. Tsunami Warning System and Related Risk Reduction Practices.

1.2.1 Stage 1: The Detection Subsystem Tsunami Warning for the Western Canada/U.S. Region

The function of the detection subsystem is to identify the presence of a hazard or the existence of hazardous conditions. In the case of a tsunami warning, this involves: the monitoring and detection of certain seismic events, the anticipation and detection of tsunami generation, the tracking and monitoring of any generated waves, and the forecasting of wave arrival times and estimated heights along the coast.

Since 1965 the detection subsystem supporting the B.C. Tsunami Warning System has been coordinated at an international level by a group under the auspices of the International Oceanographic Commission (IOC). The present name of this group is the Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System (IGC/PTWS). Canada is a member of this group, along with 28 other member states located within the Pacific Rim. Two Tsunami Warning Centers, both operated by the U.S. National Oceanic and Atmospheric Administration (NOAA), have the primary responsibility to issue tsunami notices within their areas of responsibility:

Pacific Tsunami Warning Center (PTWC)

West Coast/Alaska Tsunami Warning Center (WC/ATWC)

Both centres have real-time or near real-time access to data from large arrays of seismic and sea level stations spanning the Pacific regions.

Pacific Tsunami Warning Center

The Pacific Tsunami Warning Center, located in Hawaii, is the operations centre for the Tsunami Warning System in the Pacific. In this capacity, the PTWC provides information on potentially tsunami generating (tsunamigenic) earthquakes in the Pacific region and subsequent tsunami evaluations and communicates that information to national points of contact and others who may be threatened by tsunamis resulting from these earthquakes. The PTWC is also the national source of Tsunami Warnings, Watches, Advisories, and Information Bulletins for Hawaii, U.S. possessions, and all U.S. interests in the Pacific located outside the Continental U.S. It also operates a Regional Tsunami Warning Center for the State of Hawaii (Website: http://www.prh.noaa.gov/ptwc/).

West Coast/Alaskan Tsunami Warning Center (WC/ATWC)

The WC/ATWC, located in Palmer, Alaska, has the sole responsibility for issuing Tsunami Warnings, Watches, Advisories, and Information Statements and interpretive information to civilian and military officials in Alaska, Washington, Oregon, California and British Columbia (B.C. Provincial Emergency Program and Canadian Forces Pacific Maritime Command). In performing this mission, one of its key responsibilities is the detection, location and determination of magnitude of potentially tsunamigenic earthquakes occurring off coastal areas from Attu, Alaska to the California-Mexico border.[5] The WC/ATWC has this same responsibility for tsunamis generated by earthquakes located in the Pacific Ocean outside the WC/ATWC area of responsibility (AOR).

Although numerous non-tsunamigenic earthquakes are automatically detected and processed each month, to prevent needless evacuations, only a small number of information bulletins about these earthquakes are released to officials and the public. Tsunami Information Statements, Advisories, Watches and Warnings are issued based on earthquake location and magnitude. The four types of bulletins issued by the WC/ATWC are defined below:

> ***Information Statement*:** A text product issued to inform that an earthquake has occurred and to advise regarding its potential to generate a tsunami. In most cases, an Information Statement indicates there is no threat of a destructive tsunami affecting the WC/ATWC's AOR, and are used to prevent unnecessary evacuations as the earthquake may have been felt in coastal areas. An Information Statement may, in appropriate situations, caution about the possibility of a destructive local tsunami. A supplemental Information Statement may be issued if important additional information is received such as a sea level reading showing a tsunami signal. An Information Statement may also be upgraded to a watch or warning if appropriate. Further, the Information Statement may be used to recommend a warning when protocols agreed to by emergency management authorities within the AOR so specify.
>
> ***Tsunami Advisory:*** **The third highest level of tsunami alert.** Advisories are issued by the WC/ATWC to coastal populations within areas not currently in either warning or watch status when a tsunami warning has been issued for another region of the same ocean. An Advisory indicates that an area is either outside the current warning and watch regions, or that the tsunami poses no danger to that area. The WC/ATWC will continue to monitor the event, issuing updates at least hourly. As conditions warrant, the Advisory will either be continued, upgraded to a watch or warning, or ended.
>
> ***Tsunami Watch*: The second highest level of tsunami alert.** Watches are issued by the WC/ATWC based on seismic information without confirmation that a destructive tsunami is underway. It is issued as a means of providing advance alert to areas that could be impacted by a destructive tsunami. Watches are updated at least hourly to continue them, expand their coverage, upgrade them to a Warning, or end the alert. A watch for a particular area may be included in the text of the message that disseminates a Warning for another area.
>
> ***Tsunami Warning:*** **The highest level of tsunami alert.** Warnings are issued by the WC/ATWC due to the imminent threat of a tsunami from a large undersea earthquake, or following confirmation that a potentially destructive tsunami is underway. They may initially be based only on seismic information as a means of providing the earliest possible alert. Warnings advise that appropriate actions be taken in response to the tsunami threat. Such actions could include the evacuation of low-lying coastal areas and the movement of boats and ships out of harbors to deep waters. Warnings are updated at least hourly or as conditions warrant to continue, expand, restrict, or end the Warning.

---

[5] Intergovernmental Oceanographic Commission. (2005). National Report of the U.S. 2003-2005 IOC/ITSU-XX/7.17

After a tsunami bulletin is issued, tide gauge data is monitored to determine whether or not a tsunami has occurred. The tsunami severity as recorded on the gauges indicates to the WC/ATWC whether to continue and expand the warning or cancel. If no tsunami has reached a gauge within a half-hour of the first message, a second message will be issued as a precaution which expands the warning area. There is no way to accurately predict wave heights for a local tsunami generated near the source zone of an earthquake. Difficulties in determining the exact source mechanism, secondary tsunami generation sources, and the lack of time between tsunami generation and impact at the nearest coastal locations make an accurate prediction impossible. However, the WC/ATWC has made great improvements in estimating tsunami heights outside the source zone. Based on pre-computed tsunami models and observed tsunami heights, an estimate of tsunami height can be made for locations along the North American coast outside the source region.

Since 1980, the average time taken by WC/ATWC to issue a tsunami warning has been 10 minutes. With the recent installation of new data communication systems, instruments, and processing techniques, this time should decrease.

1.2.2 Stage 2: The Emergency Management Subsystem Tsunami Warning for the B.C. Coast

The function of the emergency management subsystem is to determine the extent and magnitude of the tsunami threat to B.C. This includes assessment of public safety threat, property loss potential, environmental damage potential, and economic loss potential.

In the event of a Tsunami Warning, Watch or Advisory bulletin being issued by the WC/ATWC for B.C. coastal populations, the provincial government (through PEP) is responsible for coordinating response within B.C. in accordance with the ***British Columbia Tsunami Warning and Alerting Plan***. It is important to note, however, that this subsystem is most effective in the case of far-field or telegenic tsunamis, where there is sufficient time to determine possible tsunami risk and affect a response along the coast. Locally generated tsunamis may pre-empt activation of this subsystem, as clearly indicated in the B.C. Tsunami Warning Plan:

> Little can be done to warn of local tsunamis because their travel time is so short. Persons living in coastal areas must assume that a tsunami may have been generated if a large earthquake has occurred off the coast or in inner waters, and react accordingly (A-4).

B.C. Tsunami Warning Procedures

Upon receipt of a WC/ATWC Watch or Warning bulletin at its Emergency Coordination Centre, PEP contacts the Tsunami Response contact for the Canadian Hydrographic Service (CHS) of Fisheries and Oceans Canada. CHS staff assesses the local tsunami threat based on ocean and tidal conditions at the time bulletins were issued.

CHS plays a twofold role in the B.C. Tsunami Warning System: 1. it provides an assessment of local threats based on bulletins received from WC/ATWC; and, 2. it provides a local detection function through a data network with three dedicated tsunami warning stations along the B.C. coast (located at Tofino, Winter Harbour, Langara Point).

After a bulletin is received via PEP, CHS staff uses tsunami travel time charts and other sources of coastal information to determine the probable locations under threat and actively monitor the three tsunami warning stations along the B.C. coast. In addition, the Pacific Geoscience Centre (PGC), located in Sidney, operates the seismograph network in Western Canada and advises PEP on earthquake events and seismic hazards.

Organizations Notified

Based upon this analysis, PEP will issue a notification to a number of key organizations who will keep people in their regions or communities informed. These organizations include:

- Communities in previously identified at-risk coastal communities
- RCMP detachments serving coastal communities
- RCMP “E” Division in Vancouver
- Stakeholder groups:
    - Canadian Forces - Joint Task Force Pacific Headquarters (JTFP HQ) Joint Operations Centre (JOC)
    - Fisheries and Oceans Canada
        - Canadian Coast Guard
        - Tsunami Response contact, Canadian Hydrographic Service (CHS)
    - Public Safety and Emergency Preparedness Canada (PSEPC)
    - Navigation Canada (NAVCAN)
    - Vancouver Airport
    - Indian and Northern Affairs Canada (INAC)
    - BC Government Ministries/Agencies:
        - Public Safety and Solicitor General
        - Aboriginal Relations and Reconciliation
        - Forests and Range
        - Environment
        - Transportation
        - Health
        - Public Affairs Bureau
- Media news organizations serving coastal communities

Provincial Zones

To ensure timeliness in warning, the Provincial Emergency Program has divided the West Coast of the province into five zones (A B C D E). Each of the five designated zones includes all islands and inlets within the location description. Figure 2 provides a map outlining the five zones.[6]:

Zone A**:** Beginning on the Alaska/B.C. border near Stewart, B.C. proceeding in a southward direction along the coast to the southern tip of Banks Island, including the Queen Charlotte Islands.

Zone B**:** Beginning on the southern tip of Banks Island to the northern tip of Vancouver Island (the western limit being the eastern boundary of Cape Scott Provincial Park). This zone has a southern limit of a line running from the mouth of the Tsitika River (in Robson Bight Ecological Reserve) on Vancouver Island in the south to the most eastern point of Broughton Island in the north.

Zone C**:** Beginning on the eastern boundary of Cape Scott Provincial Park on the northern tip of Vancouver Island and running in a south-easterly direction along the outer coast of Vancouver Island to Sombrio Point southeast of Port Renfrew.

Zone D**:** Beginning at Sombrio Point southeast of Port Renfrew and running in an easterly direction to the most northerly point of the Saanich Peninsula.

Zone E: Beginning at the most northerly point of the Saanich Peninsula, including Saanich Inlet and all the Gulf Islands within the Georgia Basin to one of two points at the northern limit. The northern limit is a line running from the mouth of the Tsitika River (in Robson Bight Ecological Reserve) on Vancouver Island in the south to the most eastern point of Broughton Island in the north.

[6] BC PEP B.C. Tsunami Notification Zones

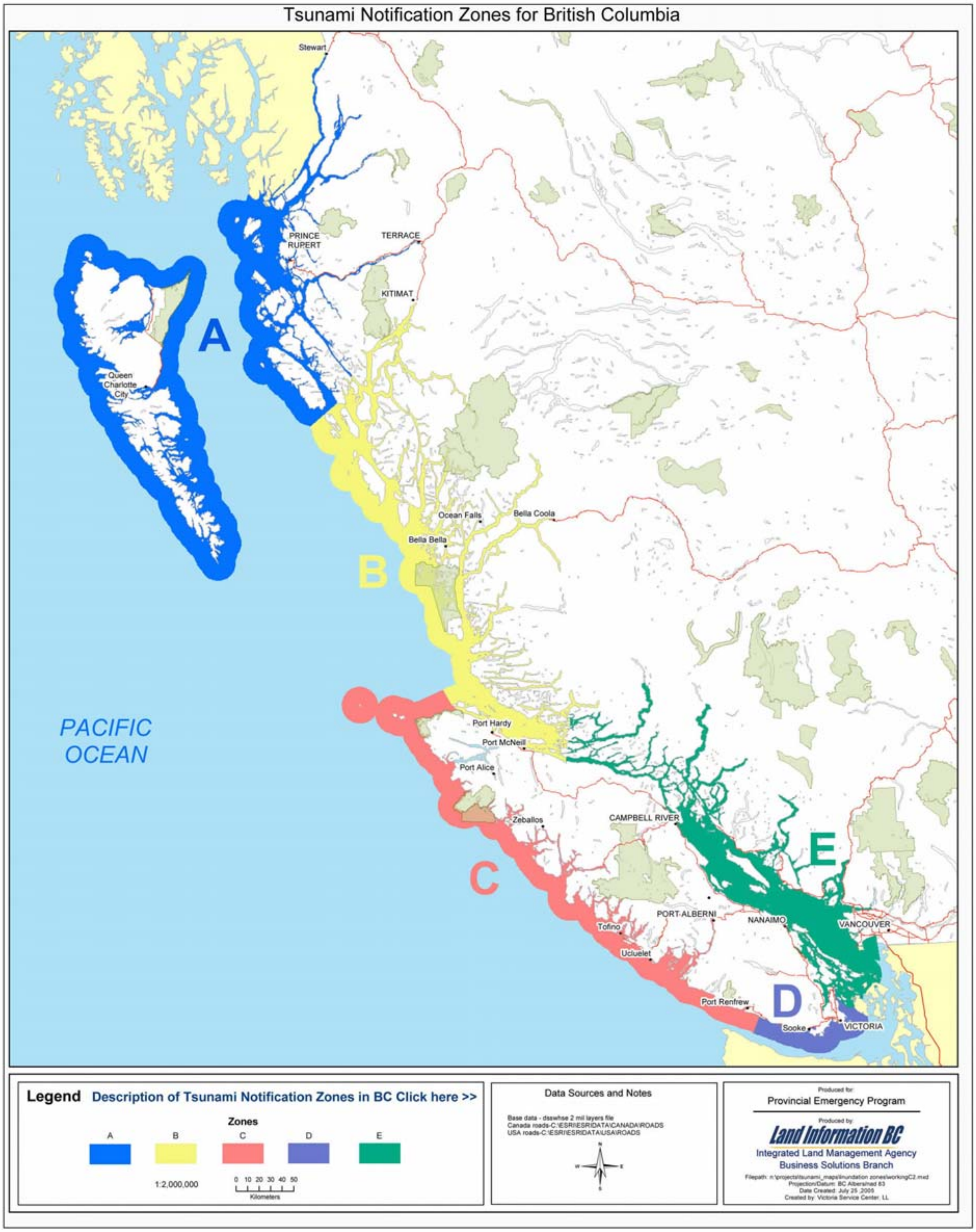


Figure 2: Tsunami Notification Zones for BC

Types of Tsunamis and Potential Areas of Impact [7]

British Columbia is susceptible to a number of different types of tsunamis. Each represents different times of arrival and may affect regions differently.

Pacific-wide Tsunami: the impact of a Pacific-wide tsunami (one which does not originate along the coasts of Alaska, British Columbia, Washington, Oregon or California) to coastal B.C. depends on the earthquake magnitude, source distance and direction of approach. B.C. arrival times of a Pacific-wide tsunami will be 6 hours or more (up to 18 hours) depending upon its place of origin. The areas most vulnerable to distant tsunamis are Zones A, B, and C.

Regional Tsunami: in the tsunami warning system, B.C. is part of a region extending from the western tip of the Aleutian Islands to California-Mexico border. Because of the vast coastal area encompassed by this region, tsunamis generated within it may impact quite differently at various locations. In some instances the effects will be much localized.

The principal source area for regional tsunamis affecting B.C. is Alaska, including the Aleutian Islands. The time to reach the northern B.C. coast can be as short as 2 hours. In 1964 waves of 4.1 metres hit Port Alberni causing $5 million in damages.

Local Tsunami: relatively small tsunamis may result from earthquakes occurring off the B.C. coast, in inner waters such as Juan de Fuca Strait, the Strait of Georgia or Puget Sound, or from submarine slides in areas such as the Strait of Georgia.

Cascadia Subduction Zone: there is the potential for a destructive tsunami from a large subduction earthquake in the northern portion of the Cascadia subduction zone. Should this occur, Zone C would be the most affected B.C. area.

Because travel time is so short for any local tsunami, there is very little that can be done to provide warnings for the closest B.C coastal areas. Anyone in designated coastal areas should assume that a tsunami has been generated if they feel strong shaking from an earthquake. They should move immediately to high ground.

Notification Terminology

Terms used by PEP during dissemination of earthquake and tsunami information include:

- ***Tsunami Information Message***: This is awareness notification. Tsunami information messages may be issued based only on preliminary seismic information without confirmation of a tsunami wave.

- ***Tsunami Watch Message***: This is notification based on early seismic information that provides advanced alerting to areas that could be impacted by a tsunami. When a Watch is issued for communities, local emergency plans should be activated. Communities should prepare for possible evacuation in the event that their area is upgraded to a Warning.

[7] BC PEP Fact Sheet – Types of Tsunamis and Risk Areas Notification Times

- ***Tsunami Warning Message****:* This is the highest and most serious level of tsunami notification. Warnings are issued when there is an imminent threat of a tsunami or confirmation of a tsunami wave. When communities are issued a warning, local emergency plans should be activated and safety actions taken. Such actions could include the evacuation of low-lying coastal areas and restricting access to emergency response routes and coastal beaches. Warnings are updated as conditions change.

- ***Tsunami Cancellation Message (All Clear)****:* This is issued when the threat of an imminent damaging tsunami is over.

Flow of Warning Messages

The WC/ATWC passes tsunami messages along to PEP using a variety of communications methods. PEP's Emergency Coordination Centre (ECC) can receive messages via:

- Satellite – NOAA Weather Wire system (NWWS);
- Telephone and facsimile network - by the U.S. National Warning System (NAWAS);
- Electronic mail; and
- WWW. The latest message is displayed at URL: http://wcatwc.arh.noaa.gov/

It is important to note that much of this information is also readily accessible to the public via Internet email distribution lists and web pages, NOAA Weather Radio, the U.S. Emergency Alert Broadcasting System and a variety of other means. Some of the methods (especially Internet-based ones) are also readily accessible to B.C. coastal and other populations. **Formal warning for all of British Columbia remains under the authority of PEP and communities.**

1.2.3 Stage 3: Public Response Subsystem Reaching the last mile

The roles of the public response subsystem are to inform local populations of a potential or imminent threat to the area and to initiate and coordinate protective-action response measures, such as evacuation. It is important to note that communities are primarily responsible for local warning and evacuation arrangements. However, to be effective, local warning activities must be undertaken and coordinated by a range of organizations and agencies, depending on the plan established within each community. Designated emergency program members will be responsible for issuing warnings and evacuation orders to members of the public within their jurisdictions. They may be aided by RCMP, search and rescue groups, fire departments and others in accordance with their plans. Where there is a large employer in the area, warnings may be issued at the worksite.

Local areas falling outside provincial jurisdiction receive warnings through the most appropriate channels. The marine community along the B.C. coast is served by Coast Guard Marine Communications and Traffic Services Division (MCTS) which is responsible for providing warning broadcast and subsequent communications service for ships at sea, in port or at anchor. Coastal shore-based populations may also intercept and monitor marine communications activity. Tsunami-related messages are routed through Prince Rupert MCTS, which is designated as primary Coast Guard link between WC/ATWC, Coast Guard Operational Sites, and PEP. Comox MCTS serves as an alternate site. Coast Guard communications may also serve as backup when requested by communities as part of an individual station's contribution to the local community plan.

The public response subsystem can be extended to include planning and mitigation measures taken *well in advance* of a tsunami event. In fact, there are several identifiable stages of local warning:

Stop Entry or Evacuate an Area: Residents and visitors first need to know if they are in or about to enter into an area at risk of tsunami.

Receiving the Warnings: Individuals and other groups need to know how they should expect to receive tsunami warnings (there may be more than one method depending on their location) and how to obtain additional information and interpret the messages that accompany them.

Responding to Warnings: Individuals and other groups need to know what to do after receiving a warning.

Getting Information: Local dissemination points must be capable of receiving, possibly editing, and then issuing tsunami warnings (notifications) in a timely and consistent manner through appropriate (possibly multiple) channels.

Giving the Right Information: Communities must be prepared to answer questions and respond to requests for additional information from members of the public.

SECTION TWO
Considerations for Effective Warning

Ultimately, the success of a warning is measured by what actions people take. Once authorities have decided to issue a public warning and have prepared the message, the challenge is to deliver the message to everyone who needs to be warned. There are numerous methods available for delivering public warnings and related information, but many factors can affect their overall warning effectiveness. Among others, these factors include:

- identifying who needs to be informed
- where they are located
- what they are doing
- what they rely upon to receive local news and information
- what special needs they may have, and
- how well they understand and accept the warning in order to take action.

There is no single best method that fits all circumstances. An effective public warning system should use as many information dissemination channels as possible. **The specific methods and technologies to be used will depend upon the requirements and capacities of the local communities involved and therefore will need to be tailored accordingly.**

Whatever methods are chosen, there is a need to ensure a fully functioning system through continued maintenance, upgrading and installation of back up procedures to ensure continued service when commercial power and telecommunications fail. For public safety purposes, it must be as close to 100 per cent reliability as technically and economically feasible.

2.1 Warning System Parameters

In designing and implementing a warning capability, consideration should be given to choosing a combination of methods and technologies that achieves an overall capability to meet the following criteria:

Reliability

- accurate
- redundant and secure, available in the absence of normal electricity service
- always operational and ready to warn
- fast transmission, with assured delivery and confirmation

Coverage

- addressable to populations in affected locations
- reaches all people within an area-at-risk (including transient populations)
- scaleable to enable expansion of warning area
- accessible to people with special needs, including various language requirements
- familiar, understood and accepted by population

Messaging

- enables only those authorized to insert messages
- employs messaging terminology that is clearly understood by recipients
- provides location for obtaining more information

Emergency Issues

- supports multiple distribution technologies (E.g., sirens/public address, telephone, radio, television, pagers, cell phones, signage, etc.)
- supports strategies for evacuation, response and recovery plans
- applies to multiple types of hazards
- doesn't put message provider or recipient at risk
- cost effective

An effective notification system always requires continuous public education and awareness about the purpose and capabilities of the system (see Section 2.3). A system can never be totally effective without education, no matter how expensive or sophisticated. Whatever methods are chosen, all groups that are part of the notification process should be involved in the planning, implementation and operation of their systems.

2.1.1 Factors to Consider in Developing a Warning Capability

A public warning comprises two essential components: 1. an alert and 2. a message with instruction. An alert is intended to interrupt people from whatever they are doing at the time and secure their utmost attention. The message must convey what, where, when, and how severe the hazard is, how likely the hazard is to occur, and what action(s) needs to be taken by the recipients of the message.

Alerts and messages are not always delivered by the same method or technology. For example, a siren or horn may be used to alert the public as a signal to tune to a local television or radio station to receive a corresponding message.

There are a number of important relationships between alerting, messaging and chosen delivery methods[8]:

[8] Adapted from Partnership for Public Warning. (2004). Protecting America's Communities an Introduction to Public Alert & Warning

Alerts and messages can be broadcast to all people:

- Who are tuned into a specific medium.

Alerts and messages can be delivered to:

- Specific locations (e.g., beaches).
- Specific devices, wherever they may be (e.g., pagers).
- Specific lists of people falling within a specific area (e.g., all schools within the flood inundation zone).
- Specific lists of people using multiple methods (e.g., group fax, telephone, email, public address, pagers, etc.).

An alert can be:

- Audible.
- Visual.
- Physical (e.g., vibrating device).
- Distinctive (e.g., specific tone or flashing light).
- Non-distinctive (e.g., telephone ring, email notification).

A message can be:

- Audible (e.g., spoken, tones).
- Visual (e.g., text, lights).
- Physical (e.g., Braille).
- Distinctive (e.g., text crawler across a TV screen).
- Non-distinctive (e.g., imbedded in a regular news broadcast).

Some methods are specific to:

- The range of the transmitter.
- A human-determined geographic boundary (e.g., a municipal or regional district boundary).
- An event driven geographic area (e.g., a flood inundation zone).
- An individual location.
- Outdoors.
- An individual facility (e.g. a school, marketplace or shopping center).
- A specific person, authority or agency.

Some methods include the ability to confirm that a message has been delivered to:

- A person or device at a specific location.
- A person or device wherever it currently may be located.
- A specific person.

With respect to the timing of the message, some methods offer alert and/or message delivery:

- To all recipients at the same time.
- To recipients over a period of time.

- To recipients within specific geographic areas or specific lists, at specific times or during specific periods of time.

With respect to capacity, some methods:

- Have substantial capacity of recipients.
- Have a capacity of recipients they can reach within specific time frames.
- Have capacities that are affected by other uses of the network they utilize.

When it comes to security and reliability, some methods are more or less:

- Vulnerable to hacking than others.
- Easily mimicked than others.
- Perform better under the challenges associated with various hazardous events.
- Dependent on electrical grids being operational.

With respect to targeting populations-at-risk, alerts and messages must take into account:

- Who are the recipients:

Emergency responders	Elected officials
Media	Elders
Children	Local residents
People with special needs (e.g., visually, hearing or physically challenged, infirm, illiterate, don't speak the primary local language, etc.)	Tourists

- Where they are located:

Home	Work
Outside	Onboard a boat or plane
School	Shopping centre, commercial area
Hospital	Restaurant
Theatre	Recreational centre
Wharf	Hiking trail
In transit	

- What they are doing:

Driving	Sleeping
Listening to iPOD	Watching TV
Listening to radio	Talking on the telephone
Sea kayaking	Working in a mill
Playing sports	Walking/running
Web surfing	Camping/hiking

- Time of day.
- Season (e.g., peak summer tourist season).

Even taking all of these factors into account, the effectiveness of warning requires not only that the message is received, but that it is based on accurate assumptions about human behavior in times of crisis.

- The warning must be capable of interrupting whatever people are doing, compelling them to understand the threat, and to act as instructed.
- People must believe that the warning is truthful and accurate.
- People must personalize the message as being relevant to them.
- People must decide to act and overcome any constraints to taking that action(s) advised.

Again, prior public education is needed for familiarity and acceptance.

2.1.2 Dissemination Methods

Dissemination methods fall basically into two categories which align with the different categories of warning message:

> ***General methods*** are mainly represented by the mass media (broadcasting).
>
> ***Specific methods*** are mainly represented by addressable (personalized) technologies or are those used to reach smaller groups (narrowcasting). They provide warnings to particular householders, businesses, industries, agencies or other clearly identifiable individuals, groups or organizations.

Depending upon location and available supporting infrastructure, many different general and specific methods may be available and each should be assessed for its relative merits and applicability.

In most tsunami events, both types of method will need to be used to increase the likelihood of the message getting through. In cases where a tsunami may affect rural or remote segments of the population, it is appropriate to convey warnings by the broadcast media as well as by telephoning individuals who can then alert their neighbours. It will be necessary to add additional ‘layers’ of warning by using specific methods in bigger events. It is important to recognize that each method of dissemination may differ in the speed by which it can deliver messages.

POTENTIAL METHODS OF TUSNAMI WARNING	
GENERAL ***More quickly disseminated*** ↓ ***More slowly disseminated***	**Sirens** **Radio and television:** message: break-in community announcements or phone-in interviews with emergency officials **Scheduled news bulletin**: may take longer to go to air **Internet web sites** **Community notice boards (mobile electronic signs)** **Newspapers**
SPECIFIC ***More quickly disseminated*** ↓ ***More slowly disseminated***	**Two-way radio – group call (**commercial, marine, private, GRS, GMRS, CB, Coast Guard, amateur radio) **Pagers and Tone Alert (**activated radios – Weatheradio**)** **Telephone** (including phone trees or cascades where each person contacted calls others) and automated mass dialing systems with pre-recorded messages **Cellular Phones and Autotel** **Internet voice-over-IP** **Internet email** (may not always be at computer**)** **Facsimile**: especially for businesses and government institutions. **Loud hailers**: mobile public address systems, route warning or **Door-to-Door**

Figure 3: Potential Methods of Public Warning

2.1.3 Location: Outdoor and Indoor Warning Methods

The location of audiences is crucial in identifying the type(s) of method to be used – specifically whether they are located indoors or outdoors. A number of methods may be used for both, as the case with telephones which can be used inside a building or residence, or outside via a cellular device. It is crucial to identify the limitations each method has when being used.

Outdoor Warning Methods

Many different sounds can be used as mass audible warnings. The basic requirements are that the sound should be clearly audible and the listener should know what it means.

The most effective sound for warning is commonly a sound generated for that specific purpose. As such, it is frequently a distinctive sound. However, there do not appear to be any universal warning sounds for floods or tsunamis.

Two crucial factors that affect the ability of a warning sound to reach a potential listener are barriers to sound in the listener's immediate vicinity and background or masking noise. These factors are discussed in more detail in Section 3 and Appendix 2.

Indoor Warning Methods

While sirens, electronic billboards and other mass notification methods can reach large segments of the outdoor population, the biggest challenge is warning people who are indoors. Structures can easily block sounds as well as sighting of visual objects. Dwellings, public and commercial facilities and work places are usually well insulated (and hence sound-proofed). Community bylaws often require large billboard and other mass messaging systems to be sighted away from residential and public spaces (e.g., parks).

Indoor warning methods must rely upon technologies that are: 1. capable of penetrating inside spaces; 2.wide-spread enough to ensure that they can reach any space where people may be residing; 3. sufficiently disruptive to capture undivided attention, and 4. are capable of disseminating messages any time of day or night.

From the most basic methods (door-to-door, indoor public address systems) to the more sophisticated (emergency broadcasting), all methods must rely upon an external source to trigger the alert and messaging system. Contemporary indoor warning methods rely upon some form of electronic communication for this purpose (telephone, radio, television). Depending upon what activities people are engaged in at the time of the warning or if they are sensory impaired, it will be necessary to rely upon methods that cater to different senses (e.g., hearing, sight) to ensure that everyone is alerted and informed.

Some methods provide limited, one-way message delivery capability (e.g., broadcast radio) while others support two-way and/or interactive messaging (e.g., telephone). These features become important considerations when confirmation of message reception is required. Further, many public telecommunication systems (telephone, voice cellular) are not scaled for community-wide use during emergency situations and experience has demonstrated that they degrade rapidly because of excessive demand and resulting congestion. As a result, limited public access should be anticipated once public warning has been initiated.

The combination of all of these factors can affect the overall effectiveness of warning devices dramatically, so it is important to take them into consideration in the design of a warning system.

2.2 WARNING AND COMMUNICATION SYSTEM PREPAREDNESS

To ensure effective response, communities carefully need to consider what warning and communication functions need to be supported before, during and immediately after emergency events. This is especially true in tsunami emergencies where there is little or no time to put into place any special notification arrangements that have not already been pre-planned. The following communications functions and supporting arrangements based upon lessons drawn from U.S. TsunamiReady communities and other experience from around the Pacific have been identified as essential for ensuring effective public warning. Details about the relative advantages of suggested communication options are discussed in Section 3 and examples of established local tsunami warning systems in different countries are described further in Appendix 1.

2.2.1 Local Tsunami Warning Reception and Community Activation[9]

An established 24-hour Warning Reception Point must be able to receive PEP Tsunami Messages, and provide local reports and advice. Typically, this might be a police or fire department dispatching point. For communities without a local dispatching point, a neighbouring agency or team of trained local officials might be able to act for them in that capacity. The warning point needs to have:

- 24 hour accessibility.
- Warning reception capability.
- Communication/dissemination capability to alert local emergency managers.
- Ability and authority to activate local public warning system(s).

In accordance with local emergency plans, an ***Emergency Operations Centre*** should be established in the community, in order to execute and coordinate tsunami warning functions. Tsunami-related attributes of an EOC can be summarized as:

- Activation to be based on plans related to PEP tsunami information and/or local tsunami events.
- Staffed by trained emergency managers.
- Ability to communicate with adjacent EOCs/Warning Points.
- Ability to communicate with PEP Emergency Coordination Centre and Provincial Regional Emergency Operations Centre.

2.2.2 Communications and Coordination

PEP Tsunami Warning Message reception. The Warning Point, key emergency officers and agencies and the EOC require a number of alternative methods to ensure the greatest possibility to receive any PEP Tsunami Messages. To protect against delivery failure, *at a minimum*, at least two methods of communication access need to operate on completely different network infrastructures. Depending upon local availability, the following are possible options:

- Fixed telephone
- Cellular telephone
- Satellite phone
- Facsimile
- Email
- Monitoring Coast Guard Marine Radio Channel 16
- Amateur Radio
- Environment Canada Weatheradio (where available)
- Autotel
- Agency radio

[9] Adapted from: NOAA. (2004). StormReady Organization and Operations Manual.

- Voice-over-IP telephone
- Monitoring media

Local Warning Dissemination. Upon receipt of PEP tsunami warnings or other reliable information suggesting a local tsunami is imminent, local emergency officials need to communicate the threat to as much of the population as possible. This requires having at least two or more means of ensuring timely dissemination of warnings to indoor and outdoor populations (based on population and local resources). Methods for consideration include:

- Fixed sirens and horns
- Local broadcasting stations
- Vehicle and boat sirens and public address systems
- Telephone notification (dial-down) systems
- Indoor public address systems
- Tone alert activated radios placed in public facilities and workplaces
- Outdoor mobile electronic signs
- Fixed signage with flashing lights and instructions (e.g., "Emergency Info when Flashing: Proceed Inland and away from Water").
- Door-to-door verbal notification and leafleting
- Marine and local two-way radio

For Regional Warning Points. A regional communication network will be required that ensures information flow to rural and remote populations. Because of widespread variations in service coverage, several different methods will need to be incorporated. Depending upon rural availability, the following are potential options:

- Telephone notification (dial-down) systems
- Marine and other two-way radio
- Amateur radio
- Iridium satellite paging
- Satellite telephone and text messaging
- Autotel
- Regional broadcasting stations
- Email and window pop-up window alerts
- Door-to-door notification
- Vehicle and boat sirens and public address systems

Response and Recovery Coordination (local and regional)

- Two-way radio
- Amateur radio (VHF and HF)
- Telephone and cellular
- Telephone conferencing
- Email – one-to-one and specialized distribution lists
- Facsimile
- MSAT dispatch radio satellite conferencing

- Marine radio
- Internet instant messaging

2.3 PUBLIC EDUCATION CONSIDERATIONS

Anyone interviewing emergency coordinators will find that the most consistent advice they give is: "educate your community". The warning process includes the planning and installation of warning devices and methods and also the assurance that the public (residents and tourists) and government officials (first responders, and other agency employees) are aware of these plans and what the warning devices do.

There are two major steps in educating the public about tsunami warning methods. The first is to identify the educational information that is needed to ensure the public's safety; the second is to determine the methods that would work best in disseminating this information to the public.

2.3.1 Educational Information

When educating the public, the community will need to have certain information. Suggestions follow about what types of information can be most beneficial:

What is a Tsunami and what are the hazards associated with them? Provide a brief description of what a tsunami is, specifically focusing on wave actions and other hazards. People may not understand that tsunami events usually have more than one wave action, and that after the first wave, succeeding waves may become larger and more devastating. Also, it may be appropriate to indicate the other hazards that may be associated with these waves (i.e. debris, collapsing structures, and surges). The matter of the destructive force of waves needs to be emphasized as well.

What is the difference between a "local" and a "distant" tsunami? Provide a brief description focusing on the differing time periods between a local and a distant tsunami. Inform that when strong ground shaking from an earthquake is felt, people in areas-at-risk should move inland or to higher ground (as specified in local plans) immediately, as a tsunami may occur within minutes. Once people understand more about the risks, they will be better prepared to focus on evasive actions.

***What can people do to protect themselves from a tsunami*?** Highlight the need for pre-planning, focusing on the preparation of family disaster plans, becoming familiar with local earthquake and tsunami plans, and preparing 72-hours+ emergency kits. It is important that the population understand that help may not reach the community for an extended period of time in some areas, depending on the nature of the disaster impacts.

When do people evacuate? It is important to explain all the warning methods used by your community, ensuring that the public knows what the various evacuation signs, sirens, broadcasting messages, etc. mean. People need to know how and when they should expect to receive evacuation orders, noting particularly that they can only return after receiving clearance from emergency officials.

How and where do people evacuate to? A picture is worth a thousand words and a good map indicating evacuation routes and staging areas accompanied by a brief explanation on how to get to higher ground or inland (i.e. walking vs. driving a car) can greatly assist safe evacuation. Some communities publish this information in telephone books. The description of staging areas and details about the support that will be provided there are also important, along with the need for individuals to have portable emergency kits.

What are the community plans? Provide information on what the community plan entails, describing emergency services, self-sufficiency, community boundaries, and staging areas. The point should be emphasized that if a near-shore tsunami event is possible, emergency responders may not be able to enter a threatened area, so people need to be prepared to evacuate on their own.

Concise instructions: Instructions need to be clear and concise about what to do, be accessible in different languages and be conveyed by communication to suit the needs of the audience.

Where to get more information? Provide contact information on where individuals can obtain more information. This is for provincial and other contacts (including web-sites) as well as community contacts.

2.3.2 Disseminating Methods

After key information has been identified and prepared, the next step is to decide on the best ways to disseminate it to the public, and the most appropriate time to do so. A good dissemination system involves many participants. Partnerships with local community businesses, government agencies and broadcasting stations will help in covering a larger audience.

Workshops can be organized involving different interest groups such as those associated with schools, hospitals, old age homes, townhall meetings, library, recreational centres, neighbourhood centres, churches, businesses (hotels, restaurants, bookstores, and mills). Private organizations (Red Cross, environmental groups, clubs) or recreational venues such as parks (registration centres or campsites) can also be utilized. Training materials are needed to help deliver the right message and to make it easy for emergency managers and others (e.g. first responders or volunteers) to deliver.

Pamphlets and brochures can be prepared to educate the public about tsunamis and how individuals can act to remain safe. These can be distributed through various means, using such mechanisms as the community's emergency website, handed out at workshops, posting or e-mailing to residents. They can be placed in tourist sites (visitor centres, hotels, restaurants); transportation sites (airports, ferries, marinas, cruise ships); business sites (shopping malls, factories); or included as inserts or articles in local newspapers or delivered door-to-door with volunteers.

If a region has a number of different communities, it can develop a brochure template containing generic information (listed in the above section) and only change information that is specific to each community (e.g., the evacuation map). A good example of this can be found on the U.S. Pacific County, Washington website (http://www.co.pacific.wa.us/pcema/).

Information signage can be in the form of evacuation signs showing evacuating routes and tsunami staging areas. General information posters can be placed in potential inundation areas where many people often congregate (shopping malls, hotels, restaurants, workplaces, trail heads, beach access points).

Media materials can also help raise general public awareness. These can include background material and media kits, education videotapes distributed to all coastal jurisdictions, broadcast shows on radio and television, or be distributed to school districts in all coastal areas. A good location for these materials would be local public or school libraries.

Emergency Preparedness Week activities can include workshops, evacuation exercises, the introduction and public discussions about new warning systems (such as signage, sirens), etc.

Public Service Announcements can provide information before and during a crisis. Consider developing broadcast shows with local emergency coordinators and creating pre-scripted emergency announcements/warnings with local broadcasters.

Other materials which can be both developed within or provided to communities are**:**

- Placing information at the front of a phone book.
- Working with local hospitality associations or hotels to place information in books found in hotel rooms or putting evacuation posters on the inside of guest rooms.
- Working with local merchants to manufacture memorabilia items such as heat sensitive coffee mugs that demonstrate how to survive a tsunami, magnets, place mats, bookmarks, tee-shirts, and other things that popularize safety slogans or illustrate ways to survive.
- Working with rental car agencies to place tsunami education material in cars; working with Tourism B.C. and others to add this information to the B.C. Road Map and Coastal Tour Books; and working with BCAA to add similar information to their newsletter and tour books, brochures on B.C. and other coastal ferries.

SECTION THREE
Warning Techniques and Procedures

The goal of any local warning system is to have the most effective coverage for the most affordable cost. Therefore, it is critical to have local needs properly evaluated. The costs of implementing new systems can be relatively high. They include not only systems costs, but costs for other component systems (such as radios for activation), installation equipment (e.g. poles), labour, maintenance, and training. The high costs associated with purchasing new systems could be offset by higher maintenance costs of older systems. In addition, if several adjacent communities decide to use the same system, costs could be reduced by purchasing equipment in quantity.[10]

A warning system can only be effective if you understand the benefits and limitations of the alerting methods available. There is a great selection of warning devices and methods available, but no one method is perfect and no method can be guaranteed never to fail. Very reliable communication systems must be in place to ensure that the notification and information sharing can occur without delay. By relying on one single method, such as the sounding of the sirens or the receiving of information solely from broadcasts, populations risk missing a warning if that system fails. To ensure people can get warning information, at least two independent methods of simultaneous communications must be available to protect against the possibility of equipment failure.

3.1 Types of Warning Methods

Warning methods fall into two basic categories.

Mass Notification Methods

These systems are not individually addressable and generally provide the same alert or message to everyone within a particular geographic area, regardless of level of individual risk. These include:

- Outdoor systems – sirens, mobile sirens, mobile electronic signs
- Mass broadcasting systems – conventional radio and television, cable television and low power radio

[10] Adapted from: Beaulieu, J. D. (2001). Tsunami Warning Systems and Procedures: Guidance for Local Officials

Addressable Notification Methods

These systems can tailor and target alerts and messages only to those at risk or to specific groups (such as emergency responders). Some newer addressable technologies are also flexible enough to support many of the same functions of traditional mass notification systems. These include:

- Broadcasting systems – amateur radio, Canadian Coast Guard and marine radio, and Weatheradio (Environment Canada)
- Telecommunication systems – telephone, autotel, paging and tone-alert radio, internet, VoIP, Cellular and Short Message Service, and satellite
- Personal systems – door-to-door and residential route-warning (using mobile public address systems)

3.2 WHICH METHOD IS BEST SUITED FOR MY COMMUNITY?

Communities today must use a multi-faceted system consisting of a combination of different methods in order to reach everybody. For example, they might use outdoor sirens for the alert signal, tone alert monitors at schools, hospitals, and industries and radio, TV and/or billboards for the message. However, as previously outlined (Section Two), there are many factors (including affordability, accessibility and coverage) to consider when choosing a particular selection of methods that best suits your community's or region's needs.

Ultimately, public warning needs to be assessed within the context of the community's overall emergency communications needs since much of the supporting telecommunications infrastructure will be the same. It is important to recognize that a warning is the trigger for all of the subsequent activities that will occur throughout the emergency period, including response, rescue, relief and recovery. The warning portion (initial alert to the all-clear) may be very short or could go on for over a day depending upon the nature of the hazard (storm, tsunami, flood, hazardous materials incident). Investing wisely in flexible, robust, redundant, multi-purpose communication infrastructure can yield dividends for all emergency needs.

The following pages provide descriptions of many potential methods along with brief discussions of their advantages and disadvantages relative to other methods, implementation considerations and costs along with a preliminary list of identified vendors. It should be noted that this document does not implicitly endorse or recommend any vendor, imply that these are the only suppliers of equipment or services, or accept responsibility for the quality of products reviewed. Readers are strongly encouraged to conduct their own research and evaluations.

3.3 MASS NOTIFICATION METHODS

3.3.1 OUTDOOR SYSTEMS

Sirens
Mobile Sirens
Electronic Signs

MASS NOTIFICATION METHODS
Outdoor Systems: Sirens

Sirens are designed to provide a rapid alert to potentially threatened populations. They are currently one of the most reliable mass notification means of alerting outdoor populations. When sirens are properly located, they can reach most populations, including those in isolated areas (e.g., beaches). They can also reach populations that have limited access to other warning devices, such as telephones, cell phones and commercial television and radio.

It is important to note that sirens have limited broadcasting and messaging capabilities. When activated, people are expected to turn to another source such as a radio or television station for further instructions. To be effective, populations must be continuously educated about the siren's purposes and intended reactions. The following description provides a brief overview of general characteristics, and advantages and disadvantages for using this type of warning system. More detailed information concerning acoustic properties, considerations for design and installation, and vendor information can be found in Appendix 2.

The siren system a community adopts will depend on the amount of funds available, and the type and area of coverage a community needs and wants. This will require an on-site assessment by a specialist. (Note: some siren manufacturers and vendors offer this service to communities). The signal or voice message from the siren should be clear, concise, and distinct. The alarm or message should be uniform over as broad an area as possible.

GENERAL CHARACTERISTICS

Sirens are devices that transmit different sounds and/or voice messages. They are either electro-mechanical or electronic. Sirens can be triggered locally or centrally and automatically[11]. Critical factors to be considered in the initial planning stages of a public warning system are: 1. defining the purpose and choosing which type of siren to use (includes - structure, coverage, broadcasting, power source, testing and maintenance); 2. identifying siren placement; and 3. costs

Structure

There are three principal parts of a siren system: the siren, controller, and actuator. The siren produces the noise, the controller controls the signal type, duration, etc., and the actuator triggers the controller either remotely or directly.

Actuator control units may transmit signals either via radio or landlines. Currently 99% of all sirens are controlled by radio frequency. Encoders transmit a Dual Tone Multi-Frequency (DTMF) signal over the radio system which takes approximately 1/2 a second. The encoder produces the DTMF signal and the radio transmitter sends the signal to the sirens. Each siren has

[11] Adapted from: Beaulieu, J. D. (2001).

a radio receiver and a decoder that receives the DTMF signal and decodes the information. The decoder decodes the command and the siren's microprocessor then selects the intended command that was sent from the encoder.

Siren units, whether electro-mechanical or electronic, are essentially of two basic types: Those designed to project sound at once in a 360 degree pattern (omnidirectional), or those designed to project sound in one direction while the unit rotates or oscillates through 360 degrees. Sirens can also be fixed or rotating.

Coverage

The main difference between fixed and rotating sirens is the amount of coverage area. A rotating siren increases the coverage area. For example, where the coverage area for a fixed siren would be a 300 to 450 metre radius from the siren; a rotating siren would increase the coverage to a 1.6 kilometre radius. For a stationary listener, the sound from a rotating siren goes up and down in loudness, while sending out the sound wave in all directions. The coverage area for an electronic siren can be increased by adding more amplification and/or additional units that are networked. The effectiveness of an electronic siren warning system can be increased by public address announcements. For more information on the acoustic characteristics of sirens see Appendix 1.

Broadcasting

Announcements on electronic systems can be stored on pre-recorded disks or chips containing short instructive messages sent through the same speakers as the siren. Most systems today have enormous messaging capability. In fact, most of the TsunamiReady communities in the US recommend having this capability. This is a valuable feature, making it possible to communicate local emergency information quickly and efficiently to the public, especially for transient and tourist populations. It is important to note that whatever message is broadcast it should be clear and concise.

Power Source

Sirens rely on electricity and would be of limited use should the system be destroyed by a local tsunami-generating earthquake. Backup systems or systems that do not rely on the main power system, such as solar, are possible provided as they survive the earthquake. Solar energy collectors will add costs to the siren system. However, costs of solar panels have dropped significantly and allow placement in areas where there are no power lines, such as isolated beaches and parks. A solar powered system, free from commercial connection, would provide service if commercial power were to be disrupted by earthquakes and would protect the system from power surges. There are also new wind powered sources available.

Testing

Although testing is important to keep residents and tourists aware and educated, the public may also object to repeat testing. Testing can be done without sounding the actual siren, thus reducing public complaints, or it can be scheduled at specific times. For example, the City of Port Alberni does a silent test every Monday when all 4 stations are polled for their state of readiness. They also perform an audible test once a month for residents to hear. Some areas also use less offensive and distinct sounds such as a mooing cow at Cannon Beach. Whatever testing method that your community chooses manufacturers all recommend testing at least once a month.

Maintenance

Modern units require very little maintenance because they are electronic with few moving parts. Testing the sirens will identify any maintenance needs and it is recommended that sirens have a bi-annual maintenance scheduled.

Placement

When placing the siren it is important to identify locations that will provide optimum coverage of the sound for the population. Besides the distance over which the warning sound is to be heard, many other important factors must be considered in the placement of sirens. Any of these other factors may in some circumstances become as important as the size of the intended coverage area.

Natural Terrain: The topography around a siren station's location can deflect the sound away from an area expected to be covered. The terrain around the siren unit site can be so important that a siren station properly placed to take advantage of the terrain's features can 'bounce' or reflect the sound to an area otherwise blocked by a hill. Types of ground surface, including different kinds of foliage and their coverage, can significantly influence sound reflectance or absorption. Seasonal changes to vegetation also can be critical in this regard.

Human-made Terrain: Structure sizes, heights, outer wall surfaces, types of roofs and their angles can all affect passage of the projected alarm sound throughout the area and reduce its effectiveness. Consideration is needed concerning the effectiveness of the 80 decibel loudness level range in awakening people asleep at night inside insulated homes.

Weather: Prevailing seasonal wind patterns can deflect projected sound from reaching its targeted area. Air temperature and humidity are also important considerations. Projected sound tends to rise in warm air. A siren's metal parts can corrode in coastal areas and can be damaged by windblown sand in beachfront areas if not designed specifically for those conditions.

Hazard Zones: Hazards that can destroy the siren should be identified. Structures such as buildings or cliffs tend to crumble during earthquakes. When placing sirens within tsunami zone areas, such as beaches, the system controls should be located above the potential water line, but still allow easy access for maintenance.

Convenience: A common problem in site selection is locating sirens next to pre-existing and convenient AC power sources. Convenience is often the determining factor rather than whether the location provides maximum effectiveness for the siren.

Public Opinion: Public objection to a technically ideal location may occur. An ideal site may be avoided because of public criticism concerning the aesthetics of the location or the belief that the proposed siren could negatively impact property values.

The selection of proper placement sites for sirens can lead to expensive alternatives, for example: having to install more units than otherwise necessary, or investing in inappropriately designed equipment. Such problems can be addressed through public education about the hazard and incorporation of the public in the planning process. Once accomplished, the location and effectiveness of the notification system will likely be considered a necessity to minimize casualties in the community.

System Selection and Implementation Considerations

In summary, the selection of the appropriate types of siren units and their effective placement is best realized when:

1. There is acceptance within the community that the hazard, for which the siren system is designed, is very real.

2. There has been full and comprehensive research conducted before final system selection. Communities will need to map out structures and terrain challenges, background noise levels, locations with good line-of-sight, noise sensitive locations, hazard zones, etc. Communities may consider hiring the services of a professional specialist, who is experienced in acoustic surveys and siren equipment. A properly designed system can avoid costly errors made by poor placement and/or investment in siren equipment that is inappropriate to the local need.

Other factors to be considered when selecting sirens are: (interview Cleve Roper, Canon Beach)

- Ensure corrosion resistance of the components that will be exposed to the weather.
- Water-resistance of the parts that shield the non-exposed components;
- Number of moving parts – more moving parts requires more maintenance;
- Sound projection and voice/sound quality and capabilities;
- Operational and maintenance ease and accessibility;
- Repair parts availability and warranty issues; and
- Get references from other users.

Community Examples

A number of communities along the western coast of North America use sirens along their shorelines. Many of the US TsunamiReady communities such as Tillamook County in Oregon, Delnorte County in California and the Kenai Peninsula Borough in Alaska have sirens. Some of these communities received old sirens by donation from industry; while others have purchased sirens new. Most of these communities recommend broadcasting capabilities, especially in those areas in which there is a heavy tourist flow. The initial cost may be substantial but communities may find sponsors to support the installation of sirens.

Cost

Sirens are expensive and can cost from $25,000 to 60,000. Main cost features are: installation, control devices, and sirens. Maintenance budgets also will need to be considered, especially if sirens are located in very rural communities and access is limited (air or water). Sirens are a cost-effective warning means for large areas such as public beaches, both for local residents and tourists.

Why Use Sirens?

Advantages

- Sirens with live public address or pre-recorded message capabilities can also be used before (testing, training, exercising) at minimal additional cost and throughout the incident. Sirens are frequently used before electrical power is restored to notify affected populations about reception centres, shelters, first aid stations, etc.
- Wide area outdoor coverage, especially in areas with no other form of alerting.
- Do not discriminate amongst recipients.
- Can awake/alert indoor residents near sirens and thus supplement indoor alerting systems.
- Units may already be in common use in community for volunteer fire departments or other purposes.
- Can be part of an integrated system using external sirens and small alerting receivers for inside of buildings.
- Widely recognized and have a single focus.
- Public address versions can broadcast in different languages.
- Can have a large number of pre-recorded messages.
- Low current draw required to operate from integral batteries and can be charged by solar panels or other alternative systems (e.g., wind generators) as protection from utility power disruptions.
- Radio controlled and, therefore, can be independent of land line utilities.
- Full time conditioning/monitoring reducing the need for live testing required solely for maintenance purposes.
- Great flexibility in placement of battery powered and radio controlled units. Can be centrally controlled and remotely accessed.
- System controllers that can initiate individual, groups or all sirens.
- System is available 24/7.

Disadvantages

- Additional notification must be provided by other means.
- Devices cannot always be heard in buildings or vehicles or in areas that have high background noise levels.
- Not-audible with high winds.
- For non-public address versions, public must be educated to turn to an additional source to gain more information.
- Public may have to be able to distinguish several different signals for different hazards or intended use.
- Siren soundings must be coordinated with other alerting methods.
- Large numbers of sirens may be needed to cover populated areas and to be loud enough to be heard indoors by most people.
- Must have a reliable power source.
- Poorly protected units can be damaged by waves, wind, sand and salty air.

MASS NOTIFICATION METHODS
Outdoor System: Mobile Sirens

As indicated under sirens, these systems are designed to provide a rapid alert to potentially threatened populations. They are currently one of the most reliable mass notification means of alerting outdoor populations. When sirens are properly situated and scaled for coverage, they can reach all populations, including those in isolated areas (e.g., beaches). A key factor for mobile community sirens is that they can be quickly moved to different locations.

GENERAL CHARACTERISTICS

For more information on general characteristics please review the section on Sirens. The only difference in structure is that these sirens are placed on trailers and moved to different locations. (Note: the use of small sirens for emergency vehicles is discussed in Section 3.4.3).

Fixed vs. Mobile Sirens

Fixed sirens are strategically placed in permanent locations. These sirens are usually accepted by the public and understood; especially if they have broadcasting capability to provide more information. As with fixed signs, the public will acknowledge and expect to receive information from these devices. These sirens are used to pre-warn of an impending disaster and especially with a short-term warning period.

Ease of moving the mobile sirens are a key feature. They are lightweight and portable, and set-up time is usually only a few minutes. They can be moved to locations where they are most needed: evacuation areas, large intersections, evacuation routes. They are also useful in terms of avoiding possible destruction from the disaster itself. However, the public may not be expecting these sirens in certain locations. Emergency personnel will need to ensure that prior education is given for recognizing the siren tones. For these reasons, it is important to consider including public address broadcasting capabilities with the sirens.

Costs

Mobile community warning sirens range in costs from $25,000 to $60,000. Costs of this equipment includes: the siren unit, activation and control devices and the trailer on which it is mounted.

Why Use Mobile Siren Systems?

ADVANTAGES

- Good to use in situations when there is a long warning period.
- Can be moved to where information is most needed.
- Widely recognized and have a single focus.
- Public address versions can broadcast in different languages.
- Can have a large number of pre-recorded messages.
- Solar or battery.
- Maintenance – can be done centrally or remotely.
- More cost effective than fixed signs – because allows for flexibility in moving the sign.

DISADVANTAGES

- Not good in situations when there is a short warning period.
- Takes time to move to a location.
- May be difficult if roads are destroyed and there is no access.
- Public may have to distinguish between several different signals for different hazards or intended use.
- Siren soundings must be coordinated with other alerting methods.
- May be vandalized if left in public spaces.

MASS NOTIFICATION METHODS
Outdoor Systems: Electronic Signs

An important visual outdoor warning system, often overlooked but widely available in most regions, are highway message boards. You may notice them along the highways and at many highway construction sites. Motorists today already see most of these signs as providing cautionary simple text messages or symbols regarding roadway conditions (e.g., severe weather conditions, roadway constructions, roadway closures). Mobile systems are usually trailer-mounted, can be easily moved from location to location and are often self-powered by solar energy.

Signage systems can be very useful during and after emergency events. These systems form an important supplement to acoustic outdoor systems, especially for a motorist that may not hear sirens or may not be tuned to an alerting radio station. The messages may contain information such as: "Tsunami Warning, Proceed North Immediately", "Flood Risk Area, No Entry, Tune to AM 1160 for Info" or "Warning, Hazard Ahead, Turn Around Now". Electronic signs can also be utilized to show pedestrian evacuation routes and give emergency status updates at staging areas.

Signage units may already exist in your community or region. Consider:

- Establishing agreements with local highways maintenance and construction firms who own and operate systems.
- Conducting an area survey to determine the most suitable locations for their deployment.
- Pre-scripting messages.
- Using them at major public events so populations become more familiar with their usage.

GENERAL CHARACTERISTICS

The main characteristics of an electronic signage system are: the control system, message capabilities, and fixed or mobile structure.

Control Systems

Signage systems are usually centrally controlled and can be connected to any agency's LAN or WAN. Systems also have local/remote control switches, ethernet ports, and dial-up modem capabilities. An optional fiber-optic controller-to-VMS interface cable will eliminate electromagnetic interface[12].

Maintenance personnel can centrally monitor subsystems such as power supply voltages, LED pixels, temperature and humidity.

[12] Daktronics Canada, 2005

Message Capabilities

The message capabilities of these systems rely on a number of factors: size of the sign and characters, resolution of the sign, the viewing cone and the changeability of the message. All of these factors focus on the need to get a clear message to motorists who may be traveling at high speeds or to pedestrian traffic.

Size of Signs

Signs vary in size. The bigger the sign the more message capability it will have. Usually signs will have three to four lines and offer options on the number of characters that can be displayed and on the size of characters. Manufacturers recommend that character sizing should be normally 18" for traffic exceeding 60 km/h which will allow for an approximate viewing distance of 1000 feet. Below is a table which outlines character sizing, speed and viewing distance.

Viewing Ranges (approximate)

Use this table to help determine the appropriate character size for a customer's display based on viewing distance and the speed at which the audience may be traveling.

Character Height in Inches	Max. Viewing Distance In Feet	Viewing Exposure in Seconds				
		20 MPH (29.3)	30 MPH (44.0)	40 MPH (58.7)	50 MPH (73.3)	60 MPH (88.0)
9	450	15.4	10.2	7.7	6.1	5.1
15	750	25.6	17.0	12.8	10.2	8.4
18	900	30.7	20.5	15.3	12.3	10.2
24	1200	41.0	27.3	20.4	16.4	13.6
30	1500	51.2	34.1	25.6	20.5	17.0

Figure 1: Daktronics Canada

Sign Resolution

Resolutions of the signs vary. Full-colour, high-resolution full-matrix variable message signs that allow choice monochrome amber or full-color, are available. This sign will also display graphics such as road signs (e.g., closures, turns, speeds). All new signs are equipped with LED lights.

Viewing Cone

The viewing cone is the angle at which the sign is read. Proper location for the sign is important. Both fixed and mobile signs have different viewing angles ranging from 15° to 70°.

Changeability of Message

Modern sign systems are capable of storing 100 preprogrammed messages. These messages may be changed from a central location or on-site. Messages can only be a certain length and should be short and concise, and can be in different languages.

Fixed vs. Mobile Signs

Fixed signs are usually larger than mobile signs giving them more of a capability in displaying longer messages. Another advantage is, when placed in a permanent position, the public tends to rely on that sign for emergency information and will look for it. Signs need to be placed in strategic locations where they will be most useful. (Example: main road used as the major evacuation route from an area).

Mobile signs are flexible and can be placed where they are most needed (rural evacuation routes or staging areas). These signs have less message capability and must be placed according to their viewing cone areas.

Cost

The cost of mobile units is approximately $25,000 each while fixed units may be as high as $250,000 (depending on the structure the unit is placed on).

Why Use Electronic Signage Systems?

ADVANTAGES

- Highly visible – many models have LED lights and dimmer capabilities – can be seen up to 1500 feet.
- Fixed signs – public know to look for information.
- Mobile signs – can be moved to where information is most needed.
- Can be repeated and/or updated.
- Remote and central programmability.
- Can be preprogrammed with many messages and in different languages.
- Solar or battery powered.
- Maintenance – can be done centrally or remotely.
- Available 24/7.

DISADVANTAGES

- Time of day and weather conditions may affect visibility of sign.
- Distance and speed of vehicles are a factor in clear visibility.
- Limited capability depending on size of sign.
- May not be able to program remotely due to model.
- Large letters limit message length capability.
- May be vandalized if left in public spaces.

3.3 MASS NOTIFICATION METHODS

3.3.2 BROADCASTING SYSTEMS

Conventional Radio and Television
Cable Television
Low Power Radio

MASS NOTIFICATION METHODS
Broadcasting Systems: Conventional Radio and Television

Radio and television are among the best mass media for distributing general information to a wide area, including emergency instructions and updates. But mass media might not be best for first level notification. For emergency broadcasting to be effective as an alerting tool, it is essential for the intended audience to be tuned to a designated radio or television channel or to be situated within hearing and/or viewing range.

Market research has indicated that there are considerable differences between the use of radio and TV at different times of the day. During the day more people listen to the radio; far fewer watch TV. This pattern changes in the late afternoon and evening when TV becomes the principal broadcast medium that the public uses to receive information. During the night, when most people are sleeping, most broadcast technologies are ineffective. These challenges make it necessary to use other means (sirens, telephones, etc) to first alert populations and to direct them to tune to designated stations for instructions.

GENERAL CHARACTERISTICS

Operations

Over the past decade, many changes have taken place concerning how stations are managed, staffed and programmed. Traditionally, private stations were locally operated and programmed, with on-air staff usually residing in the local community. Today, with the advent of networking, many commercial stations are programmed from other locations with limited or no local on-air staff or limited hours when staff is available at the station. Many community transmitters are simply re-broadcasting the entire programming content of another station located out-of-area and have no local program facilities. In other cases, there may be no local over-the-air station service at all, but programming is available via cable television, satellite or Internet stream. Another trend is the licensing of small low-power private or community-owned FM stations that provide an alternative source of local or regional programming. Establishing and maintaining regular contact with station managers is important to ensure emergency personnel are familiar with station operations, points of contact and broadcast coverage arrangements.

PEP and Broadcasters

Broadcasters throughout British Columbia routinely broadcast official “Advisories”, "Watches" and "Warnings" issued by Environment Canada and usually have standard operating procedures for receipt and broadcast of these messages. As part of the B.C Tsunami Warning System, stations are also notified by PEP of Tsunami Watches and Warnings. Many stations now operate local web sites that also provide up-to-date local news and weather information as well as live or pre-recorded audio and/or video programming data streams.

Local Warnings

Some communities, as part of their ongoing preparedness planning, have made prior arrangements with stations to broadcast supplementary information to residents during emergencies, such as floods, urban-wildland interface fires, dangerous goods incidents, etc. Similar arrangements should be considered for tsunami warning. While content may need to be tailored and submitted on a just-in-time basis to suit immediate emergency circumstances, standardized instructions, such as how to personally prepare for evacuation, how locate safe areas and reception centres, can be pre-scripted and stored with stations' news departments. When stations receive emergency messages, they will require some form of authentication, which should be in place before emergencies occur. Plans for how to contact the stations should also be pre-planned. Most stations rely upon telephone, fax and email for notification.

Emergency Program Interruption

In some regions of North America, broadcasting and cable television facilities have been fitted with special equipment that enables authorized national, state and local emergency managers to provide warning messages directly to listeners and viewers. In the United States, these arrangements have been mandated by the U.S. federal government and are organized through a national program called the "Emergency Alert System" which has established technical standards, implementation requirements and procedures for activation. EAS allows broadcast stations, satellite radio, cable systems, participating satellite companies, and other services to send and receive emergency information quickly and automatically, even if their facilities are unattended.

In Canada, there is no national equivalent to EAS. A provincial system similar to EAS called the "Alberta Emergency Public Warning System" (EPWS) has been developed by the Province of Alberta (in conjunction with CKUA). The EPWS instantaneously broadcasts warnings of imminent and life-threatening danger (short fuse warnings) through radio and television stations and cable systems under a contract between the CKUA Radio Network and the Government of Alberta (represented by Emergency Management Alberta). A series of CKUA transmitter sites, situated around the province, can be activated using the system. All other on-air broadcasters in Alberta can also receive an EPWS signal either locally or through a network. The system can be activated by local municipal officials, the Environment Canada weather office, or Alberta Environment's Flood Forecast staff. Although participation is voluntary, EPWS is a model of effective cooperation between government and private sector broadcasters.

There are no similar arrangements available in British Columbia; however, the CBC, Pelmerex (The Weather Network) and ExpressVu have all announced plans to offer automated public warning services in the near future.

In the meantime, it is possible that communities could negotiate agreements for access to local stations serving their areas. But, such arrangements could quickly become complicated if the station serves more than one community and/or is not programmed from a local facility. In such cases, arrangements will need to be coordinated on a regional and perhaps even provincial basis.

Radio and TV Stations

For a listing of your BC radio and TV stations go to the website Broadcast Dialogue. (http://www.broadcastdialogue.com/directory_simple.asp).

Why Use Radio?

Advantages

- Instant communication to all affected people if tuned in.
- Gives detailed information, and can keep people up to date.
- Generally, universally available and affordable (most people have a radio receiver).
- Respected medium. Local radio stations usually have close ties with the local community; at their best, they are a valued part of the local social structure.
- Can be used indoors, outdoors and in moving vehicles and water craft.
- Battery operated receivers can work during power outages with battery operated radios and can reach people inside their cars and outside of their homes.

Disadvantages

- Have to be tuned in to receive warning.
- Limited usefulness during periods of the day - and especially in the late evening/early morning if turned off
- Will reach people not affected by the emergency, potentially causing unnecessary concern and/or unwarranted actions.
- Depending upon staffing and program scheduling may not be accessible during late evening/early morning periods.
- Poor over-the-air reception or no local radio service in smaller communities and/or many rural areas.

Why Use Television?

Advantages

- Instant communication to all affected people if watching.
- Gives detailed information, and can keep people up to date.
- Can reach people indoors.
- Generally, universally available (majority of households have a TV).
- Respected medium, especially with utilization of a local or regional newscaster (e.g., a "familiar face")
- Television is an excellent source of emergency information. Graphics, such as maps, can be used to describe the event in detail.

Disadvantages

- Limited usefulness during daytime when most people are at work or school and in the late evening/early morning when TV is turned off.
- Limited usefulness outside of the house.
- Will reach people not affected by the emergency, potentially causing unnecessary concern and/or unwarranted actions.
- Poor over-the-air reception or no local programming service in smaller communities and many rural regions.
- May require cable television or satellite reception to receive programming.
- Not available during power outages.

MASS NOTIFICATION METHODS
Broadcasting Systems: Cable Television

Residents in many coastal communities receive radio and television as well as Internet and other services through local cable television providers. While generally not equipped to easily do so, cable television systems can be outfitted to interrupt regular programming and provide audio and video warning messages on all programmed channels. To enable such a capability will require special agreements between communities and cable companies, as well as additional technical modifications to cable systems. As new digital services continue to roll-out over cable systems, technical arrangements for inserting warnings may need to be regularly upgraded to ensure that they remain compatible with current receiver technologies.

It may be more practical to explore how existing facilities can be used to support public warning. Some of the most obvious services include the alphanumeric text message channels and the local community programming channel. Alphanumeric channels, like mobile outdoor message signs, often can be programmed from a remote location and enhanced with graphics such as maps, familiar emergency logos, etc. The community programming channel can provide a means to broadcast live emergency messages and ongoing coverage throughout the emergency period if power is available and the cable system infrastructure is not impacted by the emergency.

Why Cable Television?

ADVANTAGES (locally programmed channels)

- Widely available for indoor use.
- Gives detailed local information, and can keep people up to date.
- Text messages can be repeated until emergency is over.
- Messages can be regularly updated.
- Full programming service channels can carry a wide variety of live and pre-recorded information, including a message "crawl" over video programming.

DISADVANTAGES (locally programmed channels)

- Must have cable TV service.
- Must have receiver turned on.
- Must be tuned to specific channel.
- Not suitable for initial alert, but could be used to provide additional instructions if people know in advance to turn to the channel.
- Limited usefulness during periods of the day - and especially in the late evening/early morning if turned off.
- Not available during power outages.
- Programming staff not generally available on a 24/7 basis.
- Poor service coverage outside communities and/or in rural areas.

MASS NOTIFICATION SYSTEMS
Broadcasting Systems: Low Power Radio

In addition to mainstream radio broadcasting, a new form of local Canadian broadcasting has emerged. Low power broadcasting stations take advantage of relatively inexpensive programming insertion and transmission equipment and transmitters. These range in power from less than one Watt upwards to 50 Watts. Extremely low power stations are operated for many purposes including from real-estate, car dealership drive-by promotion and special outdoor events. Slightly more powerful stations are often operated by local commercial not-for-profit and commercial enterprises, especially in rural and remote communities. Some provide a full range of programming services while others serve as network rebroadcast stations.

GENERAL CHARACTERISTICS

Special low power AM and FM stations are also used by communities for temporary emergency broadcasting purposes. The equipment is similar to that used by community stations, with fixed or portable transmitters. Program insertion (studio) equipment can be integrated with the basic transmitter or separated and operated as a remote unit. Some communities have purchased their own equipment to be able to broadcast to their residents on a specific broadcast frequency. Depending upon the transmitter power, topography and any other physical obstructions, type of antenna and location, coverage may range from a few hundred metres to about 10 kilometres. Most units permit battery operation. Costs range from about $3,500 to $10,000.

Licensing and Regulation

Depending upon the system chosen and intended use, some systems are fully exempt from requiring government authorization to operate, while others are partially exempt. These requirements are discussed in more detail below.

All forms of broadcasting in Canada are regulated by two government organizations, Industry Canada and the Canadian Radio-television and Telecommunications Commission (CRTC). To operate an FM broadcasting transmitter, one must apply for a Broadcasting Certificate from Industry Canada and a Broadcasting Licence from the CRTC. Industry Canada, the Radio Frequency Spectrum Manager, determines if the proposed transmission is compatible with other broadcasting transmissions, as well as non-broadcasting transmissions. The CRTC regulates the programming content and ownership issues. Under certain circumstances, low power radio may be exempt from CRTC licensing requirements.

CRTC exemption order respecting public emergency radio undertakings

For emergency broadcasting purposes, the CRTC has chosen to exempt certain classes of low power AM and FM stations from licensing. Communities or emergency agencies may be exempt from licensing if they meet the following criteria, as set out in Public Notice CRTC 2000-11:

- The undertaking meets all technical requirements of the Department of Industry and has acquired all authorizations or certificates prescribed by that Department.
- The undertaking operates between 525 and 1705 kHz in the AM frequency band or between 88 and 107.5 MHz in the FM frequency band.
- The undertaking broadcasts at a power of 5 watts or less transmitter power for AM or with an Effective Radiated Power (ERP) of 5 watts or less for FM.
- The undertaking is operated by a member of a police department, fire department or any organization designated by a federal, provincial or municipal government as being responsible for the coordination of emergency relief.
- The programming provided by the undertaking is information and instruction regarding a public emergency.
- The programming provided by the undertaking contains no music or advertising material.
- The programming is live or pre-recorded and, if the latter, is broadcast within 24 hours of the original recording.
- The undertaking broadcasts its programming over a period of not more than seven consecutive days.
- The undertaking does not broadcast programming that is religious or political in nature.

Industry Canada Authorization

Because Industry Canada and the CRTC are responsible for different aspects of broadcasting, a broadcasting transmitter exempt from CRTC's licensing is not automatically exempt from Industry Canada's authorization requirement. Most transmitters may still need to meet authorization requirements from Industry Canada. Industry Canada, which also has a role to play in facilitating emergency telecommunications, is prepared to work with emergency organizations during an actual emergency to streamline authorization and to give access to radio spectrum as soon as possible. It is not prepared to give blanket exemption to all low power transmitters.

Industry Canada exempted low power radio

The only radio broadcasting transmitters Industry Canada exempts from authorization are Low Power Announcement Radios, or real estate radios. These have very small coverage areas. Transmitter coverage ranges between 100 to 1000 metres depending upon obstructions, atmospheric propagation conditions and antenna height. Small, self-contained units are designed to be used as portable or fixed transmitters and enable live voice or pre-recorded messages to be broadcast. Typically, stored messages are 8-10 minutes in length that can be looped for continuous repeat. These units are typically installed in locations along roadsides and public spaces where listeners are expected to stop or park long enough to hear the recorded messages. Locations during emergencies could include parking lots outside reception centres, evacuation safe sites, special care facilities, etc. In some cases, they are integrated with electronic message signs.

Additional information about regulation is available at:

Canadian Radio-television and Telecommunications Commission (CRTC)

- Home page
  http://www.crtc.gc.ca
- Exemption order respecting public emergency radio undertakings**,** CRTC 2000-11
  http://www.crtc.gc.ca/archive/ENG/Notices/2000/PB2000-11.htm
- Community radio policy, Public Notice CRTC 2000-13
  http://www.crtc.gc.ca/archive/ENG/Notices/2000/PB2000-13.htm

Industry Canada

- Frequently Asked Questions on Low Power FM Broadcasting
  http://strategis.ic.gc.ca/epic/internet/insmt-gst.nsf/en/sf02087e.html
- Application for a Broadcasting Certificate Very Low Power FM (VLPFM) or Very Low Power Television (VLPTV) in Small Remote Communities
  http://strategis.ic.gc.ca/epic/internet/insmt-gst.nsf/en/sf06113e.html

Why Use Low Power Radio?

Advantages

- Instant communication to all affected people if tuned in.
- Gives detailed information, and can keep people up to date.
- Generally, universally available and affordable (most people have a radio receiver).
- Community owns its own station and can use it at any time.
- Can be used indoors, outdoors and in moving vehicles and water craft.
- Battery operated receivers can work during power outages with battery operated radios and can reach people inside their cars and outside of their homes.

Disadvantages

- Have to be tuned in to receive warning.
- Limited usefulness during periods of the day - and especially in the late evening/early morning if turned off
- Requires trained staff to operate who must be available at all times.
- Limited coverage, especially in outlying rural areas.

3.4 ADDRESSABLE NOTIFICATION METHODS

3.4.1 BROADCASTING SYSTEMS

Amateur Radio
Canadian Coast Guard
Weatheradio (Environment Canada)

ADDRESSABLE NOTIFICATION METHODS
Broadcasting Systems: Amateur Radio

Amateur radio, often referred to as "ham radio", is a hobby enjoyed by many thousands of people throughout the world. Amateur radio operators use two-way radios to communicate with each other. Unlike other personal radio services such as CB radio, Family Radio Service (FRS) or General Mobile Radio Service (GMRS), amateur radio operators are required to pass an examination and be government certified.

Amateur radio operators have access to special frequencies throughout the entire radio frequency spectrum. Choice of frequency allows for effective communication across a community, region, country, continent or the entire world, regardless of season, time of day or night. The use of shortwave frequency bands, or HF bands, can facilitate worldwide and inter-regional communication, the use of VHF and UHF bands local and regional communication and the use of microwave bands can provide enough bandwidth for television and high-speed data transmissions.

In contrast to commercial and personal radio services, most radio amateurs are not restricted to using government type-approved equipment. They can construct or modify radio equipment in almost any way so long as they meet radio regulations and national and international non-interference standards.

EMERGENCY COMMUNICATION CHARACTERISTICS

Amateur radio has a long history of public emergency communication service. This is particularly true during natural disasters that cripple public telecommunications and broadcasting services, and where amateur radio is often the only surviving means of communication.

Amateur radio operators have the skill, equipment and experience to provide immediate support when other communication methods are unavailable. Recent examples include the December 26, 2004 tsunami that spread across the Indian Ocean and destroyed all communication with the Andaman Islands. A remote amateur radio post provided a critical link with the Indian mainland to coordinate relief efforts. During Hurricane Katrina in September, 2005, amateur radio was used to coordinate disaster relief activities when other systems failed. In British Columbia, amateur radio played a key backup communications role for interior communities during the 2003 wildland-urban interface fires.

Amateur radio is suitable for emergency activities because most of the radio equipment used is battery powered, highly portable and capable of operating on a wide variety of frequencies. This enables interoperability across frequency bands and rapid deployment of networks within and outside communities. Operators are also generally well-versed in improvising and restoring communications under the primitive conditions (as maybe found during disasters) because they practice this skill as a key part of their hobby. An annual international contest event called

“Field Day” gives amateur radio clubs and an opportunity to practice emergency preparedness by establishing emergency stations using temporary antennas and emergency power.

Organization of Emergency Amateur Radio Services in British Columbia

Within British Columbia, the Provincial Emergency Radio Communications Service (PERCS) operates in support of the British Columbia Provincial Emergency Program and communities in B.C. The PERCS concept was developed to create a unique sense of identity and source of information for amateur radio volunteers. A Provincial Emergency Radio Advisory Committee (PERAC), composed of amateur radio operators, provides advice on issues relating to emergency radio communications.

At the national level, emergency amateur radio services are organized and coordinated through the national Radio Amateurs of Canada Amateur Radio Emergency Service (ARES). The emergency-preparedness program of ARES is linked to the daily message traffic-handling program of the National Traffic System (NTS). In an emergency, the NTS serves to relay message traffic over medium and long distances while local ARES networks take care of local communications and deliveries.

In partnership, both PERCS and ARES organizations support the continuing development of an emergency radio communications capability within the British Columbia amateur radio community. This is achieved through a number of coordinating functions and is not limited to the following:

- maintenance of resource and qualification lists;
- development of training materials and conduct of training activities;
- development, conduct and evaluation of emergency communications exercises.

At the local authority level, a Municipal Amateur Radio Coordinator (MAC) and Deputy (DMAC) are responsible for developing a local Amateur Radio Communications Plan. All local amateurs, the local authority’s Emergency Plan Coordinator(s), and the Regional Amateur Radio Representative (RARR) and Deputy(s), as well as the MAC and DMAC in the neighboring communities should all have copies of this plan.

The MAC and DMAC are responsible to the local authority’s Emergency Plan Coordinator and/or Municipal Emergency Communication Coordinator. The MAC and DMAC need to work with the municipal emergency staff to ensure that the Amateur Radio plan fits into the municipal plan. While the local authority should have a Municipal Emergency Communication Coordinator (MECC) to oversee all modes of communication, not just radio, in smaller communities the MAC or DMAC often fills this role.

Emergency Communication Functions

Many operational functions are supported by local and regional amateur radio emergency networks including:

- Voice and data messaging

- Dispatch
- Surveillance and notification

Voice communication allows the user agency to pass messages over voice networks connecting several locations inside and outside the impacted area. The messages may be pre-written and forwarded using a standardized format (similar to telegrams), or unwritten where personnel of the user agencies may talk with each other.

Data communication allows the user agency the ability to pass messages over a digital radio network connecting several locations inside and outside the impacted area or region. These messages are entered by computer keyboard and transmitted to another location. Typically these messages contain lists of items or details of such complexity and length that using the voice traffic service is impractical.

Dispatch allows the user agency the ability to direct the movements of radio equipped vehicles over a voice network connecting the dispatch location and the vehicles. The dispatcher is located in the Emergency Operations Centre (EOC). Amateur radio operators and their equipment may also ride in an agency's vehicle to provide a radio link.

Surveillance allows the user agency to monitor and control activities in an area using a voice network. Monitoring is carried out by amateurs, using hand-held radios, either working by themselves or in conjunction with representatives of the user agency. Typically the amateurs monitor parking lots, roadways, special facilities and crowds to report any problems that arise.

In some cases, amateurs are trained and help in early warning phases as trained spotters and observers (storm and flood watchers, and even tsunami wave observers when situated in safe locations). With today's available technology, many amateur groups can also install remote wireless camera systems to enhance these activities, especially in high risk areas. They can incorporate many of the features of commercial notification systems into their infrastructures, including paging and tone-alert radio, radio-activated alarms and sirens, hazard detection and monitoring equipment, etc.

Emergency Networks and Supporting Infrastructures

Several provincial and regional radio networks operate in the province to support emergency communications during emergencies and disasters. These are primarily operated on HF and VHF frequencies.

BC Public Service Net

The BC Public Service Net on 3729 KHz is used to assign jobs and dispatch amateur radio operators. During emergencies, radio amateurs check into this net and stand by on its frequency for further instruction and to handle message traffic.

PEP Net

The Provincial Emergency Program emergency amateur radio network, PEP Net, provides a link to the National Traffic System (NTS) for the relay of Health and Welfare traffic outside the province. PEP Net also assists with the handling of message traffic within BC when required.

During an emergency, the primary intention of the PEP Net is to establish and maintain communications between the Provincial Emergency Coordination Centre and the Provincial Regional Emergency Operations Centres. This network may also be used by federal departments, provincial ministries and agencies, communities, and key external agencies to communicate with the PECC or PREOCs when other means of communication are not available.

Operating Frequencies

Frequency:	1900 KHz	3735 KHz	7060 KHz
Mode:	Lower Sideband	Lower Sideband	Lower Sideband
Band:	160 Metres	80 Metres	40 Metres

The primary frequency for PEP Net is 3735 KHz Lower Sideband on the 80 Metre HF band. During activation the net control station will monitor 2 of the above noted frequencies and call for net check-ins. Frequencies selected will depend on signal propagation conditions. If the frequencies identified above are in use, the net control station will move in +5 KHz increments within the designated HF band. When a clear frequency has been identified following this procedure, the net control station will initiate the directed net.

Regional Networks

Many regions in the province operate HF and VHF networks to provide emergency communication support to and between communities and their associated Provincial Regional Emergency Operations Centre. PEP operates amateur stations at each PREOC, as do most communities at their EOCs. Many of the voice VHF and UHF local area repeaters are now networked across the province, enabling several individual sites to be quickly linked together to form wide area regional networks. An example is the Vancouver Island Trunk Radio System that links amateur radio repeaters all the way up the east coast of Vancouver Island and inland as far as Port Alberni.

Traditionally, linkages between sites have been provided through radio-based backbone networks. More recently, they have been supplemented by the use of Internet connections (utilizing Voice-over-IP) in two associated projects: Internet Radio Linking Project (IRLP) and EchoLink.

Many of the regional networks also support packet data transmission. The most recent version, known as Winlink2000, is capable of sending information such as electronic mail to and from the Internet from HF, VHF and UHF radio systems. Using the Winlink2000 system, any amateur with a properly equipped radio can quickly establish a data pathway to the Internet via a participating WinLink radio station without having to rely on satellites or other terrestrial Internet services. In 2004, a permanent emergency HF WinLink gateway was installed at Simon Fraser University in partnership with several Vancouver area amateur radio clubs. In 2005, the British Columbia Wireless Amateur Radio Network (BCWARN) was formed to manage these activities as well as begin building a provincial broadband amateur radio data network to integrate and provide enhanced emergency communications in all its forms (Winlink, VoIP, WWW, Email, etc).

Contact and Additional Information

Provincial Emergency Radio Communications Service (PERCS)

Website: http://www.percs.bc.ca/

PEP North West Region
Mike Pilon - VE7DQC
Email: mpilon@princerupert.ca
Telephone: 250-638-2151
(PEP Terrace Regional Office)

PEP South West Region
Mike Andrews – VE7MPA
mike.andrews@
604-586-4373

PEP Vancouver Island Region
ED Gorse – VE7ED
Email Address: vir.rerr@percs.bc.ca
Telephone: 250-412-7879

Radio Amateurs of Canada

Website: www.rac.ca/

Amateur Radio Emergency Services (ARES)
Website: www.rac.ca/fieldorg/racares.htm
ARES BC Section Manager
Drew Watson, VA7DR
Email Address: drwatson@uniserve.com
Telephone: 250-537-9159

Coastal Region Amateur Radio Clubs and Networks

- Arrowsmith Amateur Radio Club (Port Alberni)
  Website: www.angelfire.com/ar/arrowsmithclub/index.html
- Base Amateur Radio Club (CFB Esquimalt)
  Website: www.ve7rcn.ca/
- BC Boaters' Net
  Website: www.qsl.net/bcbn/
- BC Wireless Amateur Radio Network
  Website: wiki.bcwarn.net/bcwarn-wiki/BCWARN
- Comox Valley Amateur Radio Club
  Website: members.shaw.ca/cvarc/home.htm

- Greater Victoria Municipal Amateur Coordinators Committee
  Website: www.qsl.net/gvmacc/index.html
- Nanaimo Amateur Radio Club
  Website: www.nara.nisa.com/
- Vancouver Island Trunk System
  Website: www.islandtrunksystem.org/
- Vancouver Emergency Community Telecommunicators Organization (VECTOR)
  Website: www.vector.comm.sfu.ca
- Victoria Amateur Radio Packet Association
  Website: www.horizon.bc.ca/~varpa/
- Westcoast Amateur Radio Association (Victoria)
  Website: www.islandnet.com/~ve7vic/index.html

EchoLink

- Home page: http://www.echolink.org/

The Internet Radio Linking Project

- Home Page: http://www.irlp.net/
- Ham.net: http://www.eham.net/newham/irlp

WinLink2000

- Home Page: http://winlink.org/

Why Use Amateur Radio?

Advantages

- Can play an important backup communications role between EOCs and strategic community locations during emergency events.
- Most equipment is portable and can operate independently from the main electrical system.
- The wide variety of available amateur radio frequencies enables multiple networks to be established to serve different emergency support functions.
- Most communities have certified amateur radio operators.
- Equipment is often already in place and maintained by local and regional clubs.
- Increasingly, amateur radio is becoming interoperable with other communication systems (e.g., Internet email, VoIP, etc.).

Disadvantages

- Due to the volunteer nature of the hobby, not always possible to recruit and train enough operators to support a lengthy emergency operation.
- Roles for amateur radio in public warning in B.C. have not been clearly defined by most jurisdictions.
- Operators of amateur radio must hold certificates of proficiency.
- Limited VHF radio coverage on West Coast of Vancouver Island and in Central Coast Region.

ADDRESSABLE NOTIFICATION METHODS
Broadcasting Systems: Canadian Coast Guard Radio

The Canadian Coast Guard serves a broad stakeholder group ranging from the general public, to commercial shippers, ferry operators, fishers, recreational boaters, coastal communities, other government departments, other levels of government and international organizations. Its primary objective is to ensure safe and accessible waterways through five fundamental mandated roles:

- maritime safety;
- protection of the marine and freshwater environment;
- facilitation of maritime trade and commerce and maritime accessibility;
- support to marine science; and
- support to Canada's federal maritime priorities.

In the maritime realm, the lead for on-water safety falls to the Canadian Coast Guard. Within the Pacific Region, the Coast Guard carries out its responsibilities over 27,000 km of coastline, in Yukon Territory and British Columbia through an extensive maritime transportation service network. The network is comprised of marine communications and traffic services (MCTS), aids to navigation system, search and rescue, fisheries patrol, marine pollution monitoring and clean-up, channel sounding, and scientific studies and research duties. For tsunami warning purposes, the MCTS is particularly crucial in providing aid in the warning and recovery stages.

GENERAL CHARACTERISTICS

The Canadian Coast Guard's extensive network offers one of the most practical mass notification methods to alert marine and some land (especially remote) populations along the entire B.C. Coast. The Distress Communication system on the west coast involves the Pacific Region Centres and uses designated tsunami warning procedures.

Distress Communication

MCTS provides the initial response to ships in distress and is a cornerstone in marine information collection and dissemination. MCTS provides: marine safety communications co-ordination with rescue resources and Joint Rescue Co-ordination Centre Victoria (JRCC); vessel traffic services and waterway management: broadcasts marine safety information such as weather bulletins, tsunami warnings and notices to shipping.

Pacific Region Centres

In the Pacific Region, there are five MCTS centres located at Vancouver**,** Victoria**,** Prince Rupert**,** Comox and Tofino. The Regional Marine Information Centre (RMIC) is also located in Vancouver and administers all Notices to Shipping, Advance Arrival Notices, Coordinated Vessel Traffic Services (CVTS) and Pollution, Defect and Deficiency reports and various callout procedures. All centres are connected to an extensive marine radio communications network which provides continuous coverage of the entire B.C. Pacific coastal region (See Figure1). The network comprises a series of MF, HF and VHF stations as well as Inmarsat C satellite interconnection. For safety purposes, each centre monitors a key set of designated safety channels and provides marine weather forecasts and other safety information through one or more of four designated VHF weather frequencies as part of its Continuous Marine Broadcast Service (CMBS). These same weather frequencies are used by Environment Canada in other regions for its Weatheradio program. A radio-teletype service, known as NAVTEX, broadcasts similar information to fully automated receivers (on 518 kHz) that can receive broadcasts in coastal regions 300 to 400 nautical miles offshore.

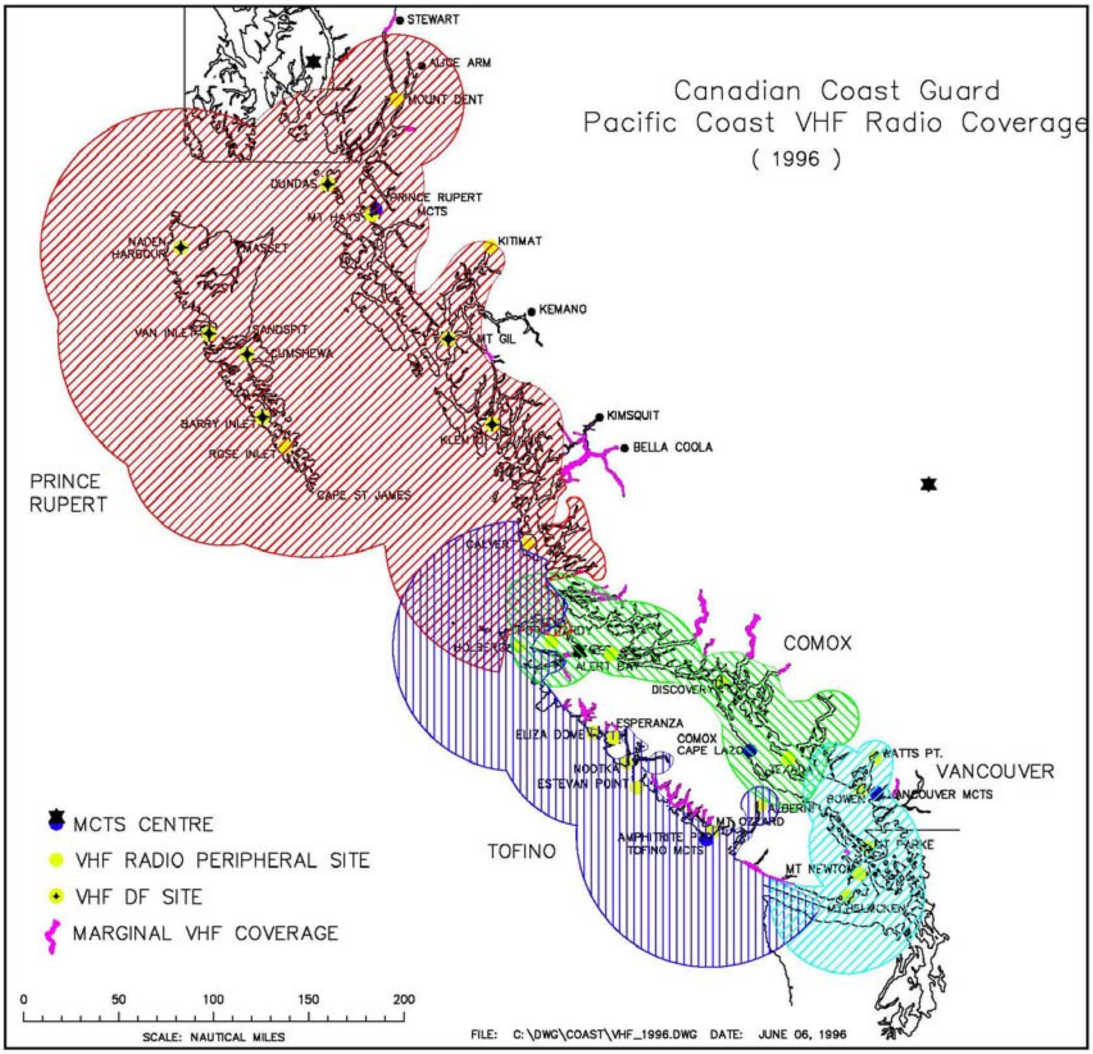


Figure 2: Canadian Coast Guard Pacific Coast VHF Radio Coverage (Canadian Coast Guard website)

Digital Selective Calling

As part of a Global Maritime Distress and Safety System (GMDSS) initiative, new marine VHF and MF radio models are equipped with a Digital Selective Calling (DSC) feature that allows selective calling on VHF Marine Channel 70 and MF 2187.5 kHz. Normally, after establishing contact on the DSC channel, both parties will change to an agreed voice channel to communicate. To make a digital call each radio must have an identity, a 9-digit Maritime Mobile Service Identity (MMSI) number that can be obtained free of charge, by Industry Canada. An important safety feature of a DSC radio is that it can initiate a special Distress Alert which will tell the Coast Guard and other boaters in the area that the caller requires immediate assistance and, if equipped with a Geographical Positioning Satellite (GPS) device, will automatically let rescuers know the radio's exact location. Although a DSC receiver will normally only respond to its individual Maritime Mobile Service Identity number call, all DSC receivers in a given area can be mass alerted by an "All Ships" DSC call. Some VHF models have a DSC watch function that monitors Ch70 while receiving another channel. Upon receiving a distress call it will automatically switch to the Coast Guard Safety Channel 16 to receive follow-on voice communication.

Radio Licensing for Pleasure Crafts

Since April 1999, VHF marine radios on pleasure boats no longer need to have a ship station radio licence within Canadian waters. This is generally not the case for commercial class vessels and if operating a marine radio in U.S. waters. Further, any person who uses a marine radio to transmit must possess a Restricted Radiotelephone Operator's Certificate (ROC).

For additional information:

Canadian Coast Guard

- Pacific Region Home Page: http://www.pacific.ccg-gcc.gc.ca/
- Marine Communications and Traffic Services (MCTS) http://www.pacific.ccg-gcc.gc.ca/mcts-sctm/index_e.htm

Industry Canada

- RIC-13 Technical Requirements for the Operation of Mobile Stations in the Maritime Service. http://strategis.ic.gc.ca/epic/internet/insmt-gst.nsf/en/sf01011e.html
- RIC-22 - General Radiotelephone Operating Procedures http://strategis.ic.gc.ca/epic/internet/insmt-gst.nsf/en/sf01020e.html
- RIC-26 - Study Guide for the General Operator's Certificate http://strategis.ic.gc.ca/epic/internet/insmt-gst.nsf/en/sf01021e.html

Coast Guard Tsunami Warning Procedures

All tsunami related messages for general marine traffic are designated URGENT and broadcast at a Centre. Messages are also placed on the Continuous Marine Broadcast Service (CMBS) ahead of the forecast and weather information. Prince Rupert MCTS functions as the primary Coast Guard link between the West Coast & Alaska Tsunami Warning Center (WC/ATWC), Coast Guard Operational Sites, Canadian Hydrographic Service (CHS) of Fisheries and Oceans Canada (Tide & Currents) and PEP. Under normal circumstances, all Coast Guard MCTS Centres route tsunami-related messages through Prince Rupert. Comox MCTS functions as the alternate operational site in the event Prince Rupert's communications service is unavailable. Tsunami messages are broadcast by the following means:

MCTS Centre	DSC Ch.70	VHF Ch.16	2182 kHz	4125 kHz	NAVTEX 518 kHz	CMBS WX1	CMBS WX2	CMBS WX3	CMBS Ch.21B
Comox VAC	X	X				X		X	X
Prince Rupert VAJ	X	X	X	X	X	X	X	X	X
Tofino VAE	X	X	X	X	X	X	X	X	X
Victoria VAK	X	X						X	X
Vancouver VAS	X	X							

Costs

Costs will vary depending upon type of communication system. Basic commercial VHF radios typically range from $150 to $400. MF radios with DCS range from $2000 and up and NAVTEX receivers' from $600-800. Most commercial marine radio dealers carry these products.

Why Use MCTS?

Advantages

- Easy for mariners to receive.
- Equipment installation and operation is mandated for larger classes of vessels and generally in widespread use by pleasure craft operators.
- Radio operators are trained and certified in use of emergency communications procedures.
- Several different modes of warning message reception available.
- Digital Selective Calling feature allows radios to be left in stand-by mode and be activated when Coast Guard issues an "All Ships" DSC call.
- For non-marine radio operators, inexpensive VHF Weatheradio receivers used by Environment Canada are capable of tuning to most of the Continuous Marine Broadcast Service channels.
- Messages can be received both outside and indoors.

DISADVANTAGES

- Messages are aimed at marine populations and do not specifically cover land-based populations.
- Because of topography and antenna orientations, VHF coverage may be poor in some on-land locations.
- Similar marine coverage issues may apply inside narrow channels due to poor line-of-sight between VHF receivers and transmitters.
- Continuous Marine Broadcast Service does not support tone alert activation features of Weatheradio.

ADDRESSABLE NOTIFICATION METHODS
Broadcasting Systems: Environment Canada Weatheradio

Utilizing the same technology as NOAA's Weather Radio service in the U.S., Environment Canada (EC) operates its own "Weatheradio Canada" nationwide network of radio stations broadcasting weather and environmental information 24 hours a day in both official languages directly from Environment Canada's storm prediction centres.

GENERAL CHARACTERISTICS

Meteorological Service of Canada (MSC), a branch of Environment Canada, operates the Weatheradio network of 179 transmitters across Canada. Public and Marine Weather information, forecasts and warnings are broadcast in a continuous loop in English and French.

Radio characteristics include: frequencies, text and digital enhancements, SAME codes and all-hazards warning.

Primary Frequencies

Eleven of the seventeen BC Weatheradios broadcast on the VHF frequencies of 162.400, 162.425, 162.450, 162.475, 162.500, 162.525, or 162.550 MHz. The other stations broadcast on AM or FM.

The average range for reception of the VHF broadcast signal is about 60 km from the transmitter site but can vary according to terrain. Users should check reception.

BC Locations (Spring 2006)

Weatheradio stations presently serving the B.C. Coast are:

VHF – FM
- 103.7 MHz Port Hardy -FM
- 162.550 MHz Aldergrove -VHF
- 162.400 MHz Vancouver-Victoria -VHF

AM Radio
- 1260 kHz Ucluelet-Pacific Rim Park

For a complete list of B.C. transmitter sites, check the "Find a Transmitter" page on Environment Canada's website (http://www.msc.ec.gc.ca/msb/weatheradio/transmitter/index_e.cfm).

Expansion Plans

- Pacific Rim. An additional VHF station is scheduled to be activated in early 2006 to augment the existing AM Ucluelet-Pacific Rim Park and improve coverage in the Ucluelet-Tofino area.
- Port Alberni. VHF station has been proposed for 2006.
- Prince Rupert. VHF station has been proposed for 2006/7.
- Port Hardy. Addition of VHF has been proposed 2006/7.

Text and Digital Enhancements

Weatheradio VHF transmitters are also being upgraded across the country in 2006 to enable transmission of codes to allow the newest generation of Weatheradio receivers to:

- Receive audio transmission
- Display text messages
- Be programmed to activate on receipt of specific warnings for specific areas. (Specific Area Message Encoding - S.A.M.E. and Canadian Location Codes - C.L.C.)
- Carry non-weather hazard messages

These features will be available for the new stations scheduled to serve the Ucluelet-Tofino and Port Alberni areas.

Specific Area Message Encoding (S.A.M.E.) and Canadian Location Codes (C.L.C.) features

New Weatheradio receiver models use the S.A.M.E. codes attached to short fuse warning and watch messages as triggers to activate their alarm features. Depending on the receiver features, users of new Weatheradios can choose to listen to the full broadcast loop, or set the device to activate for specific warnings for specific areas. These receivers can also be set to alert for specified areas (CLC Codes). These areas are often smaller than the broadcast range of the transmitter, so it enables the user to be warned of warnings in their specific area only. While the transmitters will be able to carry non weather hazard messages, this is generally not part of Environment Canada's scope and is currently being looked at being added as part of a new national CANAlert Network initiative.

Older Weatheradio receiver models will continue to receive the full range of weather watches, advisories and warnings when the unit is activated, and can be set to activate on receipt of ALL warnings. However, they will not be able to take advantage of the enhanced options offered by a Weatheradio with S.A.M.E. decoding capability. Upgrading to newer receivers is strongly recommended.

For those areas served by Weatheradio, receivers could be standard equipment for:

- Hospitals
- Schools
- Marinas
- Dispatch Offices
- Work places
- Campgrounds
- Beaches
- Trails
- Homes
- Emergency Preparedness groups
- First Responders
- Local Government

Costs

Receivers are relatively inexpensive and becoming widely available. When purchasing a Weatheradio receiver, look for models that have the 7 weather channels (often referred to as NOAA Weather channels) with the S.A.M.E/FIPS alert feature. FIPS is the US equivalent of the CLC codes and is compatible with the CLC codes. Not all receivers have this feature.

There are many models to choose from, including desktop versions and handheld versions about the size of an FRS radio. Many two-way radios now carry Weatheradio features. The desktop versions typically are AC powered with a battery backup; however, regular battery changes are critical. Many of the radios provide voice, siren, and tone alerting, but in addition to this you can also add a strobe light or some other form of visual alerting. Costs of receivers vary from about $25 to $90, and are often included in two-way radios as a bonus feature. There is no additional cost to receive messages.

Manufacturers and Vendors: Contact Information

There are several manufacturers that produce Weatheradio receivers, but as of yet, many Canadian retailers have been slow on the uptake of the technology. A current list of Weatheradio vendors is available on-line from Environment Canada at:
http://www.msc-smc.ec.gc.ca/msb/weatheradio/receivers_e.cfm

Why Use Weatheradio?

ADVANTAGES

- Current selection of weather related items will be expanded to a multi-hazard device.
- Can be tuned to specific geographic locations, warning only those people who are directly at risk.
- Can be used to alert populations that are beyond the reach of other local warning methods or are too far away to be reached in-person.
- Can be used both indoors and outdoors.
- System can broadcast messages in both official languages.
- In coordination with PEP, EC activates tsunami messages. (2006)
- Battery backed receivers can operate during a limited power outage.
- Available 24/7.

DISADVANTAGES

- Equipment needs power (AC or battery) and kept in a location where it can be heard and monitored.
- Current Weatheradio coverage is very limited along B.C. Coast.
- Some locations, including indoor, locations may require an external antenna to improve reception.
- Topography can interfere with reception and create local dead spots.
- Device needs to be powered up all the time and extra batteries should be kept available.
- Receivers need to be set to correct frequency and S.A.M.E. Code (all warnings are done by default).
- Same receivers can be used to tune to Canadian Coast Guard Continuous Marine Broadcast frequencies which also broadcast PEP tsunami messages.
- Continuous loop broadcasts in English and French create a longer broadcast cycle.
- Not everyone owns a radio capable of receiving frequencies used by EC stations.
- Older models need to be left on and monitored all the time.

3.4 ADDRESSABLE NOTIFICATION METHODS

3.4.2 TELECOMMUNICATION SYSTEMS

Telephone
Autotel
Paging and Tone-Alert Radio
Internet
VoIP
Cellular and Short Message Service
Satellite

ADDRESSABLE NOTIFICATION METHODS
Telecommunication Systems: Telephone

Various types of addressable mass notification methods exist for sending the same message to select groups of people, large and small; for example, a population within a specific geographic area or a restricted list of recipients (e.g., all members of a fire department). A popular messaging system is the dial-out telephone voice notification system in which a computer server is used to deliver a pre-recorded voice message to a list of telephone numbers.

The importance of this type of method is that the public uses telephones (both landlines and cellular) and are very reliant on this type of communication for information.

General Characteristics

Telephone voice notification systems dial each number in a pre-established list and then play a pre-recorded message when the call is answered. Multiple numbers can be dialed simultaneously, which is dependent upon the number of ports available on the server. If there is no answer, the system moves on to the next number and will periodically re-try the no-answer telephone number. The system continues to dial the numbers until the message has been delivered to all numbers in the list (or until a specified time-out period has expired). Such systems are in common use by organizations to transmit information to selected groups, ranging from public libraries notifying members that ordered books have arrived to public safety organizations issuing evacuation orders.

Characteristics of a notification system are: speed and calling capacity, GIS capabilities, and community control.

Speed and Calling Capacity

The number of calls a system can place within a given time period is determined by the call completion time and the number of available outgoing phone lines. The call completion time is the sum of the call setup time (dialing and connection to a called number) and the time it takes for a person to answer the call, listen to the message and hang-up the phone.

Most telephone systems take an average of about 20 seconds between the time the call is placed and when it is answered (a call being answered after 3-4 ringing cycles). This time must be added to the length of messaging and hang-up time (1-2 seconds). Thus a call with a 30 second message would take a little over 50 seconds to complete. The messaging time can be even longer if the system uses interactive voice recognition (IVR) or a touch-tone response system in which the called person is requested to respond before the message begins. The person is prompted for responses during the message, and afterwards is offered choices of having the message repeated or leaving a return message. To increase the chances of reaching populations quickly, additional outgoing lines are added to the notification server. For example, using an average call completion time of 60 seconds over a 30-minute warning duration time, a system using different calling capacities could deliver notifications at the following rates:

Number of lines	Potential number of calls
10	300
100	3,000
1000	30,000
10,000	300,000

The number of calls successfully completed will depend whether or not people answered the telephone call; the line was busy; people remained on-line until the message was fully delivered; there was telephone network congestion encountered, etc.

Availability during an Emergency

Almost all emergency telephone notification systems use the public telephone network for message delivery. During times of emergency, the network's local switching facility in the affected area can be expected to receive a high volume of both internal and external calls, often quickly exceeding its capacity to connect all requested circuits. Unless the telephone notification system has priority access to local circuits and/or can access inbound external trunks, it may be affected in the same manner as other regular calls and will receive "all circuits are busy" messages. High incoming call volumes from the notification system may actually add to local network congestion during the response phase. For these reasons, telephone notification systems are most useful during a watch period or at the beginning of the warning phase for disseminating initial warnings when there is likely to be less public loading of the telephone system.

GIS Capabilities

A variation of the dial-out telephone voice notification system uses the same general technology but adds electronic mapping (GIS) and database features that enable specific geographic areas to be selected quickly and numbers listed in a database to be automatically dialed. This feature can be very useful for tsunami hazards. For example, Community Alert Network's system enables a municipality to pre-identify all residences and businesses below the projected inundation elevation and store this as a GIS "shape" file. To activate the system upon receiving a tsunami warning, the emergency official simply opens the file, and clicks on the appropriate button which automatically sends the GIS map layer to the alerting company's operations centre. Upon confirming the message the municipality wishes to send, the alerting company operator, with a keystroke, extracts all numbers within this shape and the dialing begins. This entire activation process takes only a minute or two.

The municipality can also create shapes "on the fly", simply with the cursor, and can create additional alerting areas or shapes; for example, areas up-slope of the inundation zone where a simple advisory might be useful. Alerting such areas would be an additional activation, where the alerting company operator is given a separate message to deliver to different areas. The inundation zone shape can also be divided into smaller units for separate messages; for example, to give different evacuation directions or routes to minimize traffic congestion. Other systems such as Telus IVR and CodeRed offer similar features.

Community Control Systems

For very modest requirements, several PC-based products are available that enable people to set up and manage their own systems. If an organization operates their own local telephone switch (PBX), they may be able to interface a server with it and set up an internal notification system.

System Selection and Implementation Considerations

Telephone notification systems are very useful, especially for warning people indoors. However, many factors need to be considered before a final decision is made concerning which system may be appropriate for your needs, how much it will enhance your area's overall warning capacities, what it will cost and during which stage of the warning process will it be most effective. Some of the key factors are:

- ***Size and geographical locations of population*** to be notified. How many people need to be notified and will a telephone notification system reach all identified populations?
- ***Day-time versus night-time contact periods***. Will a telephone notification system be able to target indoor populations at all appropriate times of the day?
- ***Capacity of dial-out system***. Will the system be able to connect to all pre-listed numbers within the required time?
- ***Capacity of local telephone network*** to handle volume of notification calls. Can the notification system be scaled to an appropriate rate of calling so it does not overload the local telephone switching system? It is important to consult with the telephone network's engineers for appropriate system sizing recommendations, as opposed to taking a "plug-and-play" approach.
- ***Service coverage in remote regions***. For those without regular telephone service, can the system easily interface with other systems such as satellite phones or Telus Autotel?
- ***Operational accessibility***. Can the vendor demonstrate that your community will have priority access to the required system capacity?
- ***Redundancy of system components***. Is the vendor's supporting infrastructure operationally and geographically (located in more than one region) redundant?
- ***Reliability of service provider***. Is the vendor primarily dedicated to emergency notification and will they provide copies of system performance reports?
- ***Technical support***. Does the vendor offer technical and operational support with trained staff on a 24x7x365 basis?
- ***Maintenance of outbound calling database.*** Does the system allow easy and secure access to updating and editing of the calling database?

Provincial Systems: PEP Tsunami Telephone Notification System

PEP has recently begun using an IVR telephone notification service provided by Telus for issuing tsunami warning information to more than 300 individuals, agencies and media outlets in British Columbia. When there is critical emergency information to be issued, the Provincial Emergency Program will use the IVR system to contact communities at risk so local emergency officials will be able to react quickly to ensure the safety of people. System features include:

- placing approximately 125 calls in 7 minutes - delivering a 30-40 second message;
- capacity to place thousands of calls per hour in the event of an emergency;
- pre-recorded and digitally stored messages; and
- updated or new messages created "on-the-fly”

Once the message goes out, the system allows the message sender to view status reports to determine who received the message and will quickly identify locations that did not receive a phone call so that secondary contacts can be notified. The system can also inform on other call details such as exact time that a designated community emergency official was called.

Community Use of Telephone Notification Systems

Some communities in British Columbia are also using telephone notification systems for public warning purposes. For example, a chlorine producer, in conjunction with the North Shore Emergency Management Office uses the services of Community Alert Network to notify North Vancouver residents about what to do in the event of an accidental chemical release. Community Alert’s system is capable of making over 26,000 telephone calls per hour over 256 dedicated telephone lines and with access to over 2,000 additional lines as needed to handle larger activations or simultaneous emergency events.

Costs

Commercial services range in price, depending upon the population to be reached, the degree to which subscribers will maintain their own databases and the notification features selected, including use of GIS. It is best to contact providers directly to discuss your community size and alerting needs. Annual contracts for basic non-GIS systems can range from around $2,100 to over $10,000, which includes a minimum specified number of records to be included in a "notification list", and which allows records to be organized in separate groups, such as key response personnel or facilities for emergency notification (fire, ESS, care facilities, fish farms, logging camps, etc). GIS-based system contacts are more expensive yet. Calling costs are from $0.25 per call and upwards. For small communities, high entry costs can be a significant barrier to use, but a possible work-around solution might be to encourage several communities to band together to share costs.

For stand-alone systems, basic systems start at $800 for simple standalone single dialers to $5,000 for a fully integrated basic entry level server. Small systems likely will not be effective for community-wide notification, but may be useful for limited emergency personnel notification

Base prices for community-wide notification systems typically start at $30,000.00 USD and quickly jump as additional ports and outside lines are added to meet dial-out capacity needs. Additional costs will be incurred for adding redundant capacity, including an out-of-area backup system.

Why Use a Telephone System?

ADVANTAGES

- Multi-purpose. Can be used for other purposes during emergencies (e.g., call-out of employees) or outside emergencies (e.g., staff updates, important event notification, etc.)
- Can create lists of individuals or organizations with common characteristics (such as emergency responder teams or populations in flood inundation zones) and contact them as needed.
- Can be configured to target specific geographic locations, warning only those people who are directly at risk.
- Can be used to target populations that are beyond the reach of other local warning methods or are too far away to be reached in-person.
- Called parties can be logged to determine whether or not a call was answered and length of time to complete the calls.
- Messages can be pre-scripted, recorded and stored on server for future use.
- Messages can be pre-recorded in different languages as required.
- An optional protocol allows text messages to be delivered to TTY/TDD and other devices. This feature has the potential to greatly enhance ability to warn citizens who are hearing impaired as well as those carrying pagers.
- Can operate during a limited power outage.
- Can be supplemented with cellular and satellite phones.
- Can operate 24/7.

DISADVANTAGES

- Cannot reach people without telephones.
- Generally cannot reach people outdoors (unless they are carrying a cellular or satellite telephone).
- Cannot notify people inside unless they answer the telephone.
- Not available during telephone outages.
- May be necessary to make a trade-off between content and speed. Delivery of messages will be slowed if the message length is too long and/or if the system has limited call-out capacity.
- May not verify that call receivers have understood the message.
- Effectiveness decreases rapidly as public telephone network becomes congested.

GIS Enhanced Systems

ADVANTAGES

- Can be used to support warning for a variety of hazards that may have different geographical area impacts.
- Very effective for making notifications within a well-defined geographic area.
- Using a GIS interface, emergency organizations can quickly select areas affected by an incident and immediately include all telephone numbers stored in the associated calling database for the selected area.
- Can quickly modify warning and notification target areas during rapidly changing conditions.

DISADVANTAGES

- Due to privacy concerns and CRTC regulations, telephone number notification databases often contain only telephone numbers listed in the White Pages or commercially supplied databases. However, not all listed telephones are located at the same address listed in the White Pages; some listed addresses may be simply billing addresses.
- Unless manually added to the database, systems will not automatically notify people with unlisted numbers. To minimize this, many jurisdictions have provided a means for populations to voluntarily provide contact information for addition to the database. (Note: these restrictions are currently subject to an extensive CRTC review concerning the possibility of lifting some telephone customer information access restrictions for emergency notification purposes).
- Cannot override "call blocking" features used by subscribers. Subscribers may have to request to remove the feature from their phone in order to receive notification messages.
- Cell phone numbers are not automatically included in the database. They can be manually entered into the system either as part of a notification list or linked to a specific address. Note that a cell phone is mobile and users may be well out of the affected area. Or conversely, the situation where the user is mobile, is in the affected area, but is not notified because the fixed location of the number is in an unaffected area.

ADDRESSABLE NOTIFICATION METHODS
Telecommunication Systems: Autotel

Autotel is a TELUS Mobility radio telephone service designed for people working or living in remote areas of B.C. Although cellular coverage continues to expand throughout B.C., Autotel reaches areas that cell phones cannot. Autotel provides extensive coverage along coastal regions of the province.

GENERAL CHARACTERISTICS

Radio units are similar to cellular telephones in that they each have a unique telephone number. Calls are placed through one of the local area VHF radios. Coverage is divided geographically into Mobile Service Areas (MSAs). An Autotel mobile telephone is assigned a telephone number in the area closest to the community of interest. When you drive within range of radio channels in a different MSA, your Autotel mobile radio will automatically "SIGN-IN" and the network will forward incoming calls to your new location. Outgoing calls can be placed whether you are signed in or not. Voice mail and call-forwarding are also available.

Cost

Unit Costs

Terminal units can be purchased used or new: Used $500-900; New $2,000.

Operating Costs

Operating costs include network access fee and monthly airtime rates: $60.00 (one time only) Network Access, and $25.00 per month Airtime Rates: $0.60 per minute (on outgoing and incoming calls). For long distance charges, each unit is assigned a Channel Rate Centre and calls to locations outside this Centre are deemed to be long distance calls.

Why Use Autotel?

ADVANTAGES

- Provides alternative access to public switched telephone service both for marine and on-land purposes.
- May provide better line-of-sight coverage than satellite telephones in mountainous regions.
- Useful as a backup (redundant) communications service.
- Can be used for fixed or mobile applications.

DISADVANTAGES

- Compared to cellular phones, terminal units are expensive (but used models are comparable to satellite phones).
- Limited channel capacity.
- Not suitable as a mass notification method.
- May be a "sunset" technology as satellite telephones and cellular services increase market penetration.

Paging

With the increased use of cellular voice and text messaging, paging is viewed as being at the end of its lifespan. However, paging still remains an important mobile method of alerting.

GENERAL CHARACTERISTICS

Traditional paging is a method that allows people to send messages via the telephone network, radio systems, and more frequently via the Internet. The pager receiver constantly monitors a specific radio frequency dedicated to pager use. It remains silent until it 'hears' a specific identification (ID) string which tells it to display the sent message. The pager radio transmitter is constantly sending out pages, but a unit will only activate when it hears its own ID over the air**.** Most models operate in a tone alert or vibrate mode.

Some indoor voice pagers have built in loud speakers and some form of visual component such as a red or orange flashing light to further attract attention.

Types of Pager Receivers

There are five basic types of pager receivers.

Tone Pagers: These devices only send out a tone.

Numeric Pagers: These devices permit a string of numbers (usually up to 20) to be displayed on the pager.

***Alphanumeric Pagers**:* These devices allow messages of characters (letters and numbers) to be displayed so more complex messages can be sent. Callers can send you a message (from 240-300 characters) by typing it themselves (usually via an Internet web page or email client) or by calling an answering service number.

Voice Pagers: These devices receive and announce spoken messages. When someone calls and leaves a voice message the pager will beep and the subscriber will hear their message right away.

Two-way Pagers: These newer devices have a built-in keyboard allowing the user to send and receive email messages (some including file attachments), write notes to other pagers and even retrieve information via the Internet. Many are operated on the same network as cellular telephones and are described in more detail in the Section entitled, “Telecommunication Systems: Cellular and Short Message Service”.

Service Provision

Many service providers offer group or mass calling services where pre-designated groups of subscribers can be sent (multicast) the same message at the same time, rather than transmitting a separate copy of the message to each individual subscriber. This allows for mass notification, and is often used by fire departments, search and rescue groups.

For coastal B.C., the most widely available commercial paging services are offered by Telus, Bell Mobility, Primus, RadioWorks, PageNet and Rogers Wireless. However, service coverage is restricted primarily to the B.C. Lower Mainland/Sunshine Coast, eastern and southern coasts of Vancouver Island and through the Alberni Valley into the Ucluelet-Tofino areas of the west coast.

Satellite Paging System

Another mode of paging with more extensive coverage is provided by satellite over the Iridium satellite network. Iridium's low earth orbit satellites provide global line-of-sight coverage. The Iridium pager can receive short messages up to 80 characters long. It offers both tone and vibrator alert modes.

Community Paging System

An alternative for communities to ensure coverage is to implement their own service. The method chosen will need to consider population size, topography, and budget. The most effective type would include voice paging or a system that combined voice and alphanumeric paging.

There are two types of paging systems that a community may consider investing in: "Local Area Paging" (LAP) and "Wide Area Paging" (WAP). Local area paging utilizes one single transmitter site that typically has line-of-sight (LOS) to the rest of the community. Wide area paging utilizes multiple transmitters in order to maximize coverage.

LAP: The costs of implementing a local area paging system can vary depending upon the overall desired method of paging, available supporting infrastructure and extent of coverage penetration. A community with LOS to all of the schools, hospitals, and other public facilities in the area may be able to install a single transmitter and each facility may want to install receivers in a number of key locations. As an example, depending upon terrain, a 40 watt transmitter can cover approximately 10 square kilometres. Smaller indoor systems are also available to expand coverage within and between buildings. To reduce overall costs communities could co-locate on an existing radio system, such as a fire service.

WAP: Wide area paging systems are much more versatile in awkward terrain than LAP systems, but are more costly to implement and maintain. Although they are still LOS dependent, the radio signal can be repeated for greater coverage. An alternative approach is to network a series of existing two-way radio systems to enable wide area paging.

Cost

Subscription services

To a large extent, the paging market mirrors the cellular telephone market. Depending on the plan, monthly service fees can range from $10 to $40 per month. Service fees will vary depending on whether pagers are owned or rented. Purchasing units range from $50 to $150. Pagers can be leased for a minimal monthly fee.

Iridium pagers are more expensive as they serve a more strategic market. Subscribers also get global roaming coverage. Pagers are approximately $200 and must be purchased with a 12 Month Service Agreement or Prepaid Card; $60 activation fee, and $199 per month (includes 150 pages per month).

The costs of LAP systems vary dramatically. A basic LAP voice pager system with a 40 watt transmitter will cost around $3,000-$4,000 (this will provide approximately 10 sq kilometres of coverage) and the pager speaker/receivers are approximately $300 per unit.

Note: Pager transmitters will require Industry Canada authorization and licensing. Additional information is available at: http://strategis.ic.gc.ca/epic/internet/insmt-gst.nsf/en/h_sf01847e.html

Tone-Alert Radio

Tone alert is a radio that receives a signal from a transmitter that delivers a message to the listener. The radio is always on and only when the transmitter sends a specific signal to the radio will it be activated. Often these radios can be preprogrammed so only specific events trigger the activation of the radio. This technology can be found in Environment Canada and NOAA weather radios and some local private paging/warning systems.

General Characteristics

Tone alert radio is similar to the local area paging services described above. The receivers typically operate at VHF 150 – 170MHz or UHF 850-870MHz and deliver an alert tone that is followed by a live or recorded message. Optional strobe lights and LED displays for the hearing impaired are also available. These systems can use existing infrastructure within a community (i.e. Municipal radio network).

Existing Systems

An additional option is the possibility of using the existing PA systems within buildings. These receivers should be capable of being triggered via geographical proximity or interest groups (e.g., you can target all facilities in a region, or you can target all schools etc.). Each receiver should be AC powered with a battery backup. Another consideration for a tone alert radio network is internet connectivity. Can the system connect multiple networks over IP?

Cost

An example system for a community that required 35 receivers at different locations would be approximately $30,000.

Why Use Paging/Tone-Alert Systems?

Advantages

- Depending on how the system is developed, it can provide overall coverage throughout the community and surrounding area.
- There are several options for message delivery (examples: pagers, speakers etc.).
- Tone alert capability to capture attention.
- Vibrating mode useful for hearing impaired.
- The technology could be utilized for everyday situations rather than being an entirely emergency system. (This could possibly include some cost recovery mechanisms).
- Can generally reach people indoors and outside.
- Can target subscribers through group paging.
- Satellite pagers can reach people beyond normal paging reception areas.

DISADVANTAGES

- Land-based commercial paging services have limited coverage areas.
- Reception may be impaired by poor line-of-sight to transmitter.
- Must be a subscriber (or network member) to be reached.
- Must be used and/or carried at all times to ensure messages will be received.
- Must be regularly maintained (e.g., batteries are regularly replaced).
- Maintenance of receivers cannot be monitored by local warning authority.
- Indoor units must have reliable power source.
- Extra cost to buy or rent pagers/tone-alert receivers.
- Missed terrestrial pages may not be rebroadcast or recovered (e.g., out of reception area or pager is turned off when paged).
- High cost to use satellite pagers, especially if only for warning purposes.

System operated by the community

- The initial costs of implementing service can be expensive.
- Additional technical and administrative support required, including licensing.
- If it is not used and maintained regularly it can quickly fall into a state of disrepair.

ADDRESSABLE NOTIFICATION METHODS
Telecommunication Systems: Internet

Local Area Networks (LANs) and external Internet connections can provide a variety of methods for notifying a community and/or distributing warnings.

GENERAL CHARACTERISTICS

LANs and general Internet connections use the Internet Protocol (IP) to provide communications over networks. Small messages to large files can be transmitted, with one-way or two-way communication, and can send/receive anything from text documents to audio and video information.

A major strength of the Internet is its increasingly general accessibility and the multiple ways in which IP access can be provided, from copper wires, to fiber-optics, and including wireless and satellite communications. Specific applications include: e-mail, direct datagram, multicast file delivery, web and FTP, podcasting, syndication, audio and video streaming, and peer-to-peer networking.

SPECIFIC APPLICATIONS

E-Mail

E-mail is based on a set of protocols that allows for sending mail to a mail server, transmission across the network, and delivery to, or retrieval by, the user.

Applications

- Direct e-mailing of warnings to community members or Community EOC.
- E-mail to warning systems, or to mobile e-mail devices (such as Blackberries or SMS-compatible cell-phones).

Advantages

- Easy interface for sender and receivers – no specialized knowledge needed.
- Can support delivery to multiple users.
- Can include attached files, such as images.
- Can provide easy return communication path.
- Widely supported on all computer operating systems.
- Can operate over low-Quality of Service networks.
- Can be interfaced easily to other warning systems.

Disadvantages

- Requires central e-mail servers – specialized knowledge needed to set up.
- Does not scale well to transmission of a large amount of users without extra servers.
- No guarantee of delivery time.
- Requires operating network return path for forward delivery.
- Has low security, and can be easily faked.

Direct Datagram

Direct Datagrams, using the standard IP User Datagram Protocol (UDP), allow for delivery of small amounts of information to a remote destination. UDP can be directly addressed to a single destination, or broadcasted to everyone on a network.

Applications

- Direct alert on community member's computer of incoming warning.
- Trigger of community warning system.

Advantages

- Easily adaptable to many short message systems.
- Uses basic protocol, supported on all networking products.
- Can operate on very low Quality of Service networks.
- Does not require return network path for forward delivery.
- Easily interconnected to other (non-IP) communication systems.
- Can provide one-to-many message (multicast) broadcasting.
- Does not require server infrastructure.

Disadvantages

- Requires dedicated (although simple) software.
- No guarantee of delivery.
- Multicast capability requires that network support multicasting (possible Virtual Private Network required).
- Security must be built into the application.
- Cannot operate behind NAT firewalls.

Multicast File Delivery

Multicast file delivery mechanisms drive all of the major content distribution systems on the Internet, such as major web-based news site and media producers. They are based on UDP mechanisms and come in various versions. A file can be transmitted from a source to a destination, much like e-mail, but in a highly-scalable fashion.

Applications

- Delivery of complex files to many communities, or community members.
- Triggering of a large number of warning systems.

Advantages

- Can scale to millions of users.
- Can support networks with no return path, or utilize return path to guarantee delivery.
- Can operate at very high rates of network delay (latency).
- Does not require servers.

Disadvantages

- For true multicast delivery, requires multicast-capable networks.
- Requires installation of software.

Web and FTP

Conventional web and File Transfer Protocol (FTP) allows users to manually retrieve or automatically recover data. Such systems provide large amounts of backup information and can also provide notification, for a small number of users, if the site is automatically checked by communities.

Applications

- Retrieve detailed information on an alert.
- Retrieve prepared information related to an alert.
- Using automated checking by users, broadcast alert (inside a small community or to community representatives).
- Provide updates on alert status.

Advantages

- Large, complex data can be provided.
- Very simple server easily maintained.
- Manual access possible by all users, all operating systems.
- Automated warning checking systems can easily be implemented by programmers.
- Easily interconnected to other networking and warning infrastructure.
- Can operate behind almost any firewall or NAT infrastructure.
- Can operate on low-Quality of Service networks.

Disadvantages

- Does not scale well for automatic warning distribution (best for per-community checking, and then local information delivery).
- Automatic checking requires software installation or browser with site checking capability.
- Pull-based (must be retrieved from servers) so warnings only received when someone is actually checking for messages.
- Requires 2-way networking for forward delivery.

Podcasting

Podcasting enables the distribution of audio and video media from web sites for offline computer-based or mobile access. It is being used by many news agencies, and can be used as a pull-based warning access system.

Applications

- Provision of audio and video messages to users' computers.
- Direct feed to loudspeaker and low-power radio warning systems (real time or general status announcements).

Advantages

- Audio or Video.
- Very simple server easily maintained.
- Manual access possible by all users, all operating systems.
- Automated (though infrequent) checking systems built into standard software platforms.
- Easily interconnected to other networking and warning infrastructure.
- Can operate behind almost any firewall or NAT infrastructure.
- Can operate on low-Quality of Service networks.

Disadvantages

- Does not scale well for automatic warning distribution (best for per-community checking, and then local information delivery).
- Requires reasonably high-bandwidth for timely content distribution.
- Pull-based (must be retrieved from servers) so warnings only received when someone is actually checking for messages.
- Requires 2-way networking for forward delivery.

Syndication

Syndication, the pull-based provision of news or other changing information is now the primary mechanism for Internet news distribution; software updates, and also forms the core technology in many web-logging (blog) and podcast-type systems. It is already used by many organizations for distribution of alerts, based on distribution of data from Common Alerting Protocol (CAP) feeds. New mail and web browsers support the wide range of Real Simple Syndication (RSS) standards.

Applications

- Provision of text messages to users' computers, with rich content-backup.

Advantages

- Small data footprint, but can point at web-resources for large amounts of backup information.
- Very simple servers easily maintained.
- Manual access possible by all users, all operating systems.

- Automated (though infrequent) checking systems built into standard software platforms.
- Easily interconnected to other networking and warning infrastructure.
- Can operate behind almost any firewall or NAT infrastructure.
- Can operate on low-QoS networks.
- Scales moderately well for medium-sized communities.

Disadvantages

- Pull-based, not push-based, so warnings only upon checking.
- Requires 2-way networking for forward delivery.

Audio and Video Streaming

Streaming is the method for distributing audio and video. It can be simultaneously shared among users and be easily connected to local audio and video distribution systems (loudspeakers, TV and Radio networks).

Applications

- Provision of audio and video messages to users' computers.
- Direct feed to loudspeaker, TV, and low-power radio warning systems (real time or general status announcements).

Advantages

- Audio or Video.
- Very simple servers easily maintained.
- Manual access possible by all users, all operating systems.
- Easily interconnected to other conventional warning infrastructure.
- Can operate behind almost any modern firewall or NAT infrastructure.
- Can operate on medium-Quality of Service networks.
- 2-way networking requirements small.

Disadvantages

- Requires reasonably high-bandwidth for timely content distribution, especially for video.
- Slightly higher Quality of Service requirements than some other methods (but can be tuned for quite bad networks).
- Pull-based, not push-based (automatically sent to user's computer), so warnings only noticed upon checking for them.

Peer-to-Peer Networking

Peer-to-Peer networking is a general set of tools that work across consumer-grade networks, providing file and message exchange. It can be used on the smallest and cheapest networks.

Applications

- Provision of complex, rich, warning information to community members or community.
- Provision of audio and video messages to users computers.

Advantages

- Text, Audio or Video.
- Very simple servers or no central server at all.
- Manual access possible by all users, all operating systems.
- Can operate behind almost any modern firewall or NAT infrastructure.
- Can operate on low-QoS networks.
- Can scale well for automatic warning distribution, if appropriately distributed between multiple users.

Disadvantages

- Requires reasonably high-bandwidth for timely content distribution, especially for video
- Generally pull-based, not push-based, so warnings only upon checking, unless integrated with local infrastructure, or other software built. However, possible to build many solutions using the methodology.

Why Use Internet?

Advantages

- Generic infrastructure.
- Cross-platform.
- Low-cost.
- Many possible applications and media possible.

Disadvantages

- Some applications require high-quality networks, and possibly network experts in community.
- Software installation may be required on community member computers, with user support personnel required.
- Servers may be required, and server management personnel required.

Voice-over-Internet Protocol (VoIP), also known as Internet Telephony is another way Canadians can make telephone calls. However, instead of using the traditional telephone system, calls are routed to switches over the Internet.

GENERAL CHARACTERISTICS

The sets of telecommunication rules that enable voice signals to be carried over the Public Internet (or other IP-based networks) are commonly referred to as Voice-over-IP or VoIP protocols. Using VoIP protocols, voice communications can be delivered over any IP network regardless of whether it is the public Internet, an Intranet or a Local Area Network (LAN). In a VoIP-enabled network, the voice signal is digitized, compressed and converted to IP packets and then transmitted (streamed) over the IP network. The key benefits of VoIP are very low costs and the integration of data and voice in a single network. VoIP can be used to carry virtually any type of audio, and is being used as a means to trunk between voice radio, paging and other wireless and landline communication systems to extend coverage and enable them to work together.

There are some major differences between VoIP telephone and regular telephone systems. VoIP voice content is chopped up into small packets of data, each numbered and encoded with an address for the packet to be sent to. Unlike a traditional telephone call with a continuous flow of electronic communication over a dedicated circuit between sender and receiver, VoIP voice data flows over a general-purpose network where information can flow over different network routes before reaching the final destination. Because of this, VoIP systems must adjust for out-of-order packet delivery, late packets, and lost packets.

In order to interconnect users, a method of switching and user addressing is required. Some VoIP systems use simple computer software applications to facilitate this, while others provide all of the same call features of modern advanced telephone switches (caller ID, call forwarding, voice mail, etc.). In order to place a call from a VoIP phone to someone on the main public switched telephone network (PSTN), VoIP switches must be interconnected to the PSTN. Some switches now combine both traditional and VoIP features to enable additional redundancy, using both the Internet and PSTN to route calls.

Setting up a VoIP System

Setting up a VoIP system requires a number of components:

A central device to manage the calls like a telephone switch (PBX) does in traditional phone systems. This can be a dedicated piece of equipment such as an IP PBX (a regular PBX that has been IP-enabled), or a server running specialized software. IP PBX's are available through all major telecommunications manufacturers, as well as IP equipment manufacturers such as Cisco. Prices range from around $1,000. PBX systems are becoming more popular as a lower cost option to traditional mainstream PBXs. A low cost option is an open source software implementation, such as Asterisk, a free software version that supports many features only available in expensive proprietary PBX systems.

Telephones and a data network refer to existing digital phones and computer networks. Depending on the setup, internal calls are routed over the existing phone or computer network. Calls within the same office will typically be routed over the phone network, while calls to other locations get routed over the computer network. Calls to external phone numbers get sent through the network to a gateway, which connects to the public switched telephone network. To the phone user, all calls connect seamlessly.

Community Access Gateways

Many community associations provide Internet access to the general public in many locations spread out in the province. Organizations such as South Island Community Access Network and Victoria Telecommunity Network have begun offering VoIP services to their members. These phones are connected to the PBX system in the Victoria Telecommunity Network. Other phones on this system may be called by dialing the IP phone number for that site.

Use in Amateur Radio

Amateur radio has adopted VoIP by linking repeaters and users through key projects, Echolink and the Internet Radio Linking Project (IRLP). With Echolink, licensed amateur radio operators can link VHF or UHF transceivers to their PCs, to allow anyone in range of their stations (or nearby repeaters) to communicate by voice with any other similarly-equipped station around the world. They can use their PC's to connect remotely to other repeaters and simplex stations that have Echolink capability.

Through the IRLP project, repeaters are connected to custom built computers that in turn are connected to the Internet and serve as "nodes" in the IRLP network. Radio operators control the computers by sending special tones to them to enable connection to other nodes in the IRLP network located around the world.

Current Commercial VoIP Offerings in Canada

Virtually any land-based Internet service provider in Canada can support VoIP services, either directly or as a carrier for third party providers. Canada’s four largest cable companies and dozens of smaller competitors now offer Canadian consumers VoIP service. The main telephone companies such as Telus and Bell are also moving to implement VOIP. Eventually, it is likely that almost all voice telecommunications systems will be employing VoIP, including cell phone systems.

Currently, Canadian commercial VoIP offerings are offered in two forms:

- Cable telephony, now beginning to be offered by the major cable companies such as Shaw and Rogers.
- Nomadic VoIP telephony, which is being offered by companies like Primus, Vonage.

Both Cable telephony and Nomadic VoIP telephony use the same technologies to send and receive calls. The difference between Cable and Nomadic VoIP is the network they use to relay the phone call to the PSTN or to another Digital Network. For Cable telephony, the subscriber switching generally takes place within the cable company's own physical sub-network. For Nomadic VoIP, the switch can be located virtually anywhere on the Internet. Subscribers attach an adapter or install a software program (client) on a computer (equipped with a microphone and speakers or a headset) and then plug them into any broadband Internet connection.

Cost

Cost savings are largely due to using a single network to carry voice and data. There is a basic cost for accessing Internet service, but using VoIP over this service usually does not involve any extra charges. If insufficient capacity (bandwidth) is available, the voice communication will become unintelligible. A dial-up Internet connection may have just enough capacity for low level voice quality if the link isn't being used for other applications, but a cable or DSL broadband connection will enable better service.

Cost for commercial VoIP services vary. Larger providers offer full PSTN interconnectivity including a telephone adapter, a regular telephone number and choice of area code, as well as numerous call features, including web-based management. Prices range from approximately $15 to $60 per month.

There are many service providers that offer free VoIP service with no sign up or monthly fees but charge for interconnection to the main PSTN or other VoIP providers. Examples are Skype, VoIPBuster and Yahoo Messenger.

Why Use a VoIP System?

For public warning, VoIP offers advantages and disadvantages. Advantages are low cost, off-the-shelf availability of VoIP products and services and flexibility. Disadvantages include quality of service, reliability, electricity dependency and security issues.

Advantages

- ***Cost.*** VoIP takes advantage of unused capacity of IP networks and supporting equipment to enable extremely low cost voice communications.
- ***Extension and integration of warning services***. VoIP provides one or two-way voice communications to terminals or devices in virtually any location that possesses an IP connection (wired or wireless) with reasonable bandwidth. These locations can include small remote communities or businesses that have broadband Internet service through

new national and provincial satellite and landline programs. Connected systems and devices could include telephone notification systems, local and remote sirens, paging and other tone-alerting transmitters and receiving devices, radio transmitters, etc.

- ***Mitigating effects of local telephone network congestion***. VoIP provides a potential solution to local telephone network congestion. Because VoIP telephones use IP networks, they can operate independently of the local PSTN (but be interconnected as required). They can continue to function when regular phone service is unavailable.
- ***Transitioning***. Many existing office telephone systems can be adapted for VoIP. Existing phone wires can be used within offices and VoIP for calls between locations. This combination will work well, especially if offices have relatively new telecom equipment - many office switches (PBXs) can be IP-enabled with software upgrades and minor hardware additions. Vendors may also be able to set up systems that use only traditional lines and extensions at first, but support expansion to VoIP at a later stage.
- ***Mobility and functionality***. VoIP phones and server switches can be moved and located anywhere in the network, and with full Internet operability, can be located almost anywhere in Canada or the world. This provides flexibility in placing key critical communications components out of hazard zones.
- ***User friendliness***. VoIP adapters are easy to install and use.

DISADVANTAGES

- ***Reliability.*** Any system is only as good as its weakest link. IP networks on which VoIP applications depend consist of a number of interdependent components (modems, routers, domain name and other servers, cable and other physical connections, etc). A failure of any of these components can disrupt services. A major issue is the requirement for reliable power needed for all of the network components, including end-user phone adapters. Unlike conventional telephones that are connected directly to telephone company phone lines, which in the event of a power failure are kept functioning by batteries and back-up generators located at the telephone exchange, there are no such arrangements for connections on the public Internet. For assured networking, all IP components must be provided with some form of uninterruptible power supply.
- ***Quality of service***. As IP was originally designed for carrying data, it does not provide real time guarantees to support the Quality of Service (QoS) standards required for VoIP. Common QoS issues include latency (delays in data packets arriving at a destination, often when satellite circuits are involved), and jitter (variations in the delay of the packets) and packet loss. Networks can be designed to address these issues, but the problem can resurface when connecting to the public Internet or other outside networks. Indeed, there are estimates that as much as 85% of even highly controlled corporate networks are not ready for VoIP, and, over the public Internet, the quality of VoIP connections can rapidly deteriorate with the number of hops across the network. Different implementations can be sensitive to different aspects of QoS. For instance, the nomadic services are often designed for the public Internet, and trade less overall performance for increased steady performance under a wide range of QoS conditions. Conversely, many low-end solutions, such as IRLP and many SIP-based systems, such as Asterisk, and even

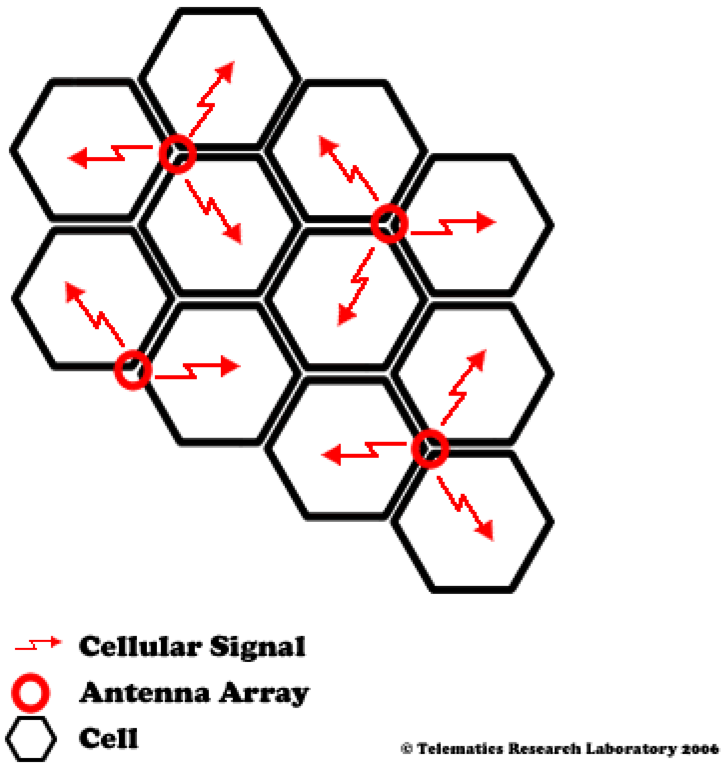
commercial-grade VoIP solutions, cannot easily handle QoS issues, and rapidly fail over extended networks, or networks under stress. Thus there are complex issues around the use of VoIP in public warning applications. This may make other audio over network technologies, such as Streamed Audio (such as RealMedia, Windows Media, etc) or distributed Audio (Syndicated Podcasting, Peer to Peer networking, etc) more appropriate for alert communication. Such issues may be resolved by offloading the trunk voice communications to the PSTN, and only using VoIP on short-hop networks, but this reduces the usefulness of the VoIP infrastructure.

- ***Interoperability.*** Not all VoIP products from different vendors will operate with each other. This necessitates putting in place gateway technologies to bridge the networks.
- ***Security.*** Operating in an open network such as the Internet, exposes VoIP applications to all of the vulnerabilities of general public IP networking (viruses, denial-of-service attacks, hacking, etc.).
- ***Firewalls.*** As a security precaution, most organizations have set up firewalls to insulate their own networks from unauthorized access from the outside. Firewalls can present obstacles for enabling VoIP connections between internal and external networks. Often additional configuration and network management tools are required to enable interconnection. This can present problems in times of crisis when network links may need to be rapidly extended.
- ***Scalability.*** - VoIP systems need to be flexible enough to grow to meet increased user demand as services become more accepted. Some network management, user management technologies and products may not be sufficiently developed to address these issues. Similarly, networks supporting the applications will require the necessary bandwidth to ensure QoS.
- ***Emergency calls***. Many VoIP services allow subscribers to select a telephone number whose area code and exchange belong to an area or region they don't live in. When 911 calls are placed via the Internet, the call is routed to the 911 centre designated to the area code and exchange people are dialing from, which may not correspond to the area they live in. In 2005, the CRTC brought in new regulations for fixed (non-nomadic) VoIP services. Where end-users are assigned a regular public telephone number, the VoIP is required to provide 911 or enhanced 911 services within regions where it is provided by incumbent telephone companies. However, nomadic VoIP remains problematic as end-users can be located virtually anywhere in the world.

People rely on cellular communication due to its portability and convenience. However, the system is not yet 100% reliable or accessible. Within British Columbia, there are still many underserved and unserved areas due to a lack of transmitters or geography that restricts coverage.

General Characteristics

A cellular phone is essentially a two-way radio. Cellular phones operate over a network of transceivers called "cell sites". By breaking the airspace down into many smaller cells cellular networks are able to use their frequencies much more efficiently and it allows for more usage than one single high powered transceiver. The cost of creating cellular networks is quite high and they tend to exist in more populated areas. Cellular networks have a limited number of frequencies that they lease from the federal government, and each cell site has a limited number of frequencies available. In emergency situations it is very easy to exceed this capacity. Consequently, cellular is not an assured method for delivering time sensitive and life critical voice-based warnings.



Short Messenger Service (SMS)

The latest generation of cellular networks (3G) offers a variety of non-voice features such as data access and Short Message Service (SMS). SMS allows users to send and receive short textual messages directly on their cellular or PCS cell phones. SMS uses the handset keypad and menus to write, format, send and receive text. SMS messages can be sent from a PC over the Internet, from other handsets, and from other Internet capable, cellular devices. SMS is a digital service and is only available in areas where carriers provide digital coverage. SMS has been around since around 1991 and has been widely adopted in Europe and Asia, and has recently seen wide spread usage in North America. Most phones now are capable of SMS at a relatively low cost.

SMS can be a very efficient way of sending quick short (usually under 160 characters) messages. It uses a different portion of the cellular network and can be an alternative to voice communications. SMS messaging can continue to function on congested networks, although often at a slower rate of exchange. For example, during the terrorist attacks on September 11, 2001, high traffic volumes made it extremely difficult to connect cellular voice calls, but SMS text messaging continued to operate and provided a communications means for people who understood how to use it.

Since 9/11 and the post-2004 Indian Ocean tsunami, SMS is being used as a way to alert people when there is an emergency situation. Both free and commercial subscription-based service SMS are available. Subscribers can pre-register and then be sent a text message giving them a warning or information concerning a potential hazard.

Many vendors have devised server systems which, upon being triggering by an event, will send out large numbers of SMS messages for delivery to mobile terminals. However, timeliness of message delivery cannot be guaranteed. SMS messages must be sent separately to each individual subscriber and delivery times can be dramatically affected by the capacity of servers, the infrastructure used to link to the cellular SMS service, the cellular SMS receiving and processing capacity and the traffic loading on the cellular. Because subscription service providers can access cellular SMS subscribers through the open public Internet, cellular network operators don’t know how many such systems there are, or have a way to control how many subscribers are signed up. Therefore, there is no current method to ensure priority access for public SMS emergency messaging.

“Cell broadcasting” is another method of relaying short messages to cell phones. Cell broadcasting allows a single text message to be broadcast to all mobile handsets in a given geographical area at the same time. This area can range from the radius covered by a single cell to the entire network. Because cell broadcasting targets cell sites and all phones linked to them at the time, no pre-registration of mobile telephone numbers is required. Cell broadcasting places very little loading on the network as a cell broadcast to every subscriber on the network is the same as sending an SMS message to a single phone. Cell broadcasting is not yet available in Canada, although it is in pilot test phase in various countries.

Cellular Internet Access

Many 3G cellular phones and adapter cards can function as a mobile IP Internet gateway for a laptop or any IP capable computing device. These services are provided by all Canadian cellular carriers. Rogers Wireless markets its data services as EDGE/GPRS (with data rates up to 160 kbps), while Telus and Bell Mobility market 1XRTT (up to) and a new EV-DO service (download speeds between 400 and 700 kbps).

Costs

The costs of SMS are relatively inexpensive. Many cellular rate packages include free incoming text messaging. IP data rates generally range from $25.00 per month to $100 + dollars depending on how data is sent/received. SMS messages are typically around 10 cents per message.

Why Use Cellular and Short Message Service Systems?

ADVANTAGES

General

- Wide spread urban coverage.
- Can be used indoors or outdoors.
- Portable.
- Many different types of devices can use these networks (cell phone, PDA laptop computers etc.).
- It is a technology that is familiar to many people.
- Relatively inexpensive.

Short Message Service

- Can target specific groups of subscribers (e.g., emergency personnel).
- Can often pass messages even when voice side of cellular service is congested.
- Can originate SMS messages from any Internet email client (phone or other mobile two-way messaging device, email program, web page, etc.).
- Alternate way of reaching hearing impaired.

DISADVANTAGES

General

- Lack of rural and remote coverage, especially in outer coastal regions.
- During emergency events cellular voice channels are easily overloaded.
- Unlike simple 2-way radios, cell phones and data terminals require external infrastructure and cannot communicate directly with each other without the infrastructure. Damage to infrastructure can directly impact service quality and availability.
- Call requests are not routed through local switches but rather must be trunked back to central switches often located out-of-region. Calls between different service providers must be routed through each others' switching facilities. Loss of any trunking capabilities will result in loss of local service.

Short Message Service

- ***Non-SMS users.*** Not all cellular users use SMS.
- ***Message length***. Short message length (160 characters) restricts content to short alerts with limited instruction.
- ***Timeliness***. Each SMS message is processed separately by the server. Messages sent between users on the same network are usually exchanged fairly quickly. Reliability of network connections on servers will significantly affect timeliness of message delivery, especially if sender and receiver are on different networks.
- ***Pre-registration***. It is necessary to know the individual SMS address of each mobile that needs to be contacted. This information is not freely available and has to be obtained by subscribers 'signing up' to the service. Since the service is voluntary, it is also difficult to determine how many local area users are not signed up.
- ***Not distinctive.*** Difficult for subscribers to differentiate between a normal SMS message and an emergency alert, possibly resulting in messages being unread.
- ***Not geographic***. At present there is no easy way of knowing where a mobile SMS user is. The location from where the subscriber signed up may not have any relationship to where the subscriber is at time of warning.
- No ***priority access*** for SMS warnings.

Satellite technology plays an important role in extending services to regions unreachable by traditional landline communications services, or where the costs of providing landline services are considered prohibitive. Broadcasters use satellite systems to distribute content between stations or as backup to their land-based networks. Satellite TV has become an alternative method for receiving broadcasting services in both urban and rural homes. Even cable television and terrestrial TV stations use satellite feeds to obtain programming. Telephone and Internet links are also being provided by satellite as a more affordable means for reaching the "last mile" rural and remote populations, both on land and at sea.

General Characteristics

Communication satellite systems are generally available in two forms, fixed and mobile. Fixed systems usually employ a satellite antenna focused on a satellite in a fixed geostationary orbit (GEO) around the Earth's equator. These systems typically relay television and radio broadcasting network feeds, direct-to-home broadcasting services, and telephone voice, fax and high speed data services. In the past decade, costs for data services have decreased and government initiatives are allowing services such as high speed Internet to be extended to rural and remote communities.

Mobile systems enable switched voice and slower speed data communications. Two types of satellite systems support mobile satellite services: 1.GEO satellites which communicate with mobile self-tracking end-user terminals and 2. low earth orbit satellite (LEO) systems which deploy global constellations of small satellites that orbit in a grid-like formation around the world. LEOs also enable the use of handheld phones. An advantage of using LEO satellites is that there is no voice delay. Examples of GEO mobile communication system providers are MSAT and Inmarsat. LEO service providers include Iridium and Globalstar. All of these systems support access to public telephone networks and slow speed data interconnection. Both Iridium and Globalstar support SMS and Iridium also supports text paging.

Mobile systems offer opportunities to extend telephone warning notification to rural and remote regions, as well as to serve as vital community backup systems for voice, fax and limited data communication.

All satellite terminals require clear line-of-sight paths to orbiting satellites. For many coastal areas of B.C., mountainous terrain can pose serious challenges for ensuring reliable connections. If satellite communications are to be considered for public warning purposes, proper site assessment and extensive testing must first be conducted to ensure that terminals are situated in appropriate locations. Even mobile terminals may be restricted in practical use unless they are placed in strategic locations.

Fixed Systems

Telesat Anik F2 HSe Ka-band Broadband Satellite Service

On July 17th, 2004, Telesat launched its Anik F2 satellite - the world's largest commercial communications satellite. Anik F2 is the first satellite to fully commercialize a new frequency band called Ka for delivering two-way broadband IP services. The new High Speed Enterprise (HSe) Service is extended across Canada through a series of small spot beams, each focused on a specific area. The Anik F2 Ka-band service and hardware is sold by Telesat Service Providers and their own networks of retail sellers.

The Anik F2 HSe service is capable of data service only, but at download speeds of up to 2 Mbps and upload of up to 500 Kbps. The service provides a cost-effective method of extending Internet service into remote regions, as well as a backup (and possibly primary) service for community emergency communication applications. However, that the service does not offer the necessary Quality of Service to support Voice-over-IP telephone service. A more expensive Telesat service operating in the Ku-band is capable of supporting VoIP.

Satellite terminals include a 0.67-Meter satellite dish, transceiver, modem and AC power supply and retails for about $800. Monthly access fees start at $90 per month (download speed of up to 1 Mps and upload of 256 kbps) and go up to $180 per month (download speed of up to 2 Mps and upload of 500 kbps) based on a one-year contract. Other fees include activation and spectrum access.

Hughes DirectWay Broadband Satellite Service

The Hughes DirectWay Broadband Satellite Service is owned and operated by Hughes Network Systems, located near Washington, D.C. Hughes offers a similar service to Telesat’s HSe, but operates its service in the Ku band which uses slightly larger satellite dish antennas. The Hughes DirectWay Broadband Satellite service and hardware is sold by DirectWay Service Providers appointed by Hughes Network Systems.

The DirectWay service is capable of Data only at download speeds of up to 2 Mbps and upload of up to 1 Kbps, depending on the hardware used and the Airtime plan. Satellite terminal packages range from $400 to $2,500 depending on the size of dish required for the location (northern locations require larger dish antennas) and speed of access. Monthly charges range from $89 (download speed of up to 700 kbps and upload of 128 kbps) to $480 per month (download speed of up to 2 Mps and upload of 1 Mbps) based on a one-year contract. Other fees include activation and spectrum access. The service does not offer the necessary Quality of Service to support Voice-over-IP telephone service.

Mobile Systems

MSAT

The MSAT service is owned and operated by Mobile Satellite Ventures (MSV). MSV operates the longest operating GEO-based mobile satellite service in North America. Services include voice and dial-up data (4.8 kbps), fax, packet data and dispatch radio (talk group voice communications). The MSAT service and hardware is sold by MSAT Service Providers.

There are several models of terminals available for accessing MSAT services, ranging from briefcase to mobile dome versions for vehicles and boats. Prices for terminals range from approximately $1, 500 to $4,200.

Usage charges vary according to level of usage, ranging from $1.75 to $.99 per minute, and a monthly access fee of about $35. Additional fees apply for terminal activation and annual system access. Other fees apply for value added services such as voice mail, call forwarding, etc.

MSV recently announced plans to build and launch three new satellites, the first step in an effort to build a hybrid network that will rely on both cell phone technology and satellite links to provide broadband service with terminal devices that will be about the same size as cell phones.

Globalstar

Globalstar LLC (Globalstar) owns and operates the Globalstar Mobile Satellite System as well as Globalstar Gateway earth stations and satellite services and equipment distribution businesses in the U.S., Canada, Western Europe and Venezuela. The company operates a collection of 40 low earth orbit satellites whose signals cover 80% of the Earth's surface; everywhere but the extreme polar regions and some mid-ocean regions. Service offerings include public switched voice telephone and data at 9.6 kbps.

Globalstar offers a range of hardware including: dual mode portable handsets that can function as both cellular and satellite phones; fixed phones for remotely-located offices or worksites where stationary installations are required; data kits to connect a PC or PDA to the Internet via a Globalstar handset; specialized modem products for higher bandwidth applications, and products for aviation and marine use. In Canada, Globalstar service and hardware is distributed by Globalstar’s Canadian division, situated in Toronto, and sold through dealers across the country.

Portable telephones retail at around $1,000, with fixed units ranging between $750 and $3,000. Basic monthly service fees start at $50 per month. Activation and monthly system fees also apply as do value added fees for voice mail, SMS, etc. Airtime charges range from $1.59 to $.89 per minute depending upon rate package chosen. Dialup data service is charged the same as voice call.

Iridium

The Iridium Satellite System is owned and operated by Iridium Satellite LLC. Iridium operates its own constellation of LEO satellites (66 satellites) whose signals cover all regions of the earth (including polar). Its service offerings include public switched voice telephone, low speed data at 4.8 kbps, SMS (160 characters) and text paging (80 characters per message). The Iridium service and hardware is sold by Iridium Service Providers and their own networks of retail sellers.

Iridium's range of hardware includes fixed and handheld satellite phone units and small wearable pagers. Prices for phones range from $2,000 for handhelds to $4,600 for fixed units, and pagers are priced at around $200. Monthly subscription fees are $40 for phones, plus activation and system access fees. Other charges apply for voice mail and other value added services. SMS messages are $.60 each and voice airtime charges range from $1.99 to $1.19 per minute depending upon rate plan. Regional paging services range from $79 to $179 per month, not including activation fees.

Why Use a Satellite System?

ADVANTAGES

General

- Can be operated independently of local terrestrial communications infrastructure.
- Only wide area technology that is available everywhere and at the same cost as long as the user is within the signal beam (footprint) of the satellite and has a clear line-of-sight view to orbiting satellite.
- Satellite's inherent strength is point to multipoint transmission of data, video or audio.
- Satellites can simultaneously deliver information to virtually an unlimited number of receivers within their footprints at high speeds.
- Satellite terminals can be interconnected to terrestrial community networks to enable sharing of inbound and outbound satellite links.
- Satellite networks can be deployed in locations relatively quickly because of their wireless nature and minimal need for local infrastructure support (mostly electricity).

Mobile

- Fast deployment and installation.
- Doesn't require a trained technician to install or operate.

DISADVANTAGES

General

- Fixed broadband systems require a trained technician to install.
- Fixed satellite dishes can be easily thrown out of alignment by earthquakes and aftershocks requiring technician to realign each time unless antenna is automated and self-aligning model (more expensive).
- Fixed broadband systems requires reliable AC electricity to operate
- Require clear line-of-sight to operate.

Mobile

- Limited data communication capacity.
- Limited SMS text length makes it difficult to provide remote users with sufficient warning information if this is their only source.

3.4 ADDRESSABLE NOTIFICATION METHODS

3.4.3 PERSONAL SYSTEMS

Door-to-Door
Residential Route-warning
Canada Post

ADDRESSABLE NOTIFICATION METHODS
Personal Systems: Door-to-Door

Personal notification uses emergency personnel or trained volunteers to go door-to-door or to groups of people to deliver a personal warning message. Personal contact has an advantage in that people may be more willing to respond to a personally delivered warning and be apt to believe that a danger exists. It has a disadvantage in that it is time consuming and may require the commitment of many vehicles, boats and personnel.

System Selection and Implementation Considerations

The Door-to-Door method of warning people is very useful but there are important factors to be considered when deciding whether or not to choose this method:

- ***Notification time and safety:*** Door-knocking may need to be carried out if radical action, including evacuation, is necessary and if time permits. Because the safety of the door-knockers and the population that needs to be evacuated are at risk, door-knocking should only be used when there is enough time and personnel available, and when it is safe to do so.

- ***What message to deliver:*** Door-knockers should deliver printed material giving advice on what to do immediately. The message should include information on evacuation routes and evacuation centres, should specify what people should do before leaving home and what they should take with them. It is important that the information is clear and concise.

- ***Size and geographical locations of population to be notified:*** If the number of people to be contacted is ***small*** and the door-knocking can be planned before tsunami flooding begins, locally trained volunteers may be used. Volunteers need to be recruited and trained by a response agency and should be known to the residents. In a number of communities, local search and rescue teams are used. Within some communities trained block watch coordinators could perform such a task.

  Where the population to be personally notified is ***large or spread out over large areas*****,** trained emergency service personnel are likely to be required to carry out the task. In these instances the number of doorknockers required may be many and much planning will be necessary.

- ***Commercial and industrial zones***: For commercial properties, trained door-knockers might include local Chamber of Commerce officials or managers of industrial estates who can pass warnings by door-knock or telephone ‘cascade’ to shopkeepers, hotels and managers of industrial premises in at-risk areas.

- ***Time needed to implement method***: Planning needs to take into consideration how long it will take to assemble and brief the door-knockers, how long it will take to door-knock each building and how long each door-knocker can safely remain in an at-risk area. Experience suggests that it takes four-to-six minutes to door-knock at each house. Using two person teams, ten teams (20 personnel) plus control personnel will be required to door-knock approximately 100 homes in one hour. This rate can vary considerably, depending upon the time of day (e.g., weekday – people may be at work or late at night – people first must be woken), how far apart properties are situated and how they can be reached (e.g., rural back road or by water).

Why Use Door-to-Door?

Advantages

- High degree of credibility.
- Provides all necessary information and instructions.
- Very strategic notification.
- Can reach all people at home or at a specific location.
- One of the few methods to ensure everyone at location has been notified and understands what actions need to be taken.
- Cost effective if using trained volunteers.

Disadvantages

- Very time consuming and slow.
- Requires recruiting and training large numbers of personnel who could be used for other valuable purposes.
- May require a large amount of logistics support (cars, boats and other transportation, accurate maps and route information, etc.).
- Unable to reach a very wide area quickly.
- Expensive in terms of labor costs, if using paid personnel.
- Can place personnel delivering messages at-risk.

ADDRESSABLE NOTIFICATION METHODS
Personal Systems: Residential Route-warning

Where there are not enough people or there is not enough time to carry out door-to-door notification, vehicles or boats may be equipped with public address systems to travel pre-designated routes to notify people of an emergency. This method works best with concentrated outdoor populations.

GENERAL CHARACTERISTICS

The common features of these systems are that they are mobile and usually found on some type of vehicle or boat. The entire system is easy to install and is comprised of a controller, an amplifier, a microphone and a siren speaker. Systems can permit users a hands-free operation, cycling through two or three siren tones or giving public address (PA) repeats. There is a PA over-ride in all functions.

System Selection and Implementation Considerations

The Residential Route Warning method is very useful but there are some considerations which need to be included when deciding to choose this method:

- ***Range of warning***. It is important to note the type of PA system being used and its capacity. Standard range of typical vehicle PA systems is about 300 metres. The vehicle must stop about every 600 metres, and the message must be re-read or re-played, or the vehicle must be traveling slowly enough for people within the vicinity to hear the entire message.

- ***Type of message:*** To cover a large area within a timely period, messages must be kept short and may require instructing people to turn to another source for further instructions. If there is a time constraint, the main message should be to indicate evacuation routes and centres.

- ***Size and geographical locations of population to be notified:*** This method is useful where the population is either dense or spread out. Pre-planning these routes is recommended but it is important to remember that routes may be destroyed or blocked if a hazard has already occurred.

- ***Personnel and resources needed***: This method is reliant on vehicles having a mobile public address system and will also require personnel to run this system.

- ***Sirens only***: Police, fire and other agencies may use vehicles and marine craft equipped with sirens to notify nearby area populations. Most individuals recognize these types of sirens as an isolated emergency signal. The public may not respond appropriately to such a signal without receiving further information. There must be another source for further instructions regarding what actions to take.

Costs

The entire system is relatively inexpensive, ranging from $1,500 to $2,000 per unit.

Why Use Residential Route Warning?

ADVANTAGES

- System is more time efficient compared to door-to-door system.
- Highly credible if emergency vehicles are used.
- Can be moved from area to area quickly.
- Can target notification (e.g., warn specific homes or streets affected).
- Can reach people indoors if loud enough.
- Messages can be changed easily and repeated.
- Easy to install and on many different types of vehicles.
- Can have hands-free operation.
- Usually already installed on police cars, fire trucks and ambulances.
- Cost-effective for large areas such as public beaches and parks.

DISADVANTAGES

- Only good if vehicles/personnel available. Not good during event - could place emergency personnel in danger.
- Road damage prohibits vehicles from entering.
- Limited in area covered – sound heard within a 1/2 km radius.
- May not work well in some areas, including rural areas where residences are some distance from the road or for large buildings with few external windows.
- Limitations of loud speaker systems are often demonstrated when people go to their front doors to ascertain the nature of the noise only to find that the vehicle has disappeared and are only able to hear bits of what is now being broadcast elsewhere.
- May require a large amount of logistics support (cars, boats and other transportation, accurate maps and route information, etc.).
- Only if personnel and vehicles are available.

ADDRESSABLE NOTIFICATION METHODS
Personal Systems: Canada Post [13]

Most people probably don't realize it, but Canada Post has the capacity to play a support role in post-disaster relief.

With advance planning, Canada Post's experience with message delivery could be an asset to community warning, especially for getting educational and awareness materials to residences and businesses before events occur and helping communities plan routes for door-to-door notification and route alerting during events. To target specific populations within a specific geographical area, Canada Post's Householder Counts and Maps provide information on the counts of houses, apartments, farms and businesses throughout Canada, along with associated Forward Sortation Area (FSA) and Letter Carrier Walk (LCW) maps.

Householder count information is updated monthly on Canada Post's web site (http://www.canadapost.ca/cpc2/addrm/hh/default-e.asp) and changes to householder counts are made on a daily basis to its internal systems (available on its Householder Count Page).

Canada Post and Disaster Relief

Canada Post's service obligations extend to delivering mail in cases of disaster. During the floods in Winnipeg, Manitoba, Canada Post ensured that alternate mail delivery was established for hundreds of individuals who were temporarily displaced from their homes.

In case of disaster, and when other emergency response resources are unavailable, Canada Post vehicles and drivers could be provided to communities to aid in recovery. Whether it is transporting people or supplies into the area, or locating or relocating people, Canada Post can provide trucks and personnel to help with this process. In British Columbia there is a central Control Centre located in Vancouver that coordinates emergency efforts. This centre is open 24 hours a day, 7 days a week.

To set up this arrangement in BC, Canada Post should be brought into the planning stage. To contact them call: Vancouver Control Centre, 604-662-1616.

---

[13] Peter Wypkema, Communications Director for Western Canada, Canada Post, (December, 2005).

APPENDICES

APPENDIX 1
EXAMPLES OF ESTABLISHED LOCAL TSUNAMI WARNING SYSTEMS FROM AROUND THE PACIFIC

Many countries have established local tsunami warning systems that utilize a variety of techniques.

Arica, Chile

The Emergency Office of Arica (EOA) has identified and mapped two key areas: 1) all tsunami hazard inundation zones along the Arica coast and 2) separated from the inundation zone by a securing line, the remaining non-tsunami exposed areas. Through preparedness planning and education, when a warning is issued individuals know what actions to take based on where they are. When a local tsunami warning is issued, the local civil defense authority initiates evacuation of the coastlines. The EOA and fire department then activate sirens and the Tsunami Emergency Alert System broadcasts a message to evacuate the coastlines. The sound of sirens is a standard two minute steady alert signal that prompts people to turn on their radio to receive the evacuation notice and refer to the evacuation maps in the telephone book.

Japan

Japan, like Alaska and the Cascadia region, is located near a subduction zone that is exposed to frequent seismic activity and tsunami risks. Japan experiences significantly more tsunamis than the United States and Canada and has developed one of the most extensive warning systems in the Pacific, especially for near off-shore tsunami events.

There is one main observatory (in Tokyo) and five regional observatories, all capable of issuing a warning. Six regional centres connected to 300 sensors located across Japan's islands, including around 80 water-borne sensors, monitor seismic activity round the clock. Data is continuously collected using satellites and cellular communication techniques to avoid failures associated with landline and Internet technologies. The goal is to broadcast a tsunami warning less than three minutes from the initial sensing of the earthquake. If an earthquake occurs offshore, the observatories close to the epicenter will issue tsunami bulletins to their areas of responsibility. The bulletins will go to the prefectures (similar to Canadian provinces) through the Local Automatic Data Editing and Switching System (L-ADESS). L-ADESS will also send forecast results (tsunami heights) to the main observatory and other observatories. The main observatory will issue bulletins (warning, watch or information bulletin) to other prefectures and alert other government agencies through its Central-ADESS. Ministries and agencies at the national level are linked together in the Central Emergency Management Communication Network (CEMCN). Members of the CEMCN include Ministry of Construction, Tokyo Electric Power, and Nippon Broadcasting Corporation. Prefectures receive bulletins at the same time as the CEMCN. The prefectures then transmit them to the local governments (cities, towns) for action.

The following are local notification methods:

Simultaneous Announcement Wireless System (SAWS)

SAWS is a dedicated system of transmitters and receivers installed by communities for all types of messages. The transmitters are located in the local government office and receivers are found in hospitals, schools, fire stations, emergency management offices and other places. Receiver towers or posts with loudspeakers are also installed on streets and roof tops of prominent government and commercial buildings. SAWS effectiveness is reduced (as much as 15-20 % in urban areas) during inclement weather, when people close their windows. To compensate for this, many residents have purchased receivers for their homes; the receivers are automatically activated when a message, such as a tsunami bulletin, is being transmitted. There is also an attachment to the telephone that can serve as a dedicated radio receiver. A triggering signal from the broadcast source will turn on the loudspeaker and the SAWS message can be heard. SAWS is known as tone alert radio in the United States and Canada.

Mobile Announcer System

This system is designed for those areas without SAWS. Fire trucks mounted with loudspeakers cruise their area of responsibility to announce the warning.

Television and Radio

Tsunami warning announcements have priority to cut into ongoing programs on government and commercial television and radio stations. Stations receive tsunami bulletins from the main and regional observatories by C-ADESS or L-ADESS, respectively. The message is either a subtitle on the bottom of the screen or a window which shows a map where the watch or warning applies. However, the map cannot be shown fast enough in the case of a local tsunami. In the case of the radio, an ongoing program is interrupted with the message.

Sirens and Bells

In some villages, sirens are installed that prompt residents to turn on their radio or television for further information. Some villages clang a bell to announce a tsunami warning.

Telephone Network and Word of Mouth

Some communities have formed telephone networks to spread important information. In some communities, the only way to reach people is by going from house to house. Both methods are time consuming, but are necessary to reach populations that lack the other systems.

Building and Geographical Structures

Although JMA aims to give people in the path of the wave at least 10 minutes' warning to evacuate the area, Japan’s residents know that it is not just an early-warning system that saves lives. Strict building laws protect against tsunamis and quakes. Some prefectures along the tsunami-prone east coast, have also constructed hundreds of tsunami and quake-resistant shelters. Other coastal towns have built floodgates to prevent water from tsunamis heading inland through rivers.

Training
Local communities have extensive training, allowing them to respond to tsunami warnings. Tsunami awareness is part of coastal Japan's culture — to such an extent that upon sounding a "high level" tsunami warning, the majority of the at-risk population, even if asleep, have been known to evacuate to safe ground within five minutes.

New Zealand

The New Zealand Ministry of Civil Defence and Emergency Management (CDEM) maintains a 24/7 system to receive Pacific Tsunami Warning Center bulletins. A National Warning Message is issued to local and other authorities by fax, email and cellular text message. Recipients acknowledge receipt and activate their own arrangements to disseminate or take further action. National Warning Messages are extended for public broadcast on radio and television. Through special agreements, guidelines have been established with media outlets concerning the priority and broadcast frequency required for particular warnings. The CDEM Warning system does not prescribe the actions required in response to national warning messages. Rather, it is the responsibility of other national and communities to receive and respond to warning information received from the CDEM Warning System. The Warning System is tested four times per year. Tests are conducted unannounced and at irregular intervals.

Local warning systems can be activated in response to a national warning or a localized threat and are aimed at reaching local populations. Warning methods entail a mixture of signposts, siren systems and local radio broadcasts. For rural areas, door-to-door and telephone warning procedures are also used.

United States

The states of Alaska, Oregon, Washington and California use a variety of tsunami warning notification systems and procedures. The WC/ATWC issues a tsunami warning through its standard notification protocol. This includes distribution of a text bulletin through NOAA Weather Wire Service (NWWS) and a verbal notification, for state warning points via the National Warning System (NAWAS), a party line network of telephone circuits connecting state and Federal warning points throughout the United States. Local National Weather Service offices immediately receive the text warnings.

State emergency management agencies receive the bulletin via NWWS and rebroadcast it over state owned systems to law enforcement and other agencies. They also receive a verbal notification directly from WC/ATWC via NAWAS. The state agency makes verbal notification to local jurisdictions via NAWAS, telephone, or other communication systems. Local jurisdictions on the coast also receive a hard copy of the warning via the state-owned system, typically within about 3-4 minutes from when the state receives the message. Local jurisdictions often receive these bulletins at 911 centres, county emergency operations centres, law enforcement dispatch centres and/or fire dispatch centres where NAWAS equipment may be located.

The general public can receive an audible voiced warning directly from NOAA Weather Radio and the Emergency Alert System (EAS). Local NWS offices maintain a network of NOAA Weather Radio stations that continuously broadcast weather forecasts and special warnings along the West Coast. In Oregon, for example, approximately 70% of the at-risk population is within range of one of these transmissions.

NOAA Weather Radio transmission of the Tsunami Warning will activate alarms on specially designed receivers. Similarly, the EAS system (the primary method for state and local officials to notify the public of an emergency, using the broadcast industry system) receives the warning from NOAA Weather Radio and can automatically rebroadcast the message over commercial radio, television, and cable TV systems. All radio and television stations and cable systems with at least 10,000 subscribers are required by the FCC to have EAS equipment installed and functional. Commercial broadcast of state and local warnings, including tsunami warnings, is voluntary. However, if the local EAS plan specifies that a particular message type requires activation of EAS; broadcasters must either carry the message or go off the air.

Communities may choose to evacuate on receipt of a tsunami warning. Local officials can use the EAS system, sirens, telephone calls, or other means to give explicit evacuation directions, or other pertinent instructions, following the warning.

TsunamiReady Communities [14]

In 2001, the National Weather Service (NWS) began its TsunamiReady program to provide coastal communities in Alaska, Washington, Oregon and California with guidelines for hazard awareness, improved planning, and public education to help them survive in the event of a tsunami. A community that meets program criteria may be recognized as TsunamiReady by the NWS. The TsunamiReady program lays a foundation upon which a vulnerable coastal community can build its tsunami awareness and preparedness infrastructure. To become truly tsunami resilient, it is expected that communities will engage in a continuous process of mitigation and preparedness that includes:

- Hazard identification and risk assessment to develop an understanding of a community's vulnerability and serves as the foundation for public education.
- A good public education program that directly addresses tsunami hazard issues and presents information about mitigation and preparedness simply and clearly.
- An integrated on-shore communications that must be in place to get the warning message to the public.

[14] Crawford. TsunamiReady Communities: No Overnight Solution.

APPENDIX 2
SIRENS

Siren Types[15]

Electro-Mechanical Sirens

Electro-mechanical siren units generate sound mechanically. They are driven by an electric motor and are available in various types of design and output power engineered for various uses. These range from small units on emergency vehicles to the large wide-area outdoor alarm system siren units requiring 3-phase AC power, from standard and available AC power sources (208, 240, or 480 volts supplied by power utility special transformers). Some electro-mechanical siren units incorporate storage batteries for limited operation if AC power fails – battery charging having been maintained by AC power. During prolonged power outages, when an AC-dependent siren's use might be required more than once, or if equipped with backup batteries for limited use, electro-mechanical siren units could be operated by a portable generator. If centrally located, such as atop a fire station or city hall, auxiliary AC power is often available during general outages of AC service.

Control of siren operation can be by on-site manual switches or remote control over leased telephone line or radio link to a central emergency operation centre. Central or station controls can activate one unit, a group, or all units.

Sirens generating emergency signals for a community warning system may need to vary their sound in several ways to communicate different meanings to the public. The familiar repetitive wailing sound that usually signals an emergency is achieved by speeding up or slowing down the siren's spinning rotor to generate, respectively, high and low sound frequencies.

Length of time for the sound to change from low to high frequency or vice versa is the "Sweep Rate" and is varied by turning power to the motor on and off. The standard "Wail" is about nine seconds for the spinning rotor to speed up from generating approximately 400 Hz to peaking at 1,000 Hz when power is cut off. The rotor then slows to the lower frequency until power is switched back on. The electro-mechanical siren's signal can be varied. The standard "Attack" siren tone, distinctive from standard "Wail", has a faster sweep rate (two seconds) cycling between approximately 700 and 1,000 Hz.

Sound patterns to communicate other meanings to the public are available by other variations of sweep rate and/or length of time for the siren to operate. Some community sirens are turned on to run up to peak frequency and cycle back down once as a short activation (e.g. 15 seconds) to signal "Noon Time".

---

[15] Adapted from: Beaulieu, J. D. (2001). Tsunami Warning Systems and Procedures: Guidance for Local Officials.

Electronic Sirens

Electronic siren units are powerful loudspeaker systems broadcasting amplified electronically generated standard tone patterns, e.g. "Wail", "Attack", "Hi-Lo", "Alert", "Whoop", "Air Horn", etc. Some versions of electronic siren units offer public address announcements. This is a valuable feature, making it possible to communicate local emergency information quickly and efficiently to the public, especially more transient populations. Versions providing a public address feature can broadcast from microphone for live-voice announcements, from pre-recorded magnetic tape, or compact disk recordings. Some versions are equipped to broadcast pre-recorded messages stored in memory chips. Centralized or siren station controls can activate any single particular station, groups of stations, or all the system's stations.

Electronic siren units are available, competitively priced, in as many varieties of output power as the older technology electro-mechanical sirens.

Some units operate from 120 volt AC power while others operate from low-voltage storage battery systems. In the event of AC power failure, some have backup storage batteries enabling operation for a limited time.

Some of the electronic sirens' design provides an advantage over electromechanical sirens. One advantage is the high-power electronic siren's ability to operate from a low voltage battery power supply. In a wide-area disaster, AC power outage may be prolonged and emergency services officials will likely need more than brief use of the community notification system (e.g. repeated notifications, public address advisories about hazards, or other emergency type announcements). Electronic siren units, engineered to operate regularly from their low voltage storage battery systems, offer lengthier service than siren units intended to operate on AC. When backup batteries are depleted, they can be replaced or a portable generator can supply AC power. A disadvantage is electronic units often require more maintenance than electromechanical models in coastal environments.

A community notification system, comprised of electronic siren units which operate from low-voltage battery systems maintained by solar charging, will operate independent of AC power. Solar charging equipment has decreased in price during the last decade, making this method of maintaining batteries practical. Battery systems maintained by solar power make it practical to install siren stations in strategic locations remote from AC power service. Powering an electronic siren unit with a solar-maintained battery system has other advantages. The unit is entirely protected against AC system voltage spikes, surges, and other irregularities, which can cause maintenance problems.

Control of siren operation can be by on-site manual switches, remote control over leased telephone line, or radio link to a central emergency command centre.

Siren Sound Projection

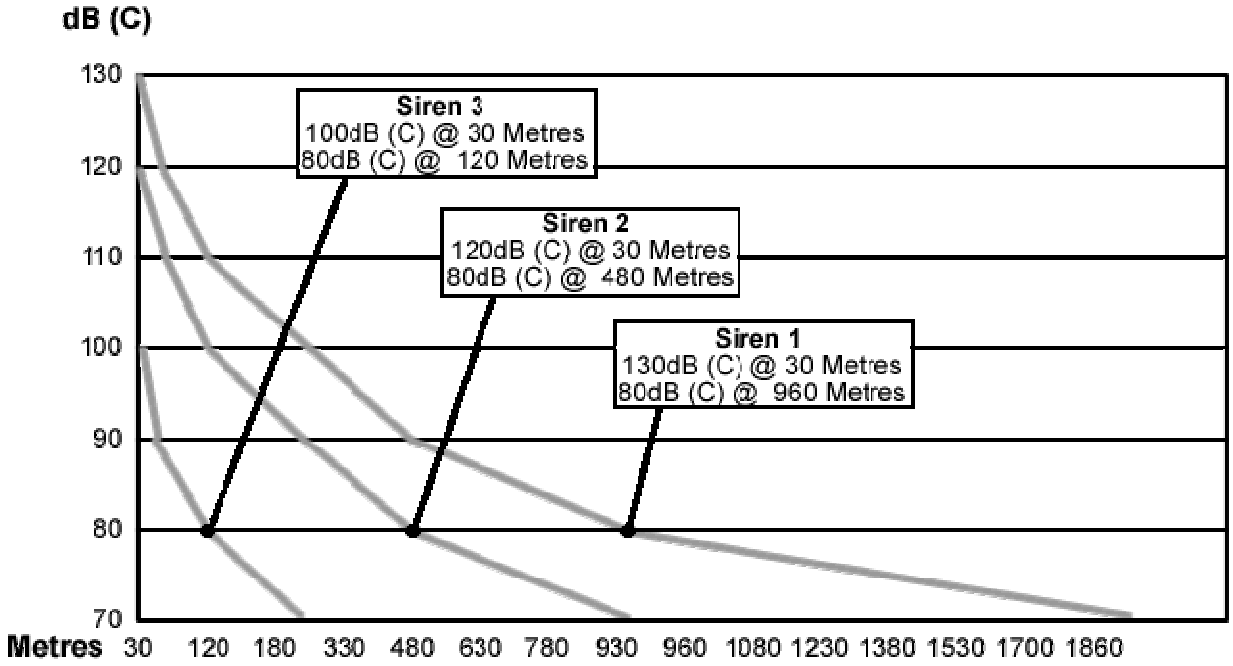
Sound is a form of mechanical energy that travels from a source (a horn, voice, and siren) to a listener as tiny oscillations of air pressure. People hearing sounds can distinguish their tone, pitch and loudness. Variations in pitch and loudness of some sounds can convey certain meanings.

Sound meters can be used to detect and measure sound characteristics, including loudness and pitch. Magnitudes of loudness are recorded in the form of decibels [abbreviated here as Db(C)]. These magnitudes closely relate to what we hear as levels of loudness. An audible warning device that produces a sound level of 110 dB(C) at 30 metres away sounds louder than one that produces a sound level of 100 dB(C) along the same path and distance. Audible outdoor warning devices are rated in terms of their sound output at 30 metres in dB(C).

Instruments can be used to measure the frequency components of sounds, and they record these ranges in the form of Hertz (Hz) or cycles per second. They closely relate to what we hear as pitch. Frequency components of sounds are important for determining how far a sound will carry through the air and how well it will be heard.

Projection of sound from either type of siren is subject to diminishing ten decibels at every doubling of distance between the source and point of measurement. This means siren output measured at 120 dB(C) 30 metres out from the unit will diminish to 110 dB(C) at 60 metres, 100 dB(C) at 90 metres, etc. Various factors apply to selecting equipment in order to hear the sound. These factors are shapes of terrain to be covered by the sounding alarm, types and distribution of significant foliage, sides and roofs of structures within the area, prevailing wind patterns, prevailing air humidity and temperatures, and frequencies of the sound being projected (lower frequencies traveling better than the higher).

When planning a wide-area siren system the reach of the siren signal is important. The ambient (background) noise level of the area to be blanketed by the alarm signal must be considered. Typical noise levels from normal surf and normal wind is approximately 70 dB(C). The standard rule is for the minimum level of the siren signal to be 10 dB(C) louder than background noise level; thus maximum effective range for a warning signal should be considered no farther than the distance from the sound generator to where it generally delivers 80 dB(C). Figure XX illustrates effective range under ideal conditions for each of three sirens having different decibel power as measured 30 metres away from the unit. The chart shows significantly greater range of alarm coverage by what might appear as only moderate increases of siren output power (decibels measured 30 metres straight out from the siren).



Distance (in metres) from Siren Unit

High-powered sirens not specifically engineered to project their principal sound outward are less suited for where people move about at ground level in the open or occupy buildings close to the siren's location. High-powered sound will blanket the siren's immediate area like a fire system sprinkler spray saturating everything nearby with full pressure.

Alternate Power Supplies

The choice of power supply for siren notification systems is vital when planning a system. Sirens rely upon either AC power of 120 up to 440 volts or low-voltage storage batteries.

A community notification system operating directly on AC service line power is at risk from power outages or electrical irregularities that can damage siren unit controls. This is particularly the case when lightening strikes within the community. Lightening can damage the entire siren unit regardless of protection devices. Power lines connected to siren units broaden the exposure to lightning strikes. In most B.C. outer coastal regions, power lines are also subject to adverse weather. Ongoing expenses for AC service should be considered.

Siren units engineered to operate directly on low voltage storage battery power with the battery charge maintained by AC service have their siren controls and equipment far better protected. The batteries stand between the siren elements (except the battery charger) and the AC power line's potential for damage to elements of the station control system (e.g., relay coils and/or solid state electronic circuitry components).

Ideal protection for siren units and their controls is to have no connection at all with AC power lines, even for charging the battery power supply. Instead, maintain the battery system by a solar powered charger. As already mentioned, during the last decade prices have fallen to make solar equipment competitive with costs of equipping alarm system stations with AC power. Wind systems are also cost effective.

Battery power supply systems need to be engineered properly. Where a siren unit is driven by AC power but is equipped with backup batteries, the batteries' life span will be shortened if they are not regularly 'exercised'. Proper maintenance will require systematically using them for a full operational test of the siren unit (power drawn by the test should parallel what an emergency activation would require) to insure they can provide enough backup power when needed. Do not rely on backup batteries in the siren unit without maintaining proper testing.

Critical to the success of a battery power supply is the selection of proper batteries for their intended use. Use of sirens in one community may differ from needs of another community. A community having a heavily populated tsunami inundation zone might anticipate the need to use their alarm system several times during an emergency. A coastal community without extensive exposure to tsunami hazards might only use the sirens briefly.

Type of battery selected is very important. Experience shows that batteries for wide-area alarm systems should be robust deep discharge, uninterrupted power supply (UPS), 6-volt batteries rather than from half as many 12-volt batteries, because of less wear and tear on battery plates. Such 6-volt batteries have sturdier plates. While discharging to power the siren, the load is also spread over more plate surface than it would be in half as many 12-volt batteries. Service life of even the highest quality 12-volt batteries can be short due to their thin plates buckling from the heat developed while powering the siren.

Careful consideration of these principles is even more important when planning systems to be used both for broadcast of siren alarm tones and public address announcements. The latter puts a heavier load on the power supply than simple siren tone patterns.

Where storage batteries will be used either as backup for loss of AC power or for basic operation directly, planners of a wide-area siren alarm system need to recognize the importance that properly engineered power supplies are the solid foundation for the system. Equipment and power supplies for a system's needs should not be determined by trial and error, but with guidance from specialized professionals having broad experience in wide-area alarm systems.

APPENDIX 3
Selected Web Links

Canada

British Columbia

Provincial Emergency Program
http://www.pep.bc.ca/

- **Tsunamis**
  http://www.pep.bc.ca/hazard_preparedness/Tsunami_Information.html

Federal Government

Fisheries and Oceans
http://www-sci.pac.dfo-mpo.gc.ca/osap/projects/tsunami/default_e.htm

- **Tsunami Models**
  www-sci.pac.dfo-mpo.gc.ca/osap/projects/tsunami/tsunamimodel_e.htm#Model%20Results

Public Safety and Emergency Preparedness Canada
http://www.psepc-sppcc.gc.ca/index-en.asp

- **Tsunami and Storm Surges**
  http://www.psepc-sppcc.gc.ca/res/em/nh/tss/index-en.asp

Industry Canada

- **Emergency Telecommunications**
  http://strategis.ic.gc.ca/epic/internet/inet-tdu.nsf/en/Home
- **CANALERT**
  http://www.canalert.gc.ca/

Universities

University of British Columbia

- **Tsunami Response**
  http://www.ubc.ca/tsunami/index.html
- **Geophysical Disaster Computational Fluid Dynamics Centre**
  http://www.eos.ubc.ca/research/infrastructure/disasters.htm

Simon Fraser University

- **Centre for Natural Hazards Research**
  http://www.sfu.ca/cnhr/

UNITED STATES

NOAA (National Oceanic Atmospheric Association)

http://www.noaa.gov/

- **National Tsunami Hazard Mitigation Program**
  http://www.pmel.noaa.gov/tsunami-hazard/
- **NOAA Center for Tsunami research**
  http://nctr.pmel.noaa.gov/
- **Pacific Tsunami Warning Centre**
  http://www.prh.noaa.gov/ptwc/
- **West Coast and Alaska Warning Center**
  http://wcatwc.arh.noaa.gov/
- **TsunamiReady Program**
  http://www.prh.noaa.gov/ptwc/tsunamiready/tsunamiready.htm

Tsunami Museum, Hilo, Hawaii

http://www.tsunami.org/

University of Washington

- **Welcome to Tsunami**
  http://www.ess.washington.edu/tsunami/index.html
- **Tsunami Hazard Mitigation**
  http://www.geophys.washington.edu/tsunami/general/mitigation/mitigation.html

US Geological Survey

http://www.usgs.gov/

- **Tsunami Research**
  http://walrus.wr.usgs.gov/tsunami/

TsunamiReady Communities

- **Tillamook County, Oregon (good aerial inundation maps)**
  http://www.co.tillamook.or.us/gov/EMGMGNT/
- **Kenai Peninsula Borough, Alaska (good education info)**
  http://www.borough.kenai.ak.us/emergency/prepared/earthquake.htm
- **Pacific County, Washington (good tsunami brochures)**
  http://www.co.pacific.wa.us/pcema/
- **Lincoln City, Oregon (good tsunami brochure)**
  http://www.lcchamber.com/
- **Homer, Alaska (All Hazards Mitigation Plan)**
  http://www.ci.homer.ak.us/

RUSSIA

- **Yuzhno-Sakhalinsk Tsunami Warning Center (Russia)**
  http://www.science.sakhalin.ru/Tsunami/

UNITED NATIONS

- **UNESCO ITIC (International Tsunami Information Centre)**
  http://www.tsunamiwave.info/
- **UN International Strategy for Disaster Reduction – Platform for the Promotion of Early Warning**
  http://www.unisdr.org/ppew/tsunami/ppew-tsunami.htm
- **TEWIS ─ Tsunami Early Warning Information System**
  http://unisdr.unbonn.org/
- **WHO (World Health Organization)**
  http://www.who.int/hac/crises/international/asia_tsunami/en/

PROFESSIONAL ORGANIZATIONS

- **Tsunami Society**
  http://www.sthjournal.org/

NEWS AGENCIES

- **UN News**
  http://www.un.org/apps/news/infocusRel.asp?infocusID=102&Body=tsunami&Body1
- **World News Network – Tsunami News**
  http://www.tsunaminews.com/
- **BBC News**
  http://news.bbc.co.uk/1/hi/in_depth/world/2004/asia_quake_disaster/default.stm
- **National Geographic News**
  http://news.nationalgeographic.com/news/2005/01/0107_050107_tsunami_index.html

REFERENCES

Anderson, Peter and Gow, Gordon (2003) An Assessment of the B.C. Tsunami Warning System and Related Risk Reduction Practices. PSEPC. Ottawa. [http://www.ocipep.gc.ca/research/resactivites/CI/2003-D001_e.asp].

Answers.com. (2005). Amateur Radio. [http://www.answers.com/topic/amateur-radio].

Alberta. (2005). Alberta Emergency Public Warning: Authorized User Handbook. Emergency Management Alberta, Edmonton. [http://www.municipalaffairs.gov.ab.ca/ema/pdf/AU_Guide.pdf].

Avanzini, F., Rocchesso, D., Belussi, A., Dal Palu and A. Dovier, A. (2004). Designing an Urban-Scale Auditory Alert System. IEEE Computer Society/ 0018-9162.

Beaulieu, J. D. (2001). Tsunami Warning Systems and Procedures: Guidance for Local Officials (Special Paper 35): Oregon Department of Geology and Mineral Industries. [http://www.pmel.noaa.gov/tsunami-hazard/SP35FORWEB.PDF].

British Columbia. (2005). What You Need to Know About Tsunamis. British Columbia Emergency Program.

British Columbia. (2005). Tsunami Notification Zones. British Columbia Emergency Program.

British Columbia. (2005). Types of Tsunamis and Risk Areas Notification Times. Columbia Emergency Program.

CEASA. (2005). Problems with SMS mass messaging. [http://www.ceasa-international.com/index.php?option=com_content&task=view&id=27&Itemid=32].

Crawford, George. (2005). TsunamiReady Communities: No Overnight Solution. Natural Hazards Observer, Vol. XXIX No.6.

Darienzo, Mark, Aya, Al, Crawford, George L., Gibbs, David, Whitmore, Paul, Wilde, Tyree and Yanagi, Brian S. (2005). Local Tsunami Warning in the Pacific United States. Natural Hazards, 35:111-119.

Emergency Management Australia. Flood Warning, Emergency Management Practice, Emergency Management Manuals Series 3, Canberra, 1999.

Federal Emergency Management Agency. (1980). Outdoor Warning Systems. CPG 1-17. Washington, D.C.

Intergovernmental Oceanographic Commission. (2005). Twentieth Session of the International Coordination Group for the Tsunami Warning System in the Pacific (ICG/ITSU-XX). National Report of the U.S. 2003-2005 IOC/ITSU-XX/7.17. Valparaiso, Chile: UNESCO. [http://ioc3.unesco.org/itic/files/itsu20_doc717.pdf].

Intrado. (2003). Emergency Telephone Notification: Critical Requirements. Longmont.

Japan Meteorological Agency. (2005). Tsunami Warning System in Japan.

Kayes, Brian. (2004). Procedural Guide for the Implementation of a Siren System as a Public Alerting Tool. City of Brandon.

Michigan Department of State Police, Emergency Management Division. (1994) Warning, Evacuation and In-place Protection Handbook [http://www.city.waltham.ma.us].

Molini, S., Begg,G.l., and Opper, S. (2002). Bells and Whistles, Belts and Braces – Designing an Integrated Flood Warning System for the Hawkesbury-Nepean valley – Part 1 Bells and Whistles. Australian Journal of Emergency Management, Vol. 17:55-59.

Murphy, Ken. (2005). After Action Report: West Coast Tsunami Warning. Oregon Emergency Management.

National Science and Technology Council. (2000) *Effective Disaster Warning:* Report by the Working Group on Natural Disaster Information Systems Subcommittee on Natural Disaster Reduction. [http://www.sdr.gov/NDIS_rev_Oct27.pdf].

NeoDym Systems. (2003). Public Alerting Using Satellite Technology. Industry Canada, Ottawa.

NOAA. (2004). StormReady Organization and Operations Manual. Silver Springs. [http://www.stormready.noaa.gov/resources/OpsManual2005.pdf].

Partnership for Public Warning. (2004). Protecting America's Communities an Introduction to Public Alert & Warning, PPW Report 2004-2. [http://www.partnershipforpublicwarning.org/ppw/docs/handbook.pdf].

Samarajiva, Rohan, Knight-John, Malathy, Anderson, Peter and Zainudeen, Ayesha. (2005). National Early Warning System: A Participatory Concept Paper for the Design of an Effective All-Hazard Public Warning System. LIRNEasia, Colombo, Sri Lanka. [http://www.lirneasia.net/projects/completed-projects/national-early-warning-system/].