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Thirtieth Session of the Intergovernmental Co-ordination Group for the Pacific Tsunami Warning and Mitigation System (ICG/PTWS)

11-15 September 2023

Agenda Item 4.3

REPORT OF

PTWS WG 2 TASK TEAM ON THE MINIMUM COMPETENCY LEVELS FOR NATIONAL TSUNAMI WARNING CENTRE (NTWC) OPERATIONS STAFF

This document has been prepared by the Task Team, co-chaired by 'Ofa Fa'anunu, Director of the Tonga Meteorological Services, and Laura Kong, Director of the International Tsunami Information Centre (ITIC).

The need to establish minimum competency level for national tsunami warning centre staff was discussed in the during the Fourth Session of the PTWS Working Group for the South West Pacific in 2016 and requested by Tonga at the Twenty-seventh Session of the ICG/PTWS-XXVII in 2017. A working draft was shared at the Twenty-eighth Session of the ICG/PTWS-XXVIII in 2019, and a Task Team on the Minimum Competency Levels for National Tsunami Warning Centre (NTWC) Operational Staff established under Working Group Two. Feedback was received from the PTWS PICT WG Task Team on Capacity Development report at the Ninth session of the PICT WG in February 2023. The meeting noted the impacts of the 2022 Hunga Tonga – Hunga Ha'apai Volcanic Eruption and Tsunami, and so the importance of including volcano-generated and non-seismic tsunami sources, as well as an understanding the disaster management and risk reduction aspects of tsunami warning.

This report contains the Framework, Minimum Competency Levels, Training Requirements, and compilation of examples from countries around the world. The competencies are general and applicable to other ICG regions.

The competency framework is built on elements of competencies which can be grouped into levels or tiers. Each level/tier has a corresponding qualification for staff to earn upon completion of all required competency elements and the successful test against the predefined performance criteria. The competencies cover science, understanding PTWS Tsunami Service Provider products, and the performance of tasks stipulated in their National Tsunami Warning Centre standard operating procedures (SOPs). No one individual is expected to be trained to the highest level in all competencies, but all should have a common understanding of the fundamentals and the skills to perform the minimum tsunami warning response tasks. At least two roles are recommended in an NTWC, one requiring an advanced level of knowledge and competency to be the primary responder, and a second with a basic level of knowledge and competency to assist with the tsunami warning process.

A draft recommendation is available in the final section.

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1 Introduction and Background

1.1 Introduction

This report contains the Framework, Minimum Competency Levels, Training Requirements, and compilation of examples from countries around the world. The competencies are general and applicable to other ICG regions.

The purpose of this document is to outline the required competences for the staff of National Tsunami Warning Centres (NTWC). In general, NTWCs will at least receive and take action on the text and graphical products from their Tsunami Service Providers (TSPs), such as the Pacific Tsunami Warning Centre (PTWC), Northwest Pacific Tsunami Advisory Centre (NWPTAC), South China Sea Tsunami Advisory Centre (SCSTAC), or other centres as they are established. NTWCs may also carry out independent earthquake and tsunami monitoring, detection and response. Additionally, while this document does not cover Disaster Management Office (DMO) competencies, it does emphasize the importance of understanding DMO requirements for tsunami warning.

To be effective, NTWC staff need a wide range of competencies in the science of tsunamis and in the causes of tsunamis such as from earthquakes, volcanoes, and landslides, as well as in performing the tasks stipulated in their national tsunami warning standard operating procedures (SOPs). No one individual is expected to be trained to the highest level in all competencies, but they all need a common understanding of the fundamentals across aspects of tsunami generation, propagation, potential impact as well as the skills to perform the minimum necessary tsunami warning response tasks. As such, each Centre should have at least two staffing roles, with each role requiring different levels (or tiers) of skills obtained by training, exercises and competency testing.

1.2 Background

The need to establish minimum competency level for national tsunami warning centre staff was discussed in the during the Fourth Session of the PTWS Working Group for the South West Pacific in 2016 and requested by Tonga at the Twenty-seventh Session of the ICG/PTWS-XXVII in 2017. A working draft was shared at the Twenty-eighth Session of the ICG/PTWS-XXVIII in 2019, and a Task Team on the Minimum Competency Levels for National Tsunami Warning Centre (NTWC) Operational Staff established under Working Group Two. Feedback was received from the PTWS PICT WG Task Team on Capacity Development report at the Ninth session of the PICT WG in February 2023. The meeting noted the impacts of the 2022 Hunga Tonga – Hunga Ha'apai Volcanic Eruption and Tsunami, and so the importance of including volcano-generated and non-seismic tsunami sources, as well as an understanding the disaster management and risk reduction aspects of tsunami warning.

Due to funding limitations for in-person meetings, the Task Team worked by email to improve and finalise the 2019 draft for approval by the Thirtieth Session of the ICG/PTWS, and to compile existing schema and training concepts for establishing the operational competency of NTWC Staff.

2 National Tsunami Warning Centre Competency Framework

2.1 Tiered Competency Framework and Staffing

The competency framework is built on elements of competencies which can be grouped into levels or tiers. Each level/tier has a corresponding qualification for staff to earn upon completion of all required competency elements and the successful test against the predefined performance criteria. The competencies cover science, understanding PTWS Tsunami Service Provider products, and the performance of tasks stipulated in their National Tsunami Warning Centre standard operating procedures (SOPs). At least two roles are recommended in an NTWC, one requiring an advanced level of knowledge and competency to be the primary responder, and a second with a basic level of knowledge and competency to assist with the tsunami warning process. Each role will have a set of core competencies and a set of optional competencies. Additional roles can be added if required. For example, there may be a need for an observational seismologist, a tsunami scientist or an ocean science specialist tier in some organisations. An example of a two-tier system would be:

- ***NTWC Staffing Role 1: Tsunami incident controller (or manager)***

  This tier 1 role requires a comprehensive understanding of tsunami causes and impacts, expert interpretation of TSP products, and competent performance of all key national warning procedures. For example, referring to the competency list below, the tier 1 role will require most competencies listed below, but some of the advanced competencies may still be optional.

- ***NTWC Staffing Role 2: Tsunami incident assistant***

  This tier 2 role requires a basic understanding of tsunami causes and impacts, simple interpretation of TSP products, and ability to perform some tasks of the national warning procedures. For example, referring to the competency list below the tier 2 role will require competencies in sections 1, 3, and 5 while several other competencies are optional but desirable.

Another approach would be to have two (or more) levels of NTWC, a minimum viable (MV) NTWC and a full NTWC. In this case:

- **MV-NTWC:** would be capable of receiving the TSP messages, interpreting the messages in the national framework context before providing tsunami national warnings. Additionally, some level of understanding of and the ability to perform response to local-source tsunami would be required. A MV-NTWC would therefore require all the competencies in sections 1, 3 and 5 (or some combination of them) below.

- **Full-NTWC**: would have all the capabilities of a MV-NTWC but would also be capable of independently accessing earthquake parameters and producing tsunami threat forecasts based on the derived earthquake parameters. In this case almost all of the competencies listed below would be required, but this may be spread over several people or roles.

2.2 National Tsunami Warning Center (NTWC) Competencies

The minimum National Tsunami Warning Center (NTWC) competencies, listed in Appendix 1, cover the knowledge and skills required by staff to operate in a tsunami warning centre. They cover five categories:

- Core science knowledge
- Advanced science knowledge
- Core operational competency
- Advance operational competency
- Core agency competencies

Appendix 1 lists the framework only - additional detail is required to become the complete competency requirements. Some competencies will be generic across all NTWCs, while others (as indicated) will depend on the sub-region as served by different IOC Tsunami Service Providers. Most importantly, competencies related to national policies, requirements and procedures will be Member State-specific. The requirements for each role (for example, according to the arrangements described in Section 2.1) can be defined by listing the required competencies in the five categories.

3 NTWC Competency Training

3.1 Requirements

Existing schema shared by Member States (Section 4) provide examples and valuable best practices that can be used by Member States to develop their own schema for building their warning center staff competency and operational readiness. The PTWS PICT WG Task Team on Capacity Development also recognised that national initiatives can and may need to be supported by international and regional partners who can assist Member States.

An NTWC Competency Training Programme should

- Include a NTWC Staffing Profile, including positions, qualifications, and capabilities,
- Establish standardized training modules, covering science, operational, and agency competencies, that have measureable assessments, performance criteria, and/or tests. Training modalities may vary according to the module goals and content,

3.2 **International Tsunami Information Centre**

For the PTWS, the International Tsunami Information Centre (ITIC), which serves as the regional tsunami information centre for the Pacific, provides support, on request, to countries in establishing and strengthening their national tsunami warning and mitigation systems. Altogether since the 2004 Indian Ocean Tsunami, the ITIC has conducted more than 145 tsunami trainings (to 70 countries globally, 53% in Pacific) on tsunami warning center and emergency response standard operating procedures (standardized as IOC Manual and Guides 76, 2017), and inundation and evacuation mapping, response planning and exercises (standardized as IOC Manual and Guides 82, 2019). In addition, the ITIC serves as a Specialized Training Center for tsunamis under the IOC's online Ocean Teacher Global Academy (OTGA), with course offerings planned on Tsunami Awareness, Tsunami Ready, and Tsunami Early Warning Systems to complement its in-person on-site training courses.

As an ICG/PTWS capacity development priority, and at the request of the global TOWS Working Group to develop a global NWTC Competency Framework based on Pacific input for all ICGs to use, the ITIC seeking funding to develop and pilot the PTWS NTWC Minimum Competency Framework in 2024. The ITIC expects to partner with the PTWC and other advanced tsunami warning centers to develop online, hybrid, and in-person training to meet the Core and Advanced Science Knowledge, and Core and Advanced Operational competencies, as well as general approaches for meeting Core Agency competencies related to Disaster Management Office emergency response, and media engagement. If funding is successful, the ITIC will pilot the Competency Training and report on its outcomes to the next session of the ICG/PTWS in 2025.

4 Existing Schema

The Task Team solicited NTWC Competency Information from several advanced National Tsunami Warning Centres. The following information was requested

- Profile of staff - background, experience for the staff that are hired (such as degrees and specialities)
- Length of NTWC training before they are officially designated as Duty Watchstanders
- Training Information – syllabus (topics, length), how watchstander readiness is measured (tests, practicum, other measures), how training is accomplished (live observer, online, offline, hands-on, classroom, online, other)

Information was received from Australia, Chile, India, New Zealand, USA (PTWC and US National Tsunami Warning Center) and Tonga, and can be found in Appendix 2.

5 PTWS-XXX Recommendation

Recalling the requests from Pacific Island Countries in 2016 and at the Twenty-seventh Session of the ICG/PTWS-XXVII in 2017 for the PTWS Working Group Two to establish minimum competency levels for NTWC operations,

Recalling the Draft NTWC Competency Framework shared at the Twenty-eighth Session of the ICG/PTWS-XVIII in 2019, and the establishment of the Task Team on the Minimum Competency Levels for National Tsunami Warning Centre (NTWC) Operational Staff established under PTWS Working Group Two during this Session,

Recalling further the establishment of the Task Team on Capacity Development established under PTWS Regional Working Group for the Pacific Island Countries and Territories on Tsunami and Mitigation at Twenty-eighth Session of the ICG/PTWS-XXVII in 2019, to continue the development of competency framework for National Tsunami Warning Centres personnel and pilot it in Australia, Vanuatu, Fiji, Samoa and Tonga and report progress and lessons learnt to ICG/PTWS WG 1, 2 and 3,

Appreciating the initiative of Tonga, ITIC, PTWC, and IOC to pilot the Draft NTWC Competency Framework with the Tonga Meteorological and Geological Services and the Solomon Islands Meteorological Services in Nuku'alofa, Tonga in October 2019,

Appreciating feedback to the PTWS NTWC Competency Framework from Task Team on Capacity Development Report to the Ninth Session of PTWS PICT WG in February 2023,

Noting the TOWS WG-XV (2022) request to its Inter-ICG Task Teams on Disaster Management and Preparedness and Tsunami Watch Operations to consider development of guidelines for a global NTWC competency framework based on the available set of documents and Pacific input, noting that implementation can be at a regional level,

Noting the TOWS WG-XVI (2023) appreciation of the intersessional progress of the Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System (ICG/PTWS) to develop a National Tsunami Warning Centre (NTWC) Competency Framework (2019), and the ITIC's leadership to pilot training courses based on the Framework,

Noting the TOWS WG-XVI (2023) instruction to the regional ICG, notably the PTWS, and the ITIC to pilot the PTWS National Tsunami Warning Centre (NTWC) Competency Framework for endorsement by ICG/PTWS with the goal to develop a global framework for all ICGs to use,

Recommends the National Tsunami Warning Centre Competency Framework, described in IOC ICG/PTWS-XXX.xx Working Document (Agenda 4.5) and Appendix 2 of this document, is accepted as the framework for minimum competencies for NTWC for the PTWS.

Welcomes the ITIC proposal to pilot the PTWS Minimum NTWC Competency Framework through the development and conduct of a training course during the intersessional period, and report back on its outcome to the Thirty-first Session of the ICG/PTWS.

Recommends the ICG/PTWS WG 2 to report on the use of the Framework by Member States during the intersessional period to the Thirty-first Session of the ICG/PTWS.

Appendix 1. NTWC Competencies

The NTWC competencies are grouped into five categories:

1. Core science knowledge
2. Advanced science knowledge
3. Core operational competency
4. Advance operational competency
5. Core agency competencies

1.0 Core science competencies

1.1 Have basic tsunami science knowledge

1.1.1 List all known causes of tsunami.
1.1.2 Describe how undersea earthquake cause tsunami.
1.1.3 Explain the basics of tsunami propagation in deep water.
1.1.4 Describe the process of tsunami attenuation.
1.1.5 Explain how tsunami wavelength, amplitude and speed change as the tsunami enters shallower water.
1.1.6 Explain the key differences between 'normal' ocean surface waves and tsunami waves
1.1.7 Identify the order of magnitude of tsunami properties in deep and shallow water in terms of speed, wavelength and period.
1.1.8 Describe the difference between crest-first and tough-first tsunami in terms of first impacts on the coast.
1.1.9 Describe how inundation is affected by the bathymetry, coastal properties and local tidal conditions.
1.1.10 Explain run-up and the difficulties of forecasting the extent of tsunami runup.
1.1.11 Explain how sea-level gauges measure tsunami.
1.1.12 Outline the limitations of sea-level gauges.
1.1.13 Describe the use and advantages of deep sea tsunameters (e.g. DART Buoys).
1.1.14 Describe how tsunami amplitudes can be dampened or amplified.

1.2 Have basic earthquake source knowledge

1.2.1 Describe the three earthquake fault types and where they are most likely to be found.
1.2.2 Explain which earthquake fault types are most likely to cause tsunami.
1.2.3 Explain the difference between the basic earthquake terms of epicentre, hypocentre, location and depth.
1.2.4 Describe how earthquake intensity is measured and why it may be useful for tsunami.
1.2.5 Explain how earthquake depth affects the potential for tsunami to be generated.
1.2.6 Explain the earthquake magnitude scale, and the most important magnitude types for tsunami.
1.2.7 Explain why a magnitude difference of 1 unit is large and what this means for tsunami generation.

2.0 Advanced science competencies

2.1 Advanced tsunami science knowledge

2.1.1 List all known causes of tsunami, and demonstrate a detailed knowledge of each.
2.1.2 Describe how undersea earthquake cause tsunami, providing detail of the mechanism.
2.1.3 Explain the basics of tsunami propagation in deep water and be able to describe dependencies.
2.1.4 Describe the various processes of tsunami attenuation and why they occur.
2.1.5 Explain in detail why tsunami wavelength, amplitude and speed change as the tsunami enters shallower water.
2.1.6 Explain the key differences between 'normal' ocean surface waves and tsunami waves, why these differences occur, and what effect this has on their impacts
2.1.7 Identify in detail the order of magnitude of tsunami properties in deep and shallow water in terms of speed, wavelength and period.
2.1.8 Describe in detail the difference between crest-first and tough-first tsunami – why they occur and their implication in terms of first impacts on the coast.
2.1.9 Describe in detail how inundation is affected by the bathymetry, coastal properties and local tidal conditions.
2.1.10 Explain in detail run-up and the difficulties of forecasting the extent of tsunami runup or inundation.
2.1.11 Explain the principles and practicalities of how sea-level gauges measure tsunami, both at the coast and in the deep ocean. List different types of sea-level gauges.
2.1.12 Explain in detail the limitations of sea-level gauges compared with other methods of measuring sea level for tsunami.
2.1.13 Describe in detail how tsunami amplitudes can be dampened or amplified.
2.1.14 Describe the use and advantages of deep sea tsunameters (DART buoys), and how they can be used to calibrate tsunami forecast models
2.1.15 Describe when the tsunami threat is likely to have passed, and what residual threat may remain.
2.1.16 Explain why the period of a tsunami is related to the level of hazard.
2.1.17 Explain why tsunamis are called "shallow-water waves" and what that means for how they affect the water column in the deep ocean.
2.1.18 Explain what a meteo-tsunami is, how it is generated and propagates, where it is more common, and how it can be detected.

2.2 Advanced earthquake source knowledge

2.2.1 Describe the three earthquake fault types and where they are most likely to be found, both within the Pacific and within the national region.
2.2.2 Explain which earthquake fault types are most likely to cause tsunami, giving reasons and exceptions.
2.2.3 Explain the difference between the basic earthquake terms of epicentre, hypocentre, location and depth and their relationship to tsunami generation.
2.2.4 Describe how earthquake intensity is measured and why it may be useful for tsunami threat estimation.
2.2.5 Explain how strong motion amplitude and extent can be used to estimate likely earthquake magnitude and rupture dimensions and the resulting tsunami impacts.

2.2.6 Explain how earthquake depth affects the potential for tsunami to be generated.

2.2.7 Explain the earthquake magnitude scale, and the direct relationship to tsunami potential, including why a magnitude difference of 1 unit is large and what this means for tsunami generation.

2.2.8 Outline the magnitude estimation types which are particularly useful for tsunami characterisation (Modified Mercalli MM, Mwp, Mw, Mww, etc.), including advantages and limitations.

2.2.9 Describe the differences and importance of unilateral or bilateral slip of a fault and compare uniform slip with non-uniform slip.

2.2.10 Explain how magnitude, hypocenter, centroid, rupture length, rupture width and slip are related, and the importance for tsunami generation.

2.2.11 Explain how tsunami periods are related to the earthquake parameters and characteristics.

2.2.12 Explain what an earthquake centroid moment tensor (CMT) is, how it is calculated, and how it is used for tsunami generation and forecasting

2.3 Advanced tsunami forecast modelling: Can competently use tsunami forecast modelling software to produce tsunami forecast impact models

The list of competencies will depend on local systems and procedures.

2.3.1 Explain the difference between long-term (such as to support evacuation planning) and short-term ('real-time') tsunami forecasting (such as performed by tsunami warning centres), in terms of data requirements and input parameters, computation complexity and speed, accuracy, resulting products, and limitations

2.3.2 List different tsunami forecast computation models, or techniques, in use by tsunami warning centres, and explain how the models compute results, how the models are used and what limitations of each model are.

2.3.3 Explain Green's Law and its assumptions, and the list geomorphic locations where Green's Law can and cannot be applied.

2.3.4 Demonstrate the ability to run tsunami forecast model(s) in real-time during a tsunami event to obtain the best solution (e.g., to be able to determine the best source parameterization that will result in the best fit to the tsunami observations)

2.3.5 Explain the causes of forecast uncertainty, and be able to explain the forecast results and uncertainty of the forecast in layman terms to decision-makers and the public.

3.0 Core operational competencies

3.1 Can understand and use TSP text and graphical products

The list of competencies will depend on the TSP. The PTWC Enhanced Products are used as an example since these products are issued to all PTWS Member States. Competencies specific to other TSPs may need to be added by each country

3.1.1 Is familiar with TSP products, and the timing(s) with which they become available following an event.

3.1.2 Acquire, understand, interpret, and use the PTWC Public Text products in the assessment of national tsunami threat.

3.1.3 Acquire, understand, interpret, and use the PTWC Enhanced Forecast products in the assessment of national tsunami threat

3.1.4 Understand the PTWC Product Staging timeline, and incorporate the availability of the PTWC Public Text and Enhanced Forecast Products into the NTWC Product Staging timeline

3.2 Can use a core set of decision support tools

These are specific to each NTWC and depend on the level of complexity operated by each. The tools aid in the performance of each NTWC's SOPs, and cover the core NTWC activities

List of Competencies

3.2.1 Acquire event source information from specified providers and/or website/applications. For earthquakes, example providers are the USGS NEIC website and/or CISN Display.

3.2.2 Apply source information to the predefined threshold table, factoring their limitations.

3.2.3 Calculate tsunami travel times at nationally specific locations by running own application or acquiring them from the provider, noting their limitations.

3.2.4 For an earthquake source, understand how a scenario database is generated through pre-calculated tsunami forecast modelling.

3.2.5 For an earthquake source, select from a scenario database the closest scenario to the current earthquake event and then make threat assessment.

3.2.6 Know the available sources of real-time sea level observations and how to use them to confirm a tsunami and monitor its propagation across the ocean.

3.3 Can perform all core activities in the National Tsunami Warning Centre's SOPs

The core NTWC activities are

1. Rapid and reliable operational services. The NTWC must respond quickly and therefore must always be operating around-the-clock, every day of the year. The NTWC must always provide the same level and quality of service -- for every potentially tsunamigenic event both small and big, and seismic and non-seismic.
2. Detection and characterization of potential tsunami event sources. The most frequent sources are seismic sources (large earthquakes). Non-seismic, less-frequent sources include landslides, volcanoes, and meteorological tsunamis. Ninety percent of tsunamis are generated by earthquakes or earthquake-triggered phenomena.
3. Forecast of tsunami arrival times and impacts (wave amplitudes, currents, and inundation (hydrodynamic models), including the revision of the forecast if necessary
4. Detection and monitoring of tsunami, such as on coastal and deep-ocean gauges, through TSPs, or through eyewitness observations
5. Issuance of products to warn and inform partners and public
    - The first product should be issued quickly after the preliminary earthquake (or non-seismic source) evaluation and positive threat assessment.
    - The forecast product should be issued once it is available
    - The tsunami observations product(s) should be issued when the tsunami is detected and measured

- Products should be issued regularly as the tsunami propagates or the threat ends

The SOPs will therefore likely require the following competencies (depending on national SOPs). The main categories are listed below

3.3.1 Can continuously monitor and act in response to TSP messages.
3.3.2 Can continuously monitor a tsunamigenic event and tsunami evolution/propagation.
3.3.3 Can calculate, analyse, and assess source event parameters, using the NTWC's normal channels.
3.3.4 Can deliver quality seismic and non-seismic source and tsunami event analyses.
3.3.5 Can assess the national tsunami threat based on the seismic, non-seismic, and tsunami data streams and other available information.
3.3.6 Can communicate significant event source information and tsunami threat and occurrence information to internal and external users using the NTWC's approved channels.

3.4 Can identify potential regional and distant source tsunami threats

List of best practice competencies. This will depend on TSP and be locally tailored.

3.4.1 Recognize TSP alert messages for distant and regional source events.
3.4.2 Identify each type of TSP message (information, threat information).
3.4.3 Quickly and accurately locate from the TSP messages or other providers the event source characteristics; for earthquakes, this is the hypocentre (origin time, epicentre (longitude, latitude, and/or geographic location), depth) and magnitude.
3.4.4 Apply TSP tsunami threat information products to national threshold table to initiate national tsunami threat SOPs.
3.4.5 Issue national messages, check that they were transmitted, and manually retransmit them if necessary.
3.4.6 Check that national messages are displayed on the national website, or other public information service, and correct it if necessary.
3.4.7 Demonstrate knowledge and ability to confirm and evaluate a tsunami with all available information, including getting additional seismic or other geoscience event data, accessing and measuring sea level data, reviewing historical data, assessing forecast models, monitoring news reports, and getting reports from countries.
3.4.8 Monitor additional TSP messages for updated TSP forecasts and changes to the forecast for national coasts.
3.4.9 Demonstrate ability to issue regularly updates or updates due to changing circumstances, including issuing cancellation or final messages.

3.5 Can identify potential local source tsunami threats

List of best practice competencies. This will depend on TSP and be locally tailored.

3.5.1 Use shaking intensity to identify possible local source tsunami threat.
3.5.2 Recognize alerts for local events including natural signs.
3.5.3 Recognize TSP alert messages that indicate a local source event, including using TSP products to identify possible local tsunami threat where applicable.

3.5.4 Use of threshold tables to initiate local tsunami threat SOPs.
3.5.5 Determine when to issue a heads-up message.
3.5.6 Execute the call down list for a local event.
3.5.7 Confirm and evaluate a local tsunami with all available information.

4.0 Advanced operational competencies

4.1 Can understand and produce national tsunami threat maps

The list of competencies will depend on national SOPs**.** Examples are included below.

4.1.1 List the different levels of tsunami threat, and national threat criteria for each level.
4.1.2 Demonstrate the ability to apply the threat criteria to generate a map showing the threat level for different locations.

4.2 Can explain the relationship of tsunami warning products to evacuation maps and routes

The list of competencies will depend on national evacuation maps and plans. Examples are included below.

4.2.1 List the Tsunami Service Provider products and the relationship of each to the National Tsunami Warning Centre products
4.2.2 List the National Tsunami Warning Centre products and explain the different parts within each product, including the different types of forecasts and what they are used for and their public safety implications such as for evacuation from unsafe areas.
4.2.3 Understand and be able to explain the difference between amplitude and inundation as it relates to tsunami warning centre forecasting and evacuation.

4.3 Can use a comprehensive set of decision support tools

The list of competencies will depend on the NTWC's decision support tools in use.

4.3.1 List potential sources of earthquake information and how to acquire earthquake information from specified providers and/or website/applications such as NEIC website and CISN Display.
4.3.2 List potential sources of non-seismic information and how to acquire source information form specified provides and/or website/applications, such as Regional Volcano Ash Advisory Centres for erupting volcanoes.
4.3.3 Apply event source information to the predefined threshold table, factoring their limitations.
4.3.4 Calculate tsunami travel times at specific locations by running own application or acquiring them from the provider, noting their limitations.
4.3.5 Understand and use pre-calculated tsunami forecast models (if they are possible), including being able to choose the event source location and size closest to that reported. Explain how these models are generated, and the limitations.
4.3.6 Understand what types of forecasts are available for non-seismic sources (such as volcanoes), and explain the limitations of such forecasts.
4.3.7 Describe the use of sea level observation tools and how they can be used to confirm tsunami generation, and calibrate tsunami forecast models.

4.3.8 List potential sources of sea level information, the differences and limitations of the data types. and how to use them in real-time to monitor tsunami generation and propagation.

4.4 Advanced practical seismology: Can locate and characterise earthquakes

The list of competencies will depend on local systems and procedures. Examples are included below.

4.4.1 Demonstrate the ability to correctly identify earthquake phases and pick phase arrival times.
4.4.2 Demonstrate the ability to correctly identify earthquake phase amplitudes and pick appropriate amplitudes.
4.4.3 Demonstrate the ability to use an earthquake analysis tool to locate an earthquake using earthquake phase arrival times, including local, regional and teleseismic events, both shallow and deep events.
4.4.4 Possess sufficient knowledge to gauge the quality/trustworthiness of the calculated earthquake solution (e.g., acceptable error bounds, judgement of anomalies)
4.4.5 Demonstrate the ability to use an earthquake analysis tool to estimate at least three types of earthquake magnitude, including the moment magnitude Mw.
4.4.6 Demonstrate the ability to use an earthquake analysis tool to estimate an earthquake focal mechanism of an earthquake.

4.5 Advanced practical sea-level observations: Can interpret and measure sea-level records

The list of competencies will depend on local systems and procedures. Examples are included below.

4.5.1 Demonstrate the ability to use sea level observation tools to time the arrival of defined tsunami waves.
4.5.2 Demonstrate the ability to use sea level observation tools to identify and measure tsunami amplitude and period.
4.5.3 Demonstrate the ability to use sea level observation tools to remove from the tidal signal from the sea-level record.
4.5.4 Demonstrate the ability to use sea level observation tools to determine the predicted tsunami arrival time, confirm the actual tsunami generation, and calibrate tsunami forecast models.

5.0 Core agency competencies

The list of competencies will depend on local systems and procedures. Examples are included below.

5.4.1 Describe the role of NTWC in the end-to-end tsunami warning system.
5.4.2 Evoke internal communication and notification protocol including escalation to senior staff (e.g. the Chief Meteorologist or NTWC Director).
5.4.3 Understand and correctly utilise the roles and responsibilities of involved local (or overseas) agencies, including key contacts and counterparts
5.4.4 Brief and liaise with the National Disaster Management Office (NDMO) and other response agencies.

5.4.5 Perform the post-event activities – record event logs, prepare significant event report, recreate timeline, archive event source information, tsunami forecasts and measurements, seismic and sea level and other event data.

5.4.6 Assess tsunami threat and determine alert level

5.4.7 Issue and disseminate alert messages, conduct the message transmission and website check, and invoke timely remedial measures if necessary.

5.4.8 Monitor news and reports of the event from traditional and social media channels.

5.4.9 Manage media inquiries and organise TV/Radio interviews or Media Briefings / Press Conferences when necessary.

5.4.10 Monitor enquiries from the general public and alike, then prioritise response.

5.4.11 Continuously assess the NTWC's operational readiness and address critical problems (e.g., data outages, communication line failures, software failures, computer failures) as rapidly as possible

5.4.12 Have and implement backup procedures when necessary to ensure the continuity of operations

References

UNESCO/IOC. 2019. *Tsunami Glossary*, fourth edition. Paris, UNESCO, IOC Technical Series, 85. (IOC/2008/TS/85 Rev.4). (update to 2023 expected), latest version can be found at: http://itic.ioc-unesco.org/index.php?option=com_content&view=article&id=1328&Itemid=1142&lang=en

UNESCO/IOC. 2017. *Plans and Procedures for Tsunami Warning and Emergency Management*. Paris, UNESCO, IOC Manuals and Guides, 76. (IOC/2017/MG/76, REV). http://ioc-tsunami.org/index.php?option=com_oe&task=viewDocumentRecord&docID=19966

UNESCO/IOC. 2020. *Preparing for Community Tsunami Evacuations: from inundation to evacuation maps, response plans and exercises.* Paris, UNESCO, IOC Manuals and Guides, 82. (IOC/2020/MG/82, Sup 1 and 2) https://unesdoc.unesco.org/ark:/48223/pf0000373019?posInSet=17&queryId=947ca611-1880-4ded-bb5a-4bd61c93c161
website for explanatory information at: http://itic.ioc-unesco.org/index.php?option=com_content&view=category&layout=blog&id=2166&Itemid=2640

Appendix 2. NTWC Competency – Existing Member State Schema

Appendix 2 includes National Tsunami Warning Center (NTWC) Staff Competency information as received from Member States. These include Australia, Chile, India, New Zealand, USA (PTWC and US National Tsunami Warning Center) and Tonga.

Filenames of PDFs that were received.

Australia (2023): Australia_BOM_NTWC_CompetencyTraining.pdf
Chile (2023): Chile_SHOA_NTWC_CompetencyTraining.pdf
India (2016): India_INCOIS_NTWC_CompetencyTraining_2016.pdf
New Zealand (2023): NZ_NTWC_CompetencyTraining.pdf
USA (2016)
Pacific Tsunami Warning Center (PTWC):
PTWS_NTWC_ComptencyTraining_2016.pdf
US National Tsunami Warning Center) (2016):
TWC_USNTWC_Training Long Version-4_2016.pdf
Tonga (2016): tongamet_tsunami_training_requirements_2016.pdf

AUSTRALIA - NTWC TRAINING

From: **Yuelong Miao** <yuelong.miao@bom.gov.au>
Date: Mon, Jul 31, 2023 at 12:02 AM
Subject: Australia TWC training - NTWC Competency Framework [SEC=OFFICIAL]
To: Laura Kong - NOAA Federal <laura.kong@noaa.gov>

Hi Laura,

I hope useful the attached Tsunami Competency Framework (also known as the Training Package) for performing the Bureau side of the JATWC operations. For completeness, I also attached three documents that were referenced in that Framework.

In short, at the Bureau of Meteorology for the Joint Australian Tsunami Warning Centre (JATWC), i.e., not including our partner Geoscience Australia's key JATWC function and process in earthquake detection and analysis.

1. Profile of staff - background, experience for the staff you hire (degrees, topic, etc)
   Meteorologists. However I don't think this meteorologist is a must have qualification for performing tsunami warning, but science degree/diploma is a minimum requirement.
2. Length of NTWC training before they are 'live'
   Up to 1 week training efforts inclusive of training and assessment activities. Shorter period needed if prior knowledge/experience/competency.
3. Syllabus of Training - topic, length, how to assure ready (tests, practicum, or ?), medium used for training (live, offline software, observer, hands-on, classroom, online, etc)
   - Three areas of competency to gain – system, science and process.
   - Role-based training requirements thus various combination of these three areas in complexity. E.g., some don't need system competency at all, some needs only basic tsunami knowledge, and some only needs process of liaison fi doing customer decision support.
   - Assessment is required, but it could take a variety of forms depending on what's being assessed. E.g., online quiz may be sufficient to assess knowledge, while for warning production process, workplace observation is needed.
   - Relying on online modules as much as possible to enable flexibility and efficiency, noting that online modules can be highly complex and interactive including their allowing video-recorded evidence for assessment.
4. National Certification - do you have
   a formal certification, or not? Yes. Role based formal certification recorded in the same human resource management system.
   how long? 3-year validity for waring production roles, 5-year for customer decision support roles. To maintain currency, also need evidence of annual refresher activities such as participating in an exercise, redoing online modules or issuing warnings in a real event.
   how to re-certify? Upon expiry, one has to go through the same training and assessment as the maiden certification to be recertified. The training period is of course shortened due to familiarity of knowledge and process.

Regards,

Yuelong
Co-Director JATWC

Yuelong Miao (he/him)
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Environmental Prediction Services Program, Community Services Group
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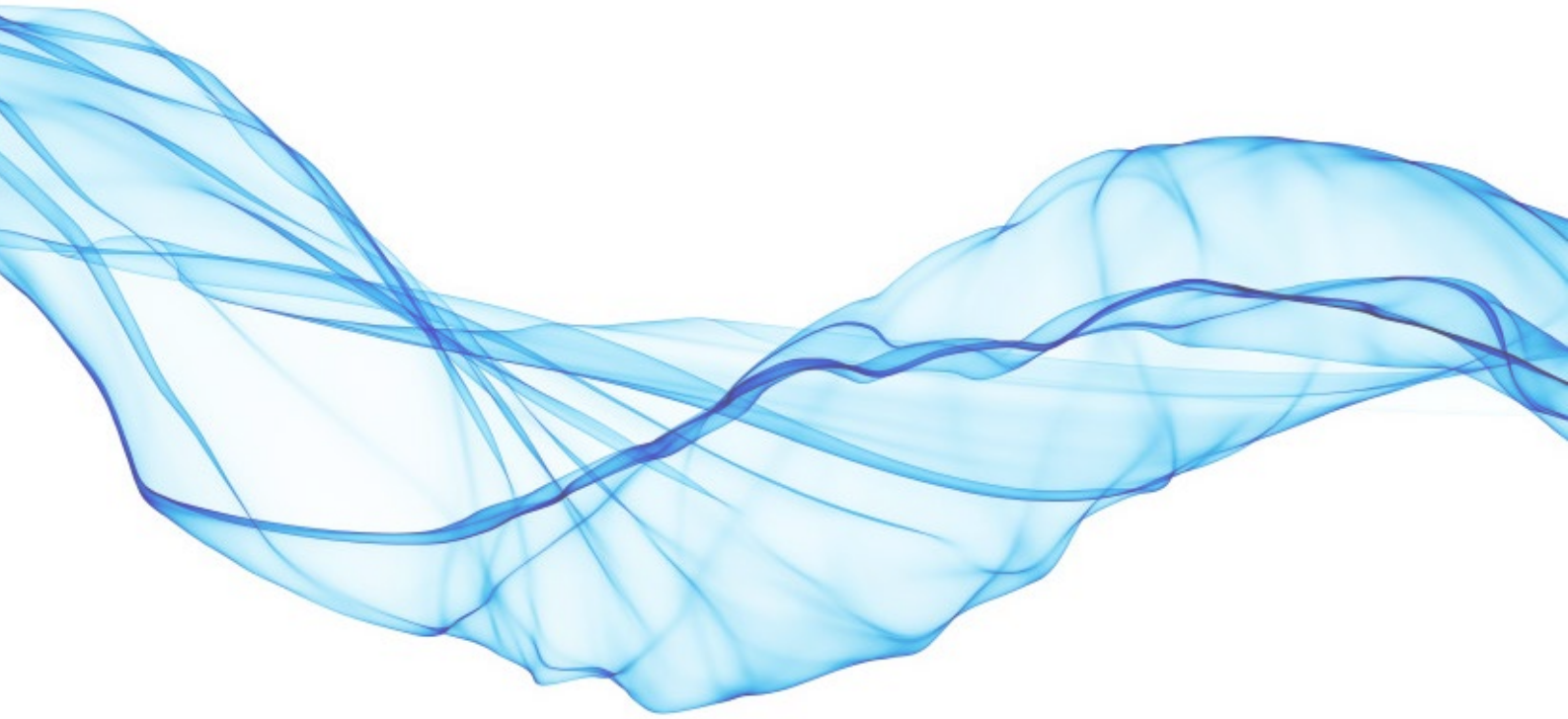
Australian Government
Bureau of Meteorology

Tsunami Training Package

Tsunami Competency



Version Control

Version	Date	Author(s)	Comments
0.1	30/6/14		
1.0	31/7/14		
1.1	23/3/15	omitted for privacy purpose	
1.2	6/5/15		
1.3	11/5/15		
1.6	16/09/20		

Document Owner

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Review Cycle

This training package will be reviewed by the Tsunami Trainer at least every two years. This will include a review of associated units of competency as required by the individual unit. Any proposed changes will be raised with relevant stakeholders (NPS, EPS, DSS and Aviation) and approval of changes will be required as described below.

Approval

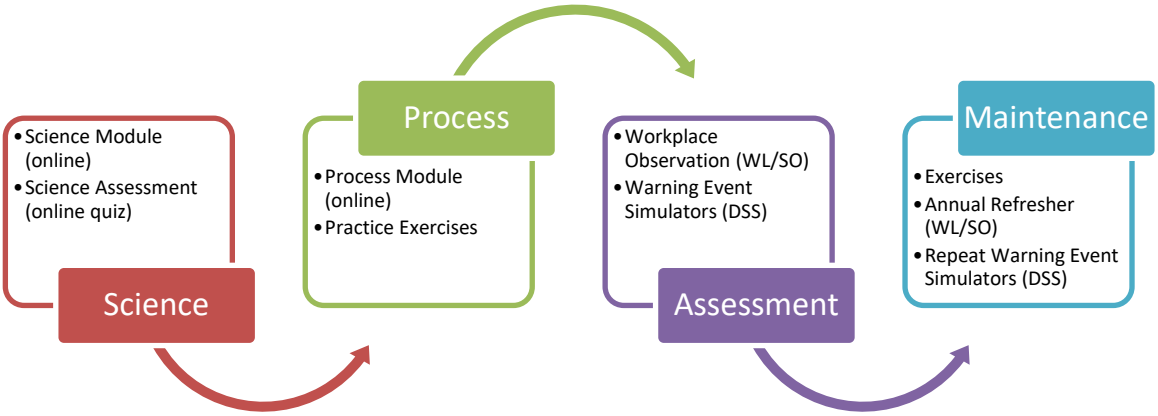
This training package and associated units of competency must be approved by SRTD and SRTW signature

Signature section omitted for privacy purpose

Training & Assessment Overview

Tsunami training is developed based on a training needs analysis and to support trainees in achieving competency where defined. Not all training will necessarily be assessed and hence lead to a qualification. Training will be developed with careful consideration of the target audience to ensure the scope of activities match the requirements.

The following learning pathway broadly defines the key knowledge and skill development steps.



The science module is common to all forecaster roles, with JATWC Tsunami Warning Lead and Science Officer roles exploring a few additional concepts with respect to modelling. Completion of a quiz satisfies the assessment requirements for this phase. Other identified Decision Support staff such as corporate communications staff and Hazard Preparedness and Response (HPR) management may also complete the science training module but may not be required to complete the science quiz. Simplified science training may also be delivered to specific audiences such as the Comms Officer role.

The process training provides relevant information regarding the SOPs and supports learners through tsunami lessons. Separate online training courses have been created to suit production and decision support roles. Participation in tsunami exercises may also support skill development during this phase. IT staff who fill comms officer roles in tsunami events will receive process training but may not require assessment. Other identified staff who may be involved in tsunami events at a peripheral level may complete relevant sections of the process training but may not require assessment.

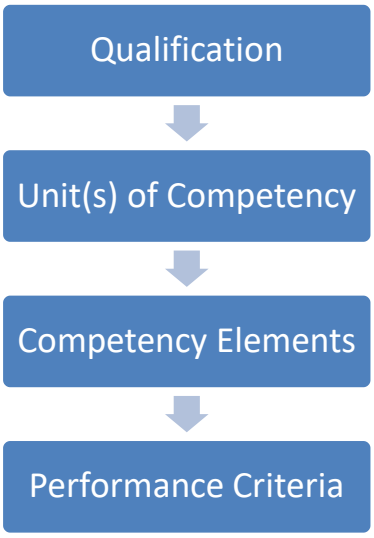
The assessment phase is conducted via workplace observation for the JATWC Tsunami Warning Lead and Science Officer roles. Online Warning Event Simulators meet the assessment requirements for Decision Support roles.

Skill maintenance will be achieved through ongoing participation in tsunami exercises, annual refresher training activities (for Warning Lead and Science Officer) and repeating Warning Event Simulators for Decision Support staff.

New staff with responsibility for any role must complete the training and assessment program and achieve the required competency prior to going solo.

Competency Framework Overview

The tsunami competency framework is stratified as shown in the image below, with increasing complexity in each subordinate level:



Qualifications map to job families/functions within the Bureau and must be held by staff performing those duties. Qualifications are awarded after successfully demonstrating competency in the required units. Each unit of competency is defined in a separate document, including competency elements performance criteria definitions and an evidence guide.

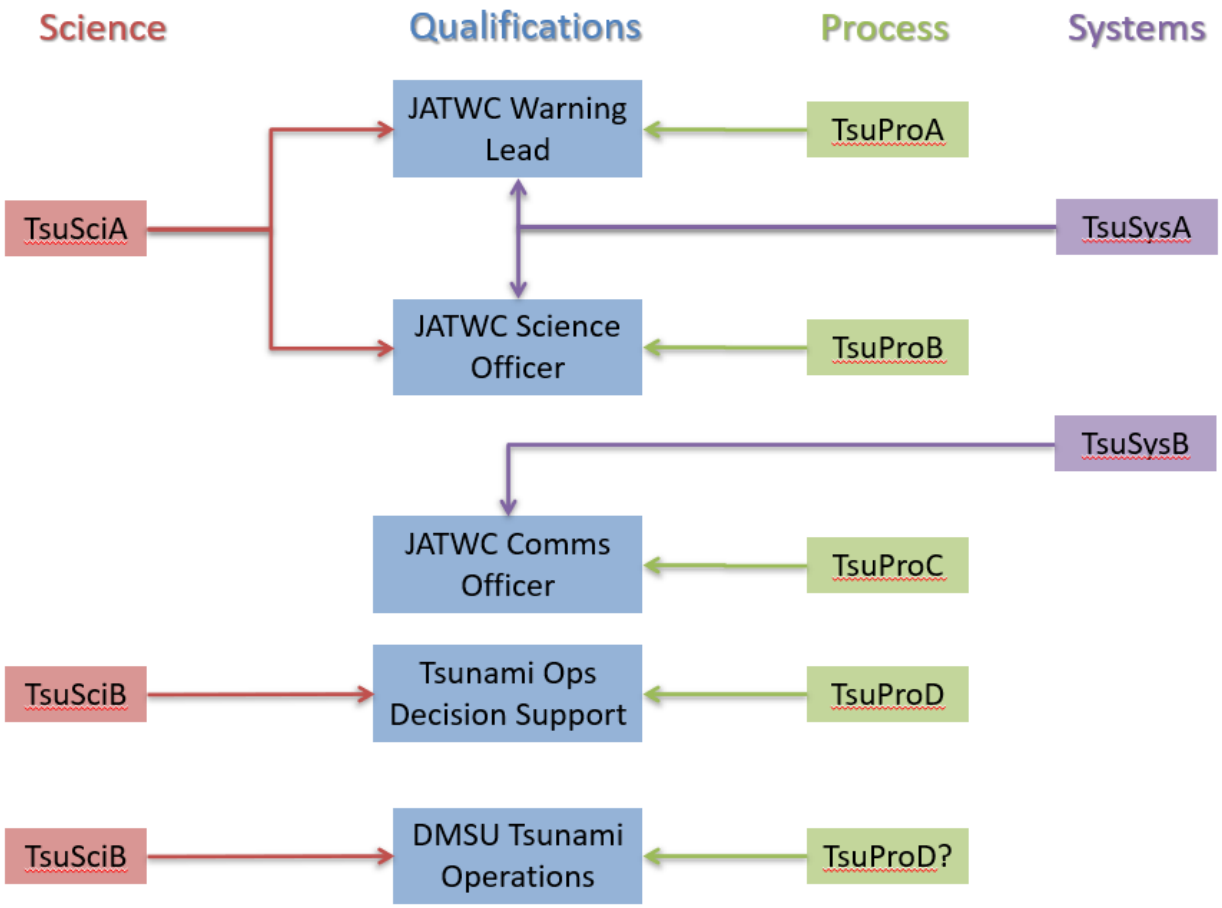
Qualification Requirements

The following table outlines the units of competency required for each qualification:

Staff Position	Qualification Required	Units of Competency Required
National Production EL2Ls and EL1s, Marine and Antarctic EPS staff	JATWC Warning Lead	TsuSciA – Tsunami Science (Level A) TsuProA – Tsunami Warning Process (Level A) TsuSysA – Tsunami Systems (Level A)
National Production, Aviation Hazardous Weather Unit and Marine and Antarctic EPS staff	JATWC Science Officer	TsuSciA – Tsunami Science (Level A) TsuProB – Tsunami Warning Process (Level B) TsuSysA – Tsunami Systems (Level A)
IT Ops Desk staff	JATWC Comms Officer	TsuProC – Tsunami Warning Process (Level C) TsuSysB – Tsunami Systems (Level B)
HPR Managers and EL1s, emergency services out-posted meteorologists	Tsunami Operations Decision Support	TsuSciB – Tsunami Science (Level B) TsuProD – Tsunami Warning Process (Level D)
DMSU forecasters	DMSU Tsunami Operations	TsuSciB – Tsunami Science (Level B) TsuProD – Tsunami Warning Process (Level D)

Note: *Only the Tsunami Systems (Level A) competency has been defined and supported with training and assessment resources. The Tsunami Warning Process (Level C) is not yet defined and no training or assessment resources have been created to support this competency. These units of competency are included above for completeness.*

The following image shows the qualifications (blue boxes) and required units of competency for those qualifications.



Qualifications may be awarded to additional staff or staff at other levels subject to job function requirements and availability of training and assessment resources to support this. Staff wishing to pursue qualifications they don't require to perform their role must be identified through the Performance Development Scheme and are subject to approval of SRTD.

Qualification Validity

Qualifications will be recorded in the Enterprise Business System (EBS). Qualifications will expire after either one year (continuous) out of the appropriate operational role or after the period of time outlined in the table below:

Qualification	Validity Period
JATWC Warning Lead	3 years
JATWC Science Officer	5 years
JATWC Comms Officer	5 years
Tsunami Operations Decision Support	5 years
DMSU Tsunami Operations	5 years

These are maximum validity periods. As indicated in the learning pathway, staff will be supported to maintain their skills through repeating training modules, warning event simulators, exercises and refresher training campaigns as specified at the regional level.

Qualification Management

Staff may complete additional tsunami training activities or competency updates between official reassessment requirements outlined in the qualification validity table above. Updates to individual units of competency will not translate to a full qualification update unless all relevant units of competency for a particular qualification are all completed within 12 months of each other.

Glossary

BMTC	Bureau of Meteorology Training Centre
DSS	Decision Support Services
DMSU	Defence Meteorological Support Unit
HPR	Hazard Preparedness and Response
DST	Decision Support Tool
EBS	Enterprise Business System
ITO	Information Technology Officer
JATWC	Joint Australian Tsunami Warning Centre
PO2	Professional Officer (Class 2)
RFC	Regional Forecasting Centre
SPOC	Senior Professional Officer (Class C)
SRTD	Supervisor Training & Development

Resources

BMTC Tsunami Training Page - https://bom365.sharepoint.com/sites/BMTCNFD/SitePages/Tsunami-Competency.aspx

Tsunami Science Module - https://learn.bom.gov.au/course/view.php?id=760

Decision Support Tsunami Warning Process Module - https://learn.bom.gov.au/course/view.php?id=761

SOPs - http://web.bom.gov.au/nmoc/srco/Tsunami/

Warning Lead/Science Officer Tsunami Warning Process Module - https://learn.bom.gov.au/course/view.php?id=764

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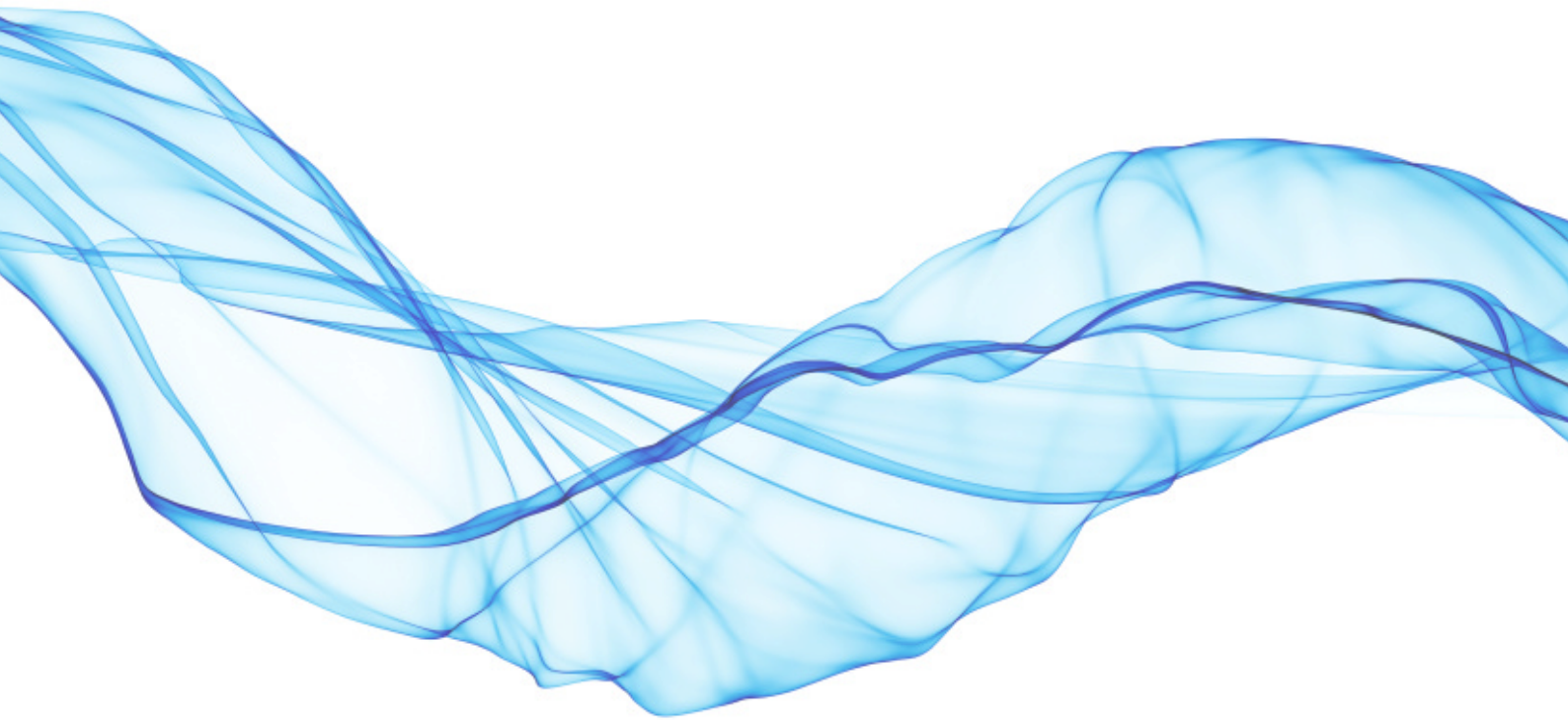
Tsunami Science (Level A)

Tsunami Competency – Unit TsuSciA



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Pre-Requisites

Nil.

Job Function Requirements

This unit of competency must be held by all BNOC duty forecasters (SPOC & PO2) as described in the Tsunami Training Package.

Review Cycle

This unit of competency will be reviewed by the Tsunami Trainer at least every two years. Any proposed changes will be raised with relevant stakeholders (services, training and affected operational offices) and approval of changes will be required as described below.

Approval

This unit of competency must be approved by SRTD and SRTW signature

Omitted for privacy purpose

Elements and Performance Criteria

1. Explain tsunami generation	1.1 List the known causes of tsunamis 1.2 Describe how undersea earthquakes along fault lines cause tsunamis 1.3 Describe the three fault line types and where each type is found around Australia 1.4 Name the three rupture types and identify which types are tsunamigenic 1.5 Explain the difference between hypocentre and epicentre 1.6 Explain why a magnitude difference of 1 corresponds to an energy release difference of 32 times 1.7 Describe how earthquake intensity is determined and why it is useful 1.8 Explain how earthquake depth affects the potential for tsunamis to be generated
2. Explain tsunami propagation	2.1 Explain why tsunamis travel as shallow water waves and describe the relationship between wave speed and water depth 2.2 Describe the process and causes of tsunami attenuation 2.3 Identify the location of Australia's tsunameters 2.4 Explain how tsunameters measure tsunamis, including the sampling frequency 2.5 Access tsunameter data and correctly identify important features this data displays, especially the tsunami signal 2.6 Determine tsunami amplitude and period from tsunameter observations 2.7 Outline the key characteristics of the MOST T2 model 2.8 Explain how magnitude, rupture length, rupture width and slip are related in MOST T2 model scenarios 2.9 Explain what Maximum Wave Amplitude (MWA) Plots convey, how they may be used and limitations 2.10 Describe how MOST T2 model scenarios are selected 2.11 Outline how MOST T2 scenarios are scaled to provide information for intermediate magnitude 2.12 Explain what envelope plots represent 2.13 Demonstrate how envelope plots can be used to determine an effective earthquake magnitude based on observed tsunami amplitude 2.14 Describe how tsunami ETA is determined for Australia, in particular the rounding applied to output 2.15 Describe how tsunami ETA is determined for Indian Ocean CFPs
3. Explain tsunami impacts	3.1 Describe how tsunami wavelength, amplitude and speed change when transitioning into shallow water 3.2 Identify the order of magnitude of tsunami properties in deep and shallow water in terms of speed, amplitude, wavelength and period 3.3 Describe the difference between crest-first and tough-first tsunamis in terms of generation and coastal impact 3.4 Describe how inundation is affected by bathymetry, coastal properties and tides 3.5 Explain run-up, including the difficulties in forecasting the extent of tsunami run-up 3.6 Describe the ATWS threat levels and explain how they were determined 3.7 Explain how IOTWS threat level is determined 3.8 Describe the products issued by JATWC 3.9 Explain how sea-level gauges measure tsunamis 3.10 Interpret sea-level data to measure tsunami amplitude 3.11 Outline the limitations of sea-level gauges 3.12 Describe how sea-level observations may be dampened or amplified

Evidence Guide

Evidence of competency in performance criteria may be collected through assessment tools as summarised in the following table:

Performance Criteria	Quiz	Interview	Observation	Portfolio	3rd Party Report
1.1	X				
1.2	X	X			
1.3	X				
1.4	X				
1.5	X				
1.6		X			
1.7		X			
1.8	X				
2.1	X				
2.2	X				
2.3		X	X		
2.4	X				
2.5			X		
2.6	X		X		
2.7	X	X			
2.8	X				
2.9	X	X	X		
2.10	X	X			
2.11	X	X			
2.12	X		X		
2.13	X		X		
2.14	X		X		
2.15	X		X		
3.1	X	X			
3.2	X				
3.3		X			
3.4	X				
3.5	X				
3.6	X	X	X		
3.7	X	X	X		
3.8		X	X		
3.9		X			
3.10	X		X		
3.11	X	X			
3.12	X	X			

Definitions

Quiz: an online series of questions, generally automatically marked

Interview: questions asked by the assessor in person

Observation: a workplace observation, either simulated or real

Portfolio: a collection of evidence prepared by the candidate for assessment

3rd Party Report: a written endorsement of the candidates ability to perform the task by a 3rd party

Underpinning Skills/knowledge

All underpinning knowledge required to achieve competency in this unit are contained within the Tsunami Science Module on Latitude (see resources)

Glossary

ATWS	Australian Tsunami Warning System
BNOC	Bureau of Meteorology National Operations Centre
CFP	Coastal Forecast Point (IOTWS)
ETA	Estimated Time of Arrival
IOTWS	Indian Ocean Tsunami Warning & Mitigation System
JATWC	Joint Australian Tsunami Warning Centre
MOST T2	Method of Splitting Tsunamis (version T2)
MWA	Maximum Wave Amplitude
SOP	Standard Operating Procedures
Tsunameter	Deep Ocean Sea-Level Detection Buoy
TTT	Tsunami Travel Time

Resources

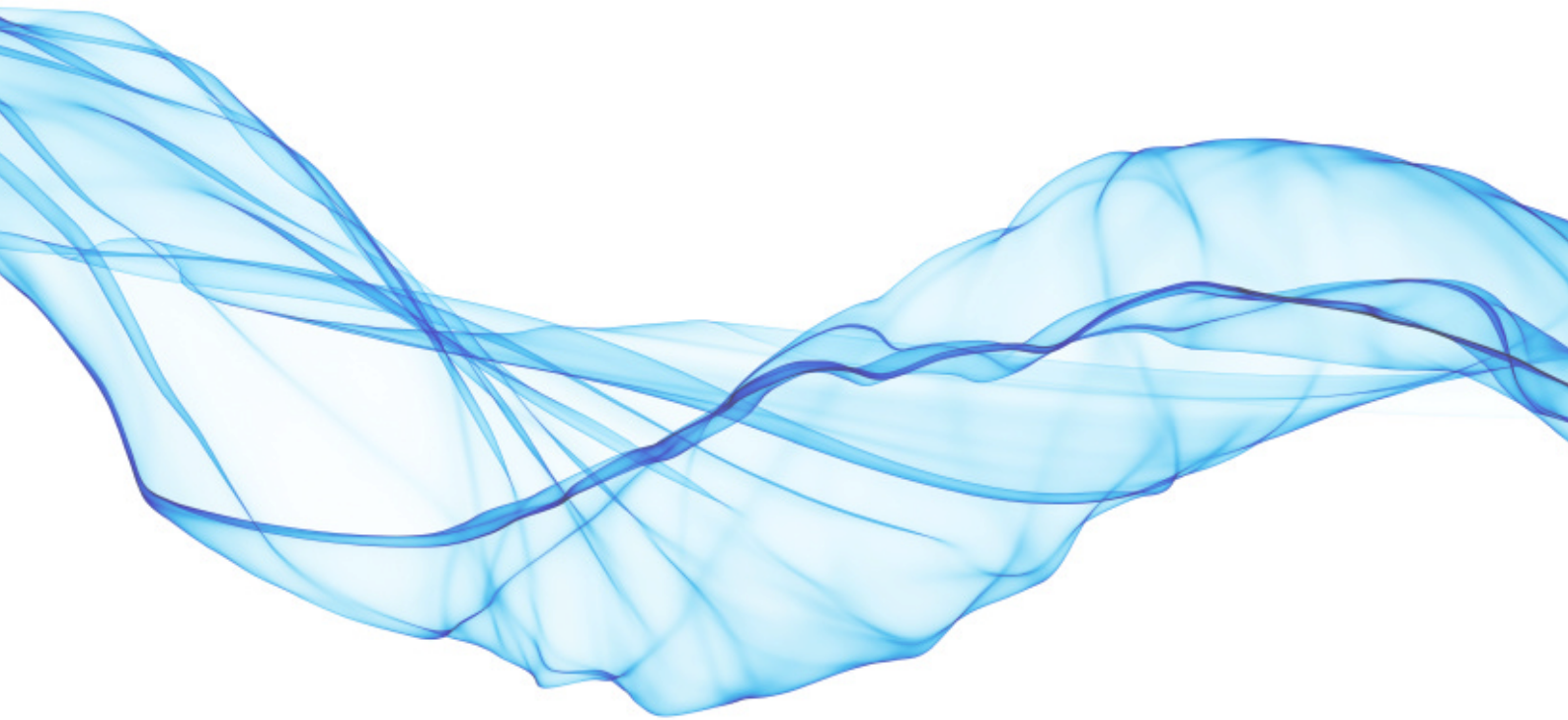
Tsunami Science Module on Latitude - http://latitude.bom.gov.au/course/view.php?id=260

BNOC SOPs - http://web.bom.gov.au/nmoc/srco/Tsunami/

Australian Government
Bureau of Meteorology

Tsunami Warning Process (Level A)

Tsunami Competency – Unit TsuProA



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Pre-Requisites

TsuSciA – Tsunami Science (Level A)
TsuSysA – Tsunami Systems (Level A)

Job Function Requirements

This unit of competency must be held by the BNOC senior duty forecaster (SPOC) as described in the Tsunami Training Package.

Review Cycle

This unit of competency will be reviewed by the Tsunami Trainer at least every two years. Any proposed changes will be raised with relevant stakeholders (services, training and affected operational offices) and approval of changes will be required as described below.

Approval

This unit of competency must be approved by SRTD and SRTW signature

Omitted for privacy purpose

Elements and Performance Criteria

1. Perform tsunami threat assessment & determine course of action	1.1 Load seismic manual solution in discussion with GA 1.2 Compare all available earthquake solutions, discuss uncertainties with GA and determine impacts of uncertainties on the threat assessment 1.3 Discuss volcanic eruption with GA and VAAC to obtain source details for threat assessment 1.4 Perform and interpret IOTWS threat assessment for Indian Ocean countries 1.5 Perform and interpret ATWS threat assessment for Australia and offshore territories 1.6 Determine course of action based on threat assessment and SOP guidelines, including threat reassessment leading to cancellation and finalisation 1.7 Interpret Tsunami ETA and prioritise actions accordingly 1.8 Perform and interpret ATWS and IOTWS threat assessments using the Simplified TTT Method where necessary 1.9 Assess tsunami potential from non-seismic oceanic sources 1.10 Modify threat assessment based on observations or new seismic information
2. Manage BNOC & JATWC resources for tsunami event	2.1 Appoint JATWC roles according to event severity 2.2 Delegate JATWC tasks to appropriate staff throughout the event 2.3 Redistribute and reprioritise business-as-usual operational duties 2.4 Ensure additional staff are called in as necessary 2.5 Ensure key information and policy decisions are logged 2.6 Close event in consultation with relevant stakeholders
3. Issue and update IOTWS & ATWS products in a timely manner	3.1 Prepare and issue relevant IOTWS products in a timely manner 3.2 Issue ATWS National Watch / No Threat Bulletin within the specified time-frame 3.3 Explain the differences between watches and warnings and the triggers for moving into warning phase 3.4 Prepare and issue Watches & Warnings in a timely manner in consultation with RFCs 3.5 Prepare and issue the National Warning Summary when required 3.6 Prepare and issue Cancellations and the National Event Summary 3.7 Confirm products have been dispatched successfully
4. Monitor, interpret and act on relevant observations	4.1 Monitor and interpret relevant sea-level observations to confirm and verify tsunami threat 4.2 Ensure maximum positive amplitude observations are recorded in the DST in the correct format 4.3 Ensure anecdotal reports are recorded in the DST 4.4 Determine the effective earthquake magnitude based on tsunameter observations 4.5 Ensure media channels are monitored for tsunami related information 4.6 Assess the need to, then if required, manually trigger tsunameters into event mode
5. Communicate tsunami information and liaise with relevant stakeholders	5.1 Liaise with the GA duty seismologist regarding potentially tsunamigenic events 5.2 Ensure the communication and notification protocol is invoked 5.3 Establish conference call with relevant RFCs, prioritising contact with regions under immediate threat 5.4 Liaise with relevant RFC Incident Managers regarding draft warnings and evacuation orders 5.5 Prioritise information when communicating about the tsunami event 5.6 Brief BNOC managers and other relevant stakeholders about the event

Evidence Guide

Evidence of competency in performance criteria may be collected through assessment tools as summarised in the following table:

Performance Criteria	Quiz	Interview	Observation	Portfolio	3rd Party Report
1.1		X	X		X
1.2	X	X	X		X
1.3		X			X
1.4	X		X		X
1.5	X		X		X
1.6	X	X	X		X
1.7	X		X		X
1.8			X		X
1.9	X	X			X
1.10		X	X		X
2.1	X	X	X		X
2.2	X	X	X		X
2.3		X	X		X
2.4	X	X			X
2.5			X	X	
2.6		X	X		X
3.1			X	X	X
3.2			X	X	X
3.3	X	X			
3.4	X		X	X	X
3.5	X		X	X	X
3.6			X	X	X
3.7			X		X
4.1	X		X		X
4.2			X		X
4.3			X		X
4.4	X	X	X		X
4.5		X			X
4.6		X	X		X
5.1		X			X
5.2	X	X	X		X
5.3	X		X		X
5.4	X		X		X
5.5	X	X	X		X
5.6		X	X		X

Definitions

Quiz: an online series of questions, generally automatically marked

Interview: questions asked by the assessor in person

Observation: a workplace observation, either simulated or real

Portfolio: a collection of evidence prepared by the candidate for assessment

3rd Party Report: a written endorsement of the candidates ability to perform the task by a 3rd party

Performance Criteria Descriptions

Performance criteria are described in more detail below, providing candidates guidance on how to demonstrate competence in each.

Performance Criteria	Description
1.1	By default, the GA manual solution should be used, however, in discussion with GA, an international bulletin may be used instead. The agreed seismic manual solution should be loaded into the DST. Discussions with GA should also focus on the earthquake magnitude, location, depth, tsunamigenic potential and fault type (if known). If no MOST scenario matches the event, this should be discussed with GA
1.2	International and GA bulletins should be accessed and assessed. Comparisons should focus on earthquake magnitude, location and depth. Travel times may also be compared. Uncertainties, particularly in relation to earthquake magnitude should be discussed with GA and 'what-if' assessments should be performed to determine the threat levels that may results from slight changes in magnitude
1.3	For large volcanic eruptions, GA may be able to provide seismic information upon which the threat assessment can be performed. VAAC should be consulted to determine the scale of the eruption and hence the possibility for a tsunami to be generated. By default, the Felt Earthquake No Threat Bulletin will be issued
1.4	Threat assessment based on the seismic solution or manually entered data should be performed in the DST by clicking on the IOTWS Assessment tab. As part of this initial assessment, the Earthquake Bulletin should be sent. The earthquake location should be investigated through mapping software to determine proximity to the fault line. Areas affected should be interpreted through the text list in DST or the graphical threat map. Discrepancies between IOTWS and ATWS threats for overlapping service areas should be explained
1.5	Threat assessment based on the seismic solution or manually entered data should be performed in the DST by clicking on the ATWS Assessment tab. The earthquake location should be investigated through mapping software to determine proximity to the fault line. Areas affected should be interpreted through the text list in DST or the graphical threat map. Discrepancies between IOTWS and ATWS threats for overlapping service areas should be explained. Orphaned zones should be included as directed in the SOPs
1.6	Actions include identifying the appropriate initial tsunami bulletins to send based on the threat assessment, deciding whether JATWC will need to be activated and whether to initiate a conference call with the RFCs and if so which RFCs to contact. Threat reassessment based on new seismic information or sufficient tsunami observational evidence may lead to lower threat levels and associated cancellation and finalisation of warning products
1.7	Tsunami travel time and ETA should be assessed to help prioritise actions such as contact with the RFCs and issuing warning products based on immediate threat (i.e. whether ATWS should be prioritised over IOTWS). The earliest impact on Australia should be noted for use in briefings. Tsunami ETA information should also be used to identify which observation sites to monitor and when the tsunami is expected to impact the sites.
1.8	When no MOST scenario can be found for the earthquake event, the DST will automatically use the Simplified TTT Method. This should be noted and communicated to GA. ATWS and IOTWS threat assessments, if required, should be performed in the DST on the basis of this method. The threat assessment should be related back to the method definition described in the SOPs
1.9	Unexplained sea-level observations should be assessed to determine whether the wave characteristics match those expected for a tsunami (i.e. long period, low

	amplitude in deep water, higher in shallow water). Reactionary warnings should be issued in these cases as directed in the SOPs
1.10	Based on new seismic information or reliable tsunameter observations (see criteria 4.4), modify the earthquake details and perform a threat reassessment in the DST. Threat upgrade may be based on one tsunameter, but two are required to downgrade
2.1	JATWC roles include Science Officer, Communications Officer and Media Liaison Officer and they should be appointed as dictated by the event severity in accordance with the SOPs. In some cases, these roles will be filled through the initiative of other staff and in such cases as Incident Manager it is necessary to simply confirm the staff are comfortable performing the role and ensure they understand what's required
2.2	JATWC staff should be used effectively throughout the event by delegating tasks appropriately in accordance with the SOPs
2.3	In the absence of another qualified BNOC staff member assuming control of business-as-usual operations, the Incident Manager must ensure BNOC tasks are redistributed and reprioritised to remaining BNOC staff as directed in the SOPs
2.4	Additional staff required for either JATWC or BNOC should be called in by the Incident Manager or the task delegated to another staff member to complete
2.5	Key information such as threat reassessments, observations/reports, system issues, unrecorded phone calls or decisions should be logged by the Science Officer, with the Incident Manager responsible for ensuring this occurs
2.6	The event should be closed at the appropriate time in accordance with the SOPs
3.1	IOTWS Bulletins should be issued in the correct sequence and within the required time-frame (where possible) in accordance with the SOPs. This may include No Threat, Potential Threat, Confirmed Threat and Finalisation Bulletins
3.2	The ATWS National Watch or No Threat Bulletin should be issued on the basis of the ATWS threat assessment within the required time-frame (where possible) in accordance with the SOPs. The National Watch Bulleting must be issued before any regional watches/warnings. Rules regarding issuing a No Threat Bulletin when only certain ATWS areas are under threat should be understood and explained
3.3	The purpose for, and appropriate context in which regional watches and warnings are issued should be understood and explained. The two triggers for moving into warning mode (i.e. confirmed tsunami or unconfirmed but immediate threat) should be explained and applied correctly in warning events
3.4	Regional watches and warnings should be prepared in the DST and uploaded for regional approval as directed in the SOPs. Regional watches and warnings must be issued hourly or at any time the threat assessment changes. Evacuation order messages should be applied as directed by the relevant authorities (see 5.4)
3.5	After regional watches/warnings have been issued, the National Warning Summary must be issued and include up-to-date observations and impact reports. After all cancellations have been issued, the Final National Warning Summary must be issued
3.6	Based on cancellation/finalisation guidelines described in the SOPs, appropriate cancellation and finalisation bulletins should be prepared and transmitted. Specific messages may be added to these bulletins in consultation with the affected regions. After the Final National Warning Summary has been issued, the National Event Summary must be prepared and transmitted
3.7	After issuing any product, the external web should be checked to confirm successful transmission. This task may be delegated to or duplicated by the Science Officer or Communications Officer
4.1	With the support of the Science Officer, sea-level observations (coastal gauges and tsunameters) should be monitored continually throughout the event using the ETA as a guide to prioritisation. Observations sites that record a tsunami may record subsequent waves of higher amplitude and must therefore be monitored after the

	first wave. Wave properties such as period and amplitude should be assessed to determine the nature of the sea-level anomaly. Reliable reports of sea-level changes associated with the tsunami may be used to confirm the tsunami threat. Verification of the tsunami threat can be performed based on tsunameter data with the help of envelope plots or based on ASLOS coastal gauges compared to the threat level for that region. Site metadata should be used when interpreting coastal sea-level gauges to assess how the site observation may translate to impacts on the surrounding area
4.2	The maximum positive amplitude (i.e. height above mean sea-level) should be determined from observations and entered into the DST Observations table by the Science Officer in the format specified as soon as possible. If a higher amplitude wave is observed at a site, this new observation should be entered both in terms of height and time of observation
4.3	Anecdotal reports may be received from a range of sources and should be entered by the Science Officer into the Reported Tsunami Impacts form in the DST
4.4	Tsunameter observations should be interpreted in conjunction with envelope plots to determine the effective earthquake magnitude associated with the observed amplitude. If the effective earthquake magnitude falls outside the envelope, this may lead to threat reassessment (see 1.10)
4.5	Televisions in JATWC and BNOC should be turned on and monitored by the Science Officer, Communications Officer and/or Media Liaison Officer. Online news and social media should also be monitored
4.6	ATWS tsunameters expected to observe the tsunami should be triggered into event mode at an appropriate time to ensure high temporal resolution reporting of sea-level in order to resolve the tsunami signal. This task could be delegated to the Science Officer or Communications Officer
5.1	The GA duty seismologist should be consulted at the start of the event and whenever significant new information is received by either GA or BNOC. Topics requiring discussion are listed in the SOPs. Liaison will take place over the dedicated tsunami video conference equipment
5.2	Communication and notification will be performed by the Communications Officer as directed in the SOPs. Successful completion of this process should be monitored by the Incident Manager
5.3	All regions responsible for areas under threat (marine or above) should be contacted using the tsunami phone and added to a conference call. Contact may initially be made only with the region(s) under immediate threat in order to issue the relevant warnings promptly. Other regions may then be added to the conference call. When adding a region to the conference call, the time that region(s) already in the call are on hold should be minimised. The tsunami phone should be left on speaker throughout the event and the microphone muted as appropriate
5.4	Regional IMs should be informed whenever draft products are uploaded to the registered user's page. Approval should be sought before transmitting warnings unless the situation is very urgent. When requesting feedback on draft warnings, a time-frame/deadline should be communicated to the regional IM. Evacuation orders may only be applied with approval from the relevant emergency management authority via the regional IM
5.5	Communication should be succinct, prioritised, tailored and appropriately emphasised for the target audience
5.6	Briefings should be provided as requested, as time permits and in accordance with the SOPs to Bureau managers and other important stakeholders (e.g. the AGCCC)

Underpinning Skills/knowledge

- Threat level definitions for IOTWS and ATWS
- Product requirements, especially in relation to offshore and Antarctic
- TTT rounding down to the nearest 15-minute interval
- Simplified TTT Method application
- Usage of envelope plots to determine effective magnitude based on tsunameter observations
- Able to use the DST
- Able to use the video conference equipment to liaise with GA
- Able to use the tsunami phone to establish a conference call with RFCs

Glossary

ATWS	Australian Tsunami Warning System
BNOC	Bureau of Meteorology National Operations Centre
DST	Decision Support Tool
ETA	Estimated Time of Arrival
GA	Geoscience Australia
IOTWS	Indian Ocean Tsunami Warning & Mitigation System
JATWC	Joint Australian Tsunami Warning Centre
RFC	Regional Forecasting Centre
SOP	Standard Operating Procedures
SPOC	Senior Professional Officer (Class C)
Tsunameter	Deep Ocean Sea-Level Detection Buoy
TTT	Tsunami Travel Time
VAAC	Volcanic Ash Advisory Centre

Resources

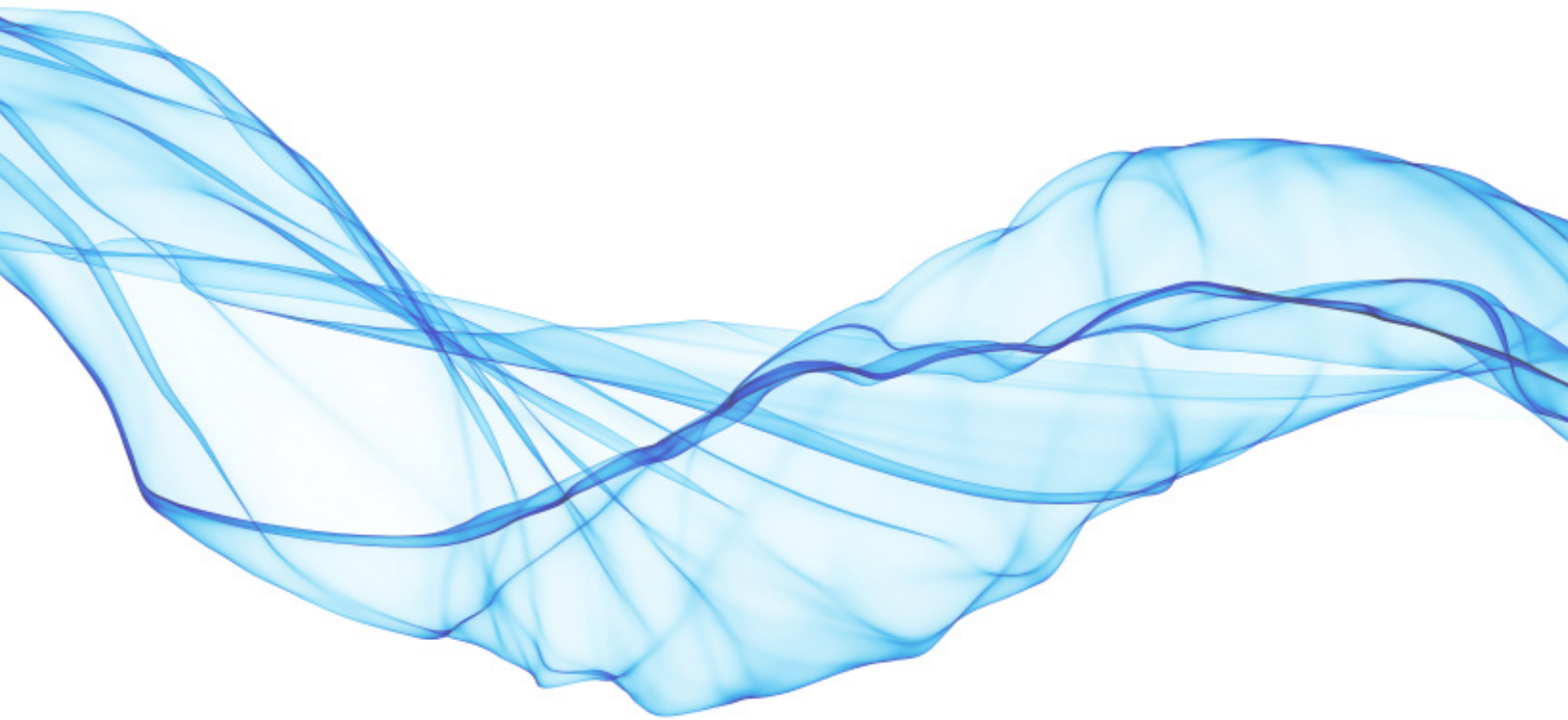
BNOC Tsunami Warning Process Module on Latitude - http://latitude.bom.gov.au/course/view.php?id=57

BNOC SOPs - http://web.bom.gov.au/nmoc/srco/Tsunami/

Australian Government
Bureau of Meteorology

Tsunami Warning Process (Level B)

Tsunami Competency – Unit TsuProB



Version Control

Omitted for privacy purpose

Document Owner

This document is owned by SRTD as the supervisor of the National Forecaster Development Group in the Bureau of Meteorology Training Centre. Contact xxx for more information or to report errors.

Pre-Requisites

TsuSciA – Tsunami Science (Level A)
TsuSysA – Tsunami Systems (Level A)

Job Function Requirements

This unit of competency must be held by the BNOC duty forecaster (PO2) as described in the Tsunami Training Package.

Review Cycle

This unit of competency will be reviewed by the Tsunami Trainer at least every two years. Any proposed changes will be raised with relevant stakeholders (services, training and affected operational offices) and approval of changes will be required as described below.

Approval

This unit of competency must be approved by SRTD and SRTW signature

Omitted for privacy purpose

Elements and Performance Criteria

1. Perform tsunami threat assessment & determine course of action	1.1 Load seismic manual solution in discussion with GA 1.2 Compare all available earthquake solutions, discuss uncertainties with GA and determine impacts of uncertainties on the threat assessment 1.3 Discuss volcanic eruption with GA and VAAC to obtain source details for threat assessment 1.4 Perform and interpret IOTWS threat assessment for Indian Ocean countries 1.5 Perform and interpret ATWS threat assessment for Australia and offshore territories 1.6 Determine course of action based on threat assessment and SOP guidelines, including threat reassessment leading to cancellation and finalisation 1.7 Interpret Tsunami ETA and prioritise actions accordingly 1.8 Perform and interpret ATWS and IOTWS threat assessments using the Simplified TTT Method where necessary 1.9 Assess tsunami potential from non-seismic oceanic sources 1.10 Modify threat assessment based on observations or new seismic information
2. Support JATWC Incident Manager	2.1 Clarify and complete tasks delegated by the JATWC Incident Manager 2.2 Log key information and policy decisions throughout the event 2.3 Monitor Incident Managers actions and decisions, offering support or advice as appropriate
3. Issue and update selected IOTWS & ATWS products in a timely manner	3.1 Prepare and issue relevant IOTWS products in a timely manner 3.2 Issue ATWS National Watch / No Threat bulletin within the specified time-frame 3.3 Explain the differences between watches and warnings and the triggers for moving into warning phase 3.4 Confirm products have been dispatched successfully and notify the Incident Manager of any problems
4. Monitor, interpret and act on relevant observations	4.1 Monitor and interpret relevant sea-level observations to confirm and verify tsunami threat 4.2 Record maximum positive amplitude observations in the DST in the correct format 4.3 Record anecdotal reports in the DST 4.4 Determine the effective magnitude based on tsunameter observations 4.5 Monitor media channels for tsunami related information 4.6 Assess the need to, then if required, manually trigger tsunameters into event mode
5. Communicate tsunami information and liaise with relevant stakeholders	5.1 Liaise with the GA duty seismologist regarding potentially tsunamigenic events 5.2 Prioritise information when communicating about the tsunami event 5.3 Brief BNOC managers and other relevant stakeholders about the event

Evidence Guide

Evidence of competency in performance criteria may be collected through assessment tools as summarised in the following table:

Performance Criteria	Quiz	Interview	Observation	Portfolio	3rd Party Report
1.1		X	X		X
1.2	X	X	X		X
1.3		X			X
1.4	X		X		X
1.5	X		X		X
1.6	X	X	X		X
1.7	X		X		X
1.8			X		X
1.9	X	X			X
1.10		X	X		X
2.1		X	X		X
2.2			X		X
2.3		X	X		X
3.1			X	X	X
3.2			X	X	X
3.3	X	X			
3.4		X	X		X
4.1	X		X	X	X
4.2			X	X	X
4.3			X	X	X
4.4	X	X	X	X	X
4.5		X			X
4.6		X	X		X
5.1		X			X
5.2	X	X	X		X
5.3		X	X		X

Definitions

Quiz: an online series of questions, generally automatically marked

Interview: questions asked by the assessor in person

Observation: a workplace observation, either simulated or real

Portfolio: a collection of evidence prepared by the candidate for assessment

3rd Party Report: a written endorsement of the candidates ability to perform the task by a 3rd party

Performance Criteria Descriptions

Performance criteria are described in more detail below, providing candidates guidance on how to demonstrate competence in each.

Performance Criteria	Description
1.1	By default, the GA manual solution should be used, however, in discussion with GA, an international bulletin may be used instead. The agreed seismic manual solution should be loaded into the DST. Discussions with GA should also focus on the earthquake magnitude, location, depth, tsunamigenic potential and fault type (if known). If no MOST scenario matches the event, this should be discussed with GA
1.2	International and GA bulletins should be accessed and assessed. Comparisons should focus on earthquake magnitude, location and depth. Travel times may also be compared. Uncertainties, particularly in relation to earthquake magnitude should be discussed with GA and 'what-if' assessments should be performed to determine the threat levels that may results from slight changes in magnitude
1.3	For large volcanic eruptions, GA may be able to provide seismic information upon which the threat assessment can be performed. VAAC should be consulted to determine the scale of the eruption and hence the possibility for a tsunami to be generated. By default, the Felt Earthquake No Threat Bulletin will be issued
1.4	Threat assessment based on the seismic solution or manually entered data should be performed in the DST by clicking on the IOTWS Assessment tab. As part of this initial assessment, the Earthquake Bulletin should be sent. The earthquake location should be investigated through mapping software to determine proximity to the fault line. Areas affected should be interpreted through the text list in DST or the graphical threat map. Discrepancies between IOTWS and ATWS threats for overlapping service areas should be explained
1.5	Threat assessment based on the seismic solution or manually entered data should be performed in the DST by clicking on the ATWS Assessment tab. The earthquake location should be investigated through mapping software to determine proximity to the fault line. Areas affected should be interpreted through the text list in DST or the graphical threat map. Discrepancies between IOTWS and ATWS threats for overlapping service areas should be explained. Orphaned zones should be included as directed in the SOPs
1.6	Actions include identifying the appropriate initial tsunami bulletins to send based on the threat assessment, deciding whether JATWC will need to be activated and whether to initiate a conference call with the RFCs and if so which RFCs to contact. Threat reassessment based on new seismic information or sufficient tsunami observational evidence may lead to lower threat levels and associated cancellation and finalisation of warning products
1.7	Tsunami travel time and ETA should be assessed to help prioritise actions such as contact with the RFCs and issuing warning products based on immediate threat (i.e. whether ATWS should be prioritised over IOTWS). The earliest impact on Australia should be noted for use in briefings. Tsunami ETA information should also be used to identify which observation sites to monitor and when the tsunami is expected to impact the sites.
1.8	When no MOST scenario can be found for the earthquake event, the DST will automatically use the Simplified TTT Method. This should be noted and communicated to GA. ATWS and IOTWS threat assessments, if required, should be performed in the DST on the basis of this method. The threat assessment should be related back to the method definition described in the SOPs
1.9	Unexplained sea-level observations should be assessed to determine whether the wave characteristics match those expected for a tsunami (i.e. long period, low

	amplitude in deep water, higher in shallow water). Reactionary warnings should be issued in these cases as directed in the SOPs
1.10	Based on new seismic information or reliable tsunameter observations (see criteria 4.4), modify the earthquake details and perform a threat reassessment in the DST. Threat upgrade may be based on one tsunameter, but two are required to downgrade
2.1	Any tasks delegated by the JATWC Incident Manager should be clarified as necessary then completed. Completion of the task or any issues must be communicated to the Incident Manager
2.2	Key information such as threat reassessments, observations/reports, system issues, unrecorded phone calls or decisions should be logged in a suitable format for use in briefings and post-event analysis
2.3	Throughout the event, attention should be paid to the Incident Managers actions and decisions in order to ensure the warning service is delivered effectively. If discrepancies are noticed in products or the process compared to SOPs, this should be raised with the Incident Manager
3.1	IOTWS Bulletins should be issued in the correct sequence and within the required time-frame (where possible) in accordance with the SOPs. This may include No Threat, Potential Threat, Confirmed Threat and Finalisation Bulletins
3.2	The ATWS National Watch or No Threat Bulletin should be issued on the basis of the ATWS threat assessment within the required time-frame (where possible) in accordance with the SOPs. The National Watch Bulleting must be issued before any regional watches/warnings. Rules regarding issuing a No Threat Bulletin when only certain ATWS areas are under threat should be understood and explained
3.3	The purpose for, and appropriate context in which regional watches and warnings are issued should be understood and explained. The two triggers for moving into warning mode (i.e. confirmed tsunami or unconfirmed but immediate threat) should be explained and applied correctly in warning events
3.4	After any product is issued by either the Incident Manager or Science Officer, the external web should be checked to confirm successful transmission. Any discrepancies or errors should be brought to the attention of the Incident Manager
4.1	With the support of the Incident Manager, sea-level observations (coastal gauges and tsunameters) should be monitored continually throughout the event using the ETA as a guide to prioritisation. Observations sites that record a tsunami may record subsequent waves of higher amplitude and must therefore be monitored after the first wave. Wave properties such as period and amplitude should be assessed to determine the nature of the sea-level anomaly. Reliable reports of sea-level changes associated with the tsunami may be used to confirm the tsunami threat. Verification of the tsunami threat can be performed based on tsunameter data with the help of envelope plots or based on ASLOS coastal gauges compared to the threat level for that region. Site metadata should be used when interpreting coastal sea-level gauges to assess how the site observation may translate to impacts on the surrounding area
4.2	The maximum positive amplitude (i.e. height above mean sea-level) should be determined from observations and entered into the DST Observations table in the format specified as soon as possible. If a higher amplitude wave is observed at a site, this new observation should be entered both in terms of height and time of observation
4.3	Anecdotal reports may be received from a range of sources and should be entered into the Reported Tsunami Impacts form in the DST
4.4	Tsunameter observations should be interpreted in conjunction with envelope plots to determine the effective earthquake magnitude associated with the observed amplitude. If the effective earthquake magnitude falls outside the envelope, this

	may lead to threat reassessment (see 1.10). Any changes to the threat assessment implied by this method must be brought to the attention of the Incident Manager for consideration
4.5	Televisions in JATWC and BNOC should be turned on and monitored. Online news and social media should also be monitored
4.6	ATWS tsunameters expected to observe the tsunami should be triggered into event mode at an appropriate time to ensure high temporal resolution reporting of sea-level in order to resolve the tsunami signal
5.1	The GA duty seismologist should be consulted at the start of the event and whenever significant new information is received by either GA or BNOC. Topics requiring discussion are listed in the SOPs. Liaison will take place over the dedicated tsunami video conference equipment
5.2	Communication should be succinct, prioritised, tailored and appropriately emphasised for the target audience
5.3	Briefings should be provided as requested, as time permits and in accordance with the SOPs to Bureau managers and other important stakeholders (e.g. the AGCCC)

Underpinning Skills/knowledge

- Threat level definitions for IOTWS and ATWS
- Product requirements, especially in relation to offshore and Antarctic
- TTT rounding down to the nearest 15-minute interval
- Simplified TTT Method application
- Usage of envelope plots to determine effective magnitude based on tsunameter observations
- Able to use the DST
- Able to use the video conference equipment to liaise with GA
- Able to use the tsunami phone to establish a conference call with RFCs

Glossary

ATWS	Australian Tsunami Warning System
BNOC	Bureau of Meteorology National Operations Centre
DST	Decision Support Tool
ETA	Estimated Time of Arrival
GA	Geoscience Australia
IOTWS	Indian Ocean Tsunami Warning & Mitigation System
JATWC	Joint Australian Tsunami Warning Centre
RFC	Regional Forecasting Centre
SOP	Standard Operating Procedures
PO2	Professional Officer (Class 2)
Tsunameter	Deep Ocean Sea-Level Detection Buoy
TTT	Tsunami Travel Time

VAAC Volcanic Ash Advisory Centre

Resources

BNOC Tsunami Warning Process Module on Latitude - http://latitude.bom.gov.au/course/view.php?id=57

BNOC SOPs - http://web.bom.gov.au/nmoc/srco/Tsunami/

CHILE - NTWC TRAINING

From: Sifon, Matias - Jefe Dpto. Oceanografía <msifon@shoa.cl>
Date: Tue, Aug 22, 2023 at 4:48 PM
Subject: Chile - NTWC Competency Framework
To: laura.kong@noaa.gov <laura.kong@noaa.gov>
Cc: Zuñiga, Carlos - Subdirector <czuniga@shoa.cl>, Matus, Jorge - Jefe de Division SNAM - OCE <jmatus@shoa.cl>

Dear Laura,

Sorry for this very late response. Im sending you an outline of our trainings. The detailed documentation in spanish will be sent in shortly. Please let me know if this is the expected information or if should I change or include something.

The training process of the Chilean National Tsunami Warning System (SNAM) is divided into two fundamental areas:

1) INITIAL PREPARATION: Training through which new people obtain the minimum competencies to operate within the Operational Rooms of the SNAM organization. In that sense, the capacitation will depend on the particular duty, but at the end of each process, no matter the job, there is a practical evaluation with a highly complex operational exercise conducted by the SNAM training team.

The whole process is controlled through a document called Operational Position Qualification (CPO by its name in Spanish), which has the theoretical and practical tasks that the person has to accomplish and its certified by a monitor, also they have to cover duty shifts accompanying experienced personnel.

The roles covered at SNAM, along with their formation and approximate time required to achieve the competency level, are:

Chief of Duty (4 months): This position is for Navy Officers with the rank of Commander or Lieutenant Commander (at least 20 years of Service). They are decision-makers and do not necessarily have a technical background in Earth Sciences. Therefore, to acquire minimal technical knowledge, they do a tsunami diploma at the "Pontificia Universidad Católica de Valparaíso" taught by various experts in Tsunamis and related areas, aimed to early warnings decisions.

Once they have approved the Diploma, they must learn through an Online platform (asynchronous) and later in person at SHOA with professionals from the SNAM Division, during which, procedures and operational flows are explained to them, along with the technical information about different softwares used.

The final part is divided into the evaluation of theoretical and technical knowledge and a period of practical training with a set of exercises that include near-field and far-field scenarios and alternative systems, among others.

The final Qualification consist of a drill in which each of them is evaluated by the director, deputy director, head of oceanography, and head of Snam Division of SHOA, involving the whole command chain of SNAM.

Communication's Officer: This position is covered by a Leautenant, who can either be specialized in oceanography or not. The two main functions are being in charge of the communications, meaning mainly dissemination to NDMO, and to assume as Chief of Duty in case he can't do it. The training is very similar, but the diploma and online part are not required, although if possible, they are done. The qualification process is very similar, including a theoretical quiz and a practical evaluation.

Technical Advisor: These are civil professionals with a background in Earth Sciences or related areas. However, this only guarantees a thorough knowledge of some subjects associated with tsunamis. Therefore, they carry out the module of theoretical classes on the online platform (asynchronous) and then in person by professionals from the SNAM Division as a standardization of knowledge.

Qualification consists of the same process as the Chief of Duty and Communication's Officer. A theoretical quiz with a practical evaluation in this case, taken by the Head of Oceanography along with the Chief of Snam Division.

Operator: Navy technical personnel trained as Oceanographer-Hydrographer trained at the SHOA Instruction Center. The CPO process for them is focused on procedures and systems operation with very identified tasks. Therefore, they are trained in the different positions to be covered: Application Operator, Information Receiver, Communications, and Logbook.

Others: There is also a simplified induction process for personnel that doesn't perform technical actions in the Operational Rooms but has a responsibility associated with it, for example, the IT technician on duty.

2) CONTINUITY OF TRAINING: Chile's NTWC has developed a training scheme based on four levels associated with the degree of involvement: on-duty personnel, institutional, inter-institutional (national level), and regional (international). Each of these levels has a different focus and specific objectives:

At the most basic level, there are daily exercises oriented to practicing internal procedures, the use of technical information, and the development of the first actions of the on-duty personnel,

with simulated situations such as equipment failures, use of alternative systems, and operation flows, focusing also on the minimal decisions excepted.

The second level contemplates the whole SHOA organization, forming the different teams of decision makers, technical advisors, maintainers, and logistic support, facing scenarios with local impact on the systems, injured personnel, damages to the

infrastructure (collapse of buildings, fires, or flooding) and use of alternative systems including the backup operational rooms. These have a monthly frequency.

The third level involves the National Disaster Prevention and Response System (SINAPRED), including the NDMO and the National Seismological Center (CSN), generating actions from the national system to the local emergency units in the communities, focusing on coordination, primary and alternative communications links, unavailability of services due to local impact and communication of the mitigation actions to the community. SINAPRED carries out these exercises quarterly.

The upper and last one is the regional level, as part of the Regional Working Group of the Southeast Pacific Tsunami Warning and Mitigation System (SEP-WG), with the execution of coordination exercises between Chile, Colombia, Ecuador, and Peru, with scenarios including the regional block, focusing on improving the information shared among the NTWC's and the common systems, procedures and terminology.

Again, if there's something that needs to be improved from the information above, let me know, and we will do it as soon as possible. The more detailed documentation will be shared in Spanish at first time in the morning (our morning).

Kindly,
Matias

---------- Forwarded message ---------
From: **Sifon, Matias - Jefe Dpto. Oceanografía** <msifon@shoa.cl>
Date: Wed, Aug 23, 2023 at 6:01 AM
Subject: Chile - NTWC Competency Framework
To: Laura Kong <laura.kong@noaa.gov>
Cc: Zuñiga, Carlos - Subdirector <czuniga@shoa.cl>, Matus, Jorge - Jefe de Division SNAM - OCE <jmatus@shoa.cl>

Dear Laura,

Complementing the previous email, I'm sending the evaluation forms we use, along with the training details and scope for each type of training and finally an example of a daily drill development which can be used as general example for any other drill carried out here at SHOA.

I believe this would answer the requirement but if there's anything missing or needs more detail please let me know so we can provide useful information.

Best Regards,
Matías
Matias I. Sifón
Lieutenant
Head of the Oceanography Department

National Tsunami Warning Center (SHOA) Staff Training Process		
Position	***Profile***	***Stages***
Chief of Duty	Navy Officer	Diploma on Earthquakes and Tsunami
		100 hrs general Knowledge leveling
		Tsunami Division Internship
		4-6 weeks in depth courses on Earthquakes and Tsunamis
		Written Test
		Operational Post Evaluation
Communications Officer	Navy Officer	Diploma on Earthquakes and Tsunami
		100 hrs general Knowledge leveling
		Operational Post Evaluation
Technical Advisor	Civilian Earth Science Degree	Diploma on Earthquakes and Tsunami
		100 hrs general Knowledge leveling
		Tsunami Division Internship
		4-6 weeks in depth courses on Earthquakes and Tsunamis
		Written Test
		Operational Post Evaluation
Operator	Navy Petty Officer	Operational Post Evaluation

National Tsunami Warning Center (SHOA) Operational Post		
Post	***Profile***	***Operational Capabilities***
Chief of Duty	Navy Officer	Leads Tsunami Threat Assessment Process
		Handles comunicatiuons with Navy'es High Command
Communications	Navy Officer / Navy Petty Officer	Radio: UHF, VHF, HF
		Satelite Coms. Iridium and Inmarsat
		Land Lines Phones
		Naval Communication's web Portal
		Collects Tsunami Field Observers reports
Seismic Source monitoring	Navy Petty Officer	Information Reception (email, Seismological and PTWC webpages)
		Decision Support System (SSD -Tailor made for SHOA)
Tsunami Threat Assessment	Navy Petty Officer	Decision Support System (SSD -Tailor made for SHOA)
	Technical Advisor	Integrated Tsunami Warning Prediction System (Tailor made)
		Sea Level Real Time Tsunami Amplitudes Monitor
		For Chilean and International Tide Gauges. Tailor made for SHOA
		Decision Support System (SSD -Tailor made for SHOA)
		PMEL - Tweb Evaluation
Manual Situational Dashboard	Navy Petty Officer	Display seismic current information under assessment
		Displays current stage of operational procedures
		Displays current Tsunami threat assessment results
		Displays Sea Level available information
		Display ETA for Tide Network
Communications Support	Navy Petty Officer	Supports Chied of Duty communications requirements
		Receives external information from Information room
Information room	Navy Petty Officer	Receives any information request from civilian authorities
		Receives informations request from the press

National Tsunami Warning Center (SHOA) Operational Drills			
Permanent Operational Capabilities Evaluation			
● Tsunami Threath Assessment Operational Procedures (SSD - SIPAT) ● PTWC Products Assessment ● Sea Level Real Time Tsunami Amplitudes Monitor ● Personal Mic-Headphones Comunication's Procedures ● Comunication's Optimization during Emergencies ● Radio and Satelite Comunication procedures and equipments operations ● Sea level data communication recovery (GOES - Inmarsat - GPRS) ● Tsunami Threat Cancelation Procedures			
Variable Operational Capabilities Evaluation			
Spectrum	***Participating Agencies***	***Frecuency***	***Operational Capabilities Evaluation***
Pacific Basin	PTWS (PacWave)	Every two years	PTWC Products Assessment
			Tsunami Modeling
			Regional Cooperation (South East Pacific - Working Group)
			Duty Staff Operational Management for long term emergencies
			Sea Level real Time monitoring improvements for international Tide Gauges
Regional	NTWC - SEP WG	Twice a wear	PTWC Products Assessment
			Sea Level real Time data sharing between Regional NTWC
			Tsunami Modeling
			Regional Comunications Protocols (South East Pacific - Working Group)
National	National Emergency Agency (SENAPRED)	Three times a year	Inter Agencies Comunication's Optimization during Emergencies
	National Seismological Center (CSN)		Power failure emergency procedures
	NTWC (SHOA)		Decision Support System (SSD -Tailor made for SHOA)
			Integrated Tsunami Warning Prediction System SIPAT -Tailor made for SHOA)
			Simultaneous seismic events from different sources
			Aftershocks Tsunami Threat Assessment
Navy	SHOA	Once a year	Naval Communication's web Portal
			Field observation and reporting from Maritime Authorithies
			Alternate NTWC operations during emergencies
			On duty staff shift rotations
			Simultaneous seismic events from different sources
			Aftershocks Tsunami Threat Assessment
Internal	SHOA	Monthly	Power Backup Emergency Porocedures
			SSD backup Servers emergency Procedures
			Power failure emergency procedures
			Internet failure emergency procedures
			Earthquake emergency evacuation procedures
			Alternate NTWC operations during emergencies
			External emergencies (Fire - Medical)
			On duty staff shift rotations
			Simultaneous seismic events from different sources
			Aftershocks Tsunami Threat Assessment
			Naval Communication's web Portal
Internal	SHOA	Daily	Simultaneous seismic events from different sources
			Aftershocks Tsunami Threat Assessment
			Naval Communication's web Portal
			SSD backup Servers emergency Procedures
			Power failure emergency procedures
			Internet failure emergency procedures
			Alternate Servers operations for Sea Level Monitoring

Pautas de Entrenamiento
Ejercicio Diario

Sección Operaciones SNAM
Marzo 2020

ENTRENAMIENTO DIARIO

- Ejemplo: Ejercicio Quellón

1. ONEMI **18:05**

De: ONEMI [mailto:jefedeturno@onemi.gov.cl]
Enviado el: 19 de Agosto de 2019 18:05
Para: SNAM 1
Asunto: Complementa Sismo Número 254-A (Mayor Intensidad)
Sistema Nacional de Alarma de Maremotos, SNAM:

El Centro Nacional de Alerta Temprana reporta información del siguiente evento sísmico

Información del Sismo

Fecha y Hora del Evento: 19/08/2019 - 18:03

Fecha y Hora del Reporte: 19/08/2019 - 18:05

Máxima Intensidad Percibida: VII (Mercalli)

Número de Sismo: 254-A

Reportes de Intensidad (Mercalli) por Localidad

Región: Los Lagos
Puerto Montt VII

- Procedimientos
  - Verificación de Parámetros: Fecha, Hora, Intensidad.
  - Activación Zafarrancho Clave TANGO por Intensidad.
  - Aviso a Oficial de Guardia y Jefe de Servicio.

ENTRENAMIENTO DIARIO

- Ejemplo: Ejercicio Quellón

3. P-TIME **18:07**

---------- Forwarded message ----------
From: <ptwc@ptwc.noaa.gov>
Date: 2019-08-19 18:08 GMT-04:00
Subject: PTWC P-TIME MESSAGE
To: snam@snamchile.cl

FROM PACIFIC TSUNAMI WARNING CENTER

THIS IS PRELIMINARY DATA, NOT FOR PUBLIC DISSEMINATION.
COMPLETE INFORMATION CAN BE OBTAINED FROM THE USGS/NEIC
TELEPHONE (303) 273-8500.

H 22:03:00Z AUG 19 2019Z LAT 43.52S LONG 74.0W DEPTH 27.0km Mwp 7.9 (13 STATIONS)

IN SOUTHERN CHILE

FORT P 181526.4 WB2 P 181547.8 WRAB P 181547.9 BBOO P 181615.3
MEEK P 181628.1 MBWA P 181630.2 MORW P 181701.0 MTN P 181701.9
QLP P 181706.6 NWAO P 181708.2 CTAO P 181746.7 COEN P 181758.7
MMRI P 181818.8 JAGI P 181906.6

- Procedimientos
  - Verificación de Parámetros: Fecha, Hora, Intensidad.
  - Inicio de Cronómetro 18:07.
  - Ubicación del Epicentro y definición de Flujo Operativo.
  - Verificación polígono de Remoción en masa y Zona Tsunamigénica.
  - Evaluación por SIPAT

ENTRENAMIENTO DIARIO

- Ejemplo: Ejercicio Quellón

Fuente	PTWC P-time
HRI	18:07
Hora Sismo	18:03
Mag	7.9
Lat	-43.52
Long	-74.00
Arica y Parinacota	Informativo
Tarapacá	Informativo
Antofagasta Norte	Informativo
Antofagasta Sur	Informativo
Atacama Norte	Informativo
Atacama Sur	Informativo
Coquimbo	Informativo
Valparaíso	Informativo
Libertador General Bernardo O'Higgins	Informativo
Maule	Informativo
Ñuble-Biobío	Precaución
Araucanía	Precaución
Los Ríos	Precaución
Los Lagos Norte	Precaución
Los Lagos Sur	Alerta
Aysén	Alerta
Magallanes	Informativo
Antártica Chilena	Informativo
Juan Fernández	Informativo
San Félix	Informativo
Isla de Pascua	Informativo

- Procedimientos
  - Tiempo Máximo de Difusión 18:12.

ENTRENAMIENTO DIARIO

- Ejemplo: Ejercicio Quellón

5. CSN PRELIMINAR **18:12**

---------- Mensaje reenviado ----------
De: <preliminar@csn.uchile.cl>
Fecha: 19 de Agosto de 2019, 18:12
Asunto: 44 km al NW de Melinka (7.8 Ml)
Para:

############################
Informe Preliminar de Sismo
############################

Hora UTC : 2019/08/19 22:03:00
Hora Loc : 2019/08/19 18:03:00
Retardo : 4.00 Min
Coord : Lat : -43.5 Lon : -73.8
MAG : 7.8 Ml
PROF : 27.0 km.
Localidad : 44 km al NW de Melinka

- Procedimientos
  - Tiempo Máximo de Difusión 18:12.
  - Nueva Información Sísmica con menor Magnitud. Debe ser Evaluada por SIPAT ya que peor escenario depende de la ubicación del Epicentro y Magnitud.
  - SIPAT no ubica escenarios, se procede a la evaluación por Radios.

ENTRENAMIENTO DIARIO

- Ejemplo: Ejercicio Quellón

Fuente	PTWC P-time	CSN Preliminar
HRI	18:07	18:12
Hora Sismo	18:03	18:03
Mag	7.9	7.8
Lat	-43.52	-43.5
Long	-74.00	-73.8
Arica y Parinacota	Informativo	Precaución
Tarapacá	Informativo	Precaución
Antofagasta Norte	Informativo	Precaución
Antofagasta Sur	Informativo	Precaución
Atacama Norte	Informativo	Precaución
Atacama Sur	Informativo	Precaución
Coquimbo	Informativo	Precaución
Valparaíso	Informativo	Precaución
Libertador General Bernardo O´Higgins	Informativo	Precaución
Maule	Informativo	Precaución
Ñuble-Biobío	Precaución	Precaución
Araucanía	Precaución	Alerta
Los Ríos	Precaución	Alerta
Los Lagos Norte	Precaución	Alerta
Los Lagos Sur	Alerta	Alerta
Aysén	Alerta	Alerta
Magallanes	Informativo	Informativo
Antártica Chilena	Informativo	Informativo
Juan Fernández	Informativo	Precaución
San Félix	Informativo	Precaución
Isla de Pascua	Informativo	Precaución

- Procedimientos
  - Evaluación por radios entrega peor escenario. Se sugiere descartar esta información por cuanto ya se dispone de resultado SIPAT previo basado en modelaciones.

ENTRENAMIENTO DIARIO

- Ejemplo: Ejercicio Quellón

6. USGS 18:14

---------- Mensaje reenviado ----------
De: **USGS ENS** <ens@ens.usgs.gov>
Fecha: 19 AUG 2019, 18:14
Asunto: 2019-08-19 22:03:00 (M8.0)
Para: snam@snamchile.cl

== INFORME PRELIMINAR DEL TEMBLOR ==

U.S. Geological Survey Earthquake Hazards Program
http://earthquake.usgs.gov

Versi&#65533;n : Este informe reemplaza cualquier informe anterior sobre este temblor.

Esto es un mensaje originado por computadora y todavia no ha sidorepasado por un sismologo.

PAR&#65533;METROS PRINCIPALES DEL TEMBLOR

Magnitud : 8.0
Fecha Y Hora Del Temblor : 19 AUG 2019 18:03:00 hora local
19 AUG 2019 22:03:00 UTC

Coordenadas : 43.45S, 74.08W

Profundidad : 12 miles (26 km)

- Procedimientos
  - Evaluación por radios entrega peor escenario. Se sugiere descartar esta información por cuanto ya se dispone de resultado SIPAT previo basado en modelaciones.
  - Nueva Información Sísmica 18:14. Aumento de Magnitud y Variación de Epicentro requiere nueva Evaluación SIPAT.

ENTRENAMIENTO DIARIO

- Ejemplo: Ejercicio Quellón

Fuente	PTWC P-time	CSN Preliminar	USGS
HRI	18:07	18:12	18:14
Hora Sismo	18:03	18:03	18:03
Mag	7.9	7.8	8.0
Lat	-43.52	-43.5	-43.45
Long	-74.00	-73.8	-74.08
Arica y Parinacota	Informativo	Precaución	Informativo
Tarapacá	Informativo	Precaución	Informativo
Antofagasta Norte	Informativo	Precaución	Informativo
Antofagasta Sur	Informativo	Precaución	Informativo
Atacama Norte	Informativo	Precaución	Informativo
Atacama Sur	Informativo	Precaución	Informativo
Coquimbo	Informativo	Precaución	Informativo
Valparaíso	Informativo	Precaución	Informativo
Libertador General Bernardo O'Higgins	Informativo	Precaución	Informativo
Maule	Informativo	Precaución	Informativo
Ñuble-Biobío	Precaución	Precaución	Precaución
Araucanía	Precaución	Alerta	Precaución
Los Ríos	Precaución	Alerta	Precaución
Los Lagos Norte	Precaución	Alerta	Precaución
Los Lagos Sur	Alerta	Alerta	Alarma
Aysén	Alerta	Alerta	Alerta
Magallanes	Informativo	Informativo	Informativo
Antártica Chilena	Informativo	Informativo	Informativo
Juan Fernández	Informativo	Precaución	Informativo
San Félix	Informativo	Precaución	Informativo
Isla de Pascua	Informativo	Precaución	Informativo

- Procedimientos
  - Evaluación por radios entrega peor escenario. Se sugiere descartar esta información por cuanto ya se dispone de resultado SIPAT previo basado en modelaciones.
  - Nueva Información Sísmica 18:14. Aumento de Magnitud y Variación de Epicentro requiere nueva Evaluación SIPAT.
  - Variación en Bloque Lagos Sur no implica cambio de acción por parte de ONEMI. Se descarta nuevo Boletín.
  - Envío de Boletín 02 con información de horas estimadas de arribo.

ENTRENAMIENTO DIARIO

- Ejemplo: Ejercicio Quellón

7. PTWC Boletín 1. **18:16**

---------- Forwarded message ----------
From: **SNAM 1** <snam@shoa.cl>
Date: 2019-08-19 18:16 GMT-04:00
Subject: RV: [Tsunami Message - IOC] NWS-NTWC Tsunami Information Statement
To: SNAM SAT <snam@snamchile.cl>

TSUNAMI MESSAGE NUMBER 1
NWS PACIFIC TSUNAMI WARNING CENTER EWA BEACH HI
2216 UTC AUG 19 2019

..PTWC TSUNAMI THREAT MESSAGE...

**** NOTICE **** NOTICE **** NOTICE **** NOTICE **** NOTICE *****

THIS MESSAGE IS ISSUED FOR INFORMATION ONLY IN SUPPORT OF THE UNESCO/IOC PACIFIC TSUNAMI WARNING AND MITIGATION SYSTEM AND IS MEANT FOR NATIONAL AUTHORITIES IN EACH COUNTRY OF THAT SYSTEM.

NATIONAL AUTHORITIES WILL DETERMINE THE APPROPRIATE LEVEL OF ALERT FOR EACH COUNTRY AND MAY ISSUE ADDITIONAL OR MORE REFINED INFORMATION.

**** NOTICE **** NOTICE **** NOTICE **** NOTICE **** NOTICE *****

PRELIMINARY EARTHQUAKE PARAMETERS
---
* MAGNITUDE 8.1
* ORIGIN TIME 2203 UTC AUG 19 2019
* COORDINATES 43.5 SOUTH 73.8 WEST
* DEPTH 15 KM / 16.15 MILES
* LOCATION SOUTHERN CHILE

- Procedimientos
  - Nueva información sísmica 18:16. Aumento de Magnitud y Variación de Epicentro requiere nueva Evaluación SIPAT.
  - Posteriormente se deberán generar nuevas horas de arribos con bloque no considerados bajo a Amenaza previamente.

ENTRENAMIENTO DIARIO

- Ejemplo: Ejercicio Quellón

Fuente	PTWC P-time	CSN Preliminar	USGS	PTWC Boletín 1
HRI	18:07	18:12	18:14	18:16
Hora Sismo	18:03	18:03	18:03	18:03
Mag	7.9	7.8	8.0	8.1
Lat	-43.52	-43.5	-43.45	-43.5
Long	-74.00	-73.8	-74.08	-73.88
Arica y Parinacota	Informativo	Precaución	Informativo	Precaución
Tarapacá	Informativo	Precaución	Informativo	Informativo
Antofagasta Norte	Informativo	Precaución	Informativo	Informativo
Antofagasta Sur	Informativo	Precaución	Informativo	Informativo
Atacama Norte	Informativo	Precaución	Informativo	Informativo
Atacama Sur	Informativo	Precaución	Informativo	Informativo
Coquimbo	Informativo	Precaución	Informativo	Precaución
Valparaíso	Informativo	Precaución	Informativo	Precaución
Libertador General Bernardo O'Higgins	Informativo	Precaución	Informativo	Precaución
Maule	Informativo	Precaución	Informativo	Precaución
Ñuble-Biobío	Precaución	Precaución	Precaución	Alerta
Araucanía	Precaución	Alerta	Precaución	Alerta
Los Ríos	Precaución	Alerta	Precaución	Alerta
Los Lagos Norte	Precaución	Alerta	Precaución	Alarma
Los Lagos Sur	Alerta	Alerta	Alarma	Alarma
Aysén	Alerta	Alerta	Alerta	Alarma
Magallanes	Informativo	Informativo	Informativo	Precaución
Antártica Chilena	Informativo	Informativo	Informativo	Informativo
Juan Fernández	Informativo	Precaución	Informativo	Precaución
San Félix	Informativo	Precaución	Informativo	Informativo
Isla de Pascua	Informativo	Precaución	Informativo	Precaución

- Procedimientos
  - Nueva información sísmica 18:16. Aumento de Magnitud y Variación de Epicentro requiere nueva Evaluación SIPAT.
  - Posteriormente se deberán generar nuevas horas de arribos con bloque no considerados bajo a Amenaza previamente.
  - Evaluaciones posteriores en base a productos contenidos en Boletín 02 PTWC no serán considerados para sismo de campo Cercano.

GRACIAS

SNAM Chile

PAUTA PARA EVALUACIÓN TÉCNICA
ZAFARRANCHO: JEFES DE SERVICIO SNAM

EVENTO: "_____"

Personal Evaluado: _____ Fecha: _____

	OBJETIVO	OBSERVACIONES DETECTADAS			
		S/OBS.	MENOR	SIGNIFICATIVA	CRÍTICA
1.	Manejo claro y priorizado de la información recibida.				
2.	Seguimiento al flujo de acciones.				
3.	Fluidez y aplomo en el manejo de la emergencia, mantiene presencia y liderazgo durante el desarrollo del evento.				
4.	Hace uso de las herramientas disponibles en el SNAM.				
5.	Comunicación con el mando (transmite novedades o decisiones).				
6.	Apego al Protocolo / Normativa vigente.				
7.	Se mantiene enfocado en el proceso, manejando interrupciones y situaciones imprevistas de forma asertiva.				
	Total Observaciones:				

% de Aprobación:	**80%**	**SAT**	**NO SAT**
% Obtenido:			

_____

FIRMA CALIFICADOR

Ecs/Jcp/Jgv/2022

PAUTA PARA EVALUACIÓN TÉCNICA
ZAFARRANCHO: JEFES DE SERVICIO SNAM

ESTADO	EVALUACIÓN DE ENTRENAMIENTO	EVALUACIÓN SR. DIRECTOR	Penalización %
(C) CRÍTICO	Una falla, por acción u omisión que impide el cumplimiento de la acción evaluada.	Deficiencia u omisión de procedimientos que afectan al SNAM en el cumplimiento de su función de evaluar y difundir la Amenaza de Tsunami. Se debe realizar la corrección de la observación en forma inmediata.	35
(S) SIGNIFICATIVO	Una falla, por acción u omisión que retrasa el cumplimiento de la acción evaluada o se aparta de la normativa aplicable.	Deficiencia u omisión de procedimientos que podrían afectar al SNAM en el cumplimiento oportuno y/o correcto de acuerdo los protocolos establecidos. Se deberá garantizar la corrección de la observación.	15
(M) MENOR	Una debilidad que por acción u omisión, es poco probable que impida el cumplimiento de la acción evaluada dentro de la normativa aplicable.	Deficiencia u omisión de procedimientos que no son frecuentes y su corrección está dentro de las capacidades del SNAM. Es poco probable que obstaculice el cumplimiento de los protocolos establecidos.	5

TABLA DE EVALUACIÓN DE ACUERDO A PORCENTAJE:		
EVALUACIÓN:	**PORCENTAJE NUMÉRICO**	**DESCRIPCIÓN**
MUY BUENO	95%-100%	➢ Sin deficiencias detectadas y haber alcanzado un desempeño sobresaliente en todas las áreas evaluables del ejercicio.
BUENO	80% - 94%	➢ Alto nivel de capacidad de operar en equipo y una sólida ejecución de los objetivos del ejercicio.
SATISFACTORIO	70% - 79%	➢ Aceptable nivel de capacidad de operar en equipo y una adecuada ejecución de los objetivos del ejercicio.
BAJO ESTÁNDAR	50% - 69%	➢ Inadecuado nivel de ejecución de los objetivos del ejercicio.
NO SATISFACTORIO	1% - 49%	➢ Inaceptable nivel de ejecución de los objetivos del ejercicio.
NO EVALUADO	0%	➢ Durante su ejecución, el ejercicio debe ser suspendido y/o reprogramado.

Ecs/Jcp/Jgv/2022

PAUTA PARA EVALUACIÓN TÉCNICA
ZAFARRANCHO: JEFES DE SERVICIO SNAM

OBSERVACIONES

Ecs/Jcp/Jgv/2022

PAUTA PARA EVALUACIÓN TÉCNICA
ZAFARRANCHO: OFICIAL DE GUARDIA SNAM

EVENTO: "_____"

Personal Evaluado: _____ Fecha: _____

	OBJETIVO	OBSERVACIONES DETECTADAS			
		S/OBS.	MENOR	SIGNIFICATIVA	CRÍTICA
1.	Verificar e informar JS Puestos Cubiertos				
2.	Estar atento a las informaciones recibidas por los medios de comunicación radial y Satelital				
3.	Manejo claro y priorizado de la información recibida.				
4.	Seguimiento al flujo de acciones.				
5.	Hace uso de las herramientas disponibles en el SNAM para la recepción y difusión de informaciones relevantes				
6.	Comunicación con el JS, transmite novedades o decisiones.				
7.	Verificar Mensaje Naval en su estructura y contenido.				
8.	Apego al Protocolo / Normativa vigente.				
9.	Se mantiene enfocado en el proceso, manejando interrupciones y situaciones imprevistas de forma asertiva.				
	Total Observaciones:				

% de Aprobación:	**80%**	**SAT**	**NO SAT**
% Obtenido:			

_____

FIRMA CALIFICADOR

Ecs/Jcp/Jgv/2023

PAUTA PARA EVALUACIÓN TÉCNICA
ZAFARRANCHO: OFICIAL DE GUARDIA SNAM

ESTADO	EVALUACIÓN DE ENTRENAMIENTO	EVALUACIÓN SR. DIRECTOR	Penalización %
(C) CRÍTICO	Una falla, por acción u omisión que impide el cumplimiento de la acción evaluada.	Deficiencia u omisión de procedimientos que afectan al SNAM en el cumplimiento de su función de evaluar y difundir la Amenaza de Tsunami. Se debe realizar la corrección de la observación en forma inmediata.	35
(S) SIGNIFICATIVO	Una falla, por acción u omisión que retrasa el cumplimiento de la acción evaluada o se aparta de la normativa aplicable.	Deficiencia u omisión de procedimientos que podrían afectar al SNAM en el cumplimiento oportuno y/o correcto de acuerdo los protocolos establecidos. Se deberá garantizar la corrección de la observación.	15
(M) MENOR	Una debilidad que por acción u omisión, es poco probable que impida el cumplimiento de la acción evaluada dentro de la normativa aplicable.	Deficiencia u omisión de procedimientos que no son frecuentes y su corrección está dentro de las capacidades del SNAM. Es poco probable que obstaculice el cumplimiento de los protocolos establecidos.	5

TABLA DE EVALUACIÓN DE ACUERDO A PORCENTAJE:		
EVALUACIÓN:	**PORCENTAJE NUMÉRICO**	**DESCRIPCIÓN**
MUY BUENO	95%-100%	➢ Sin deficiencias detectadas y haber alcanzado un desempeño sobresaliente en todas las áreas evaluables del ejercicio.
BUENO	80% - 94%	➢ Alto nivel de capacidad de operar en equipo y una sólida ejecución de los objetivos del ejercicio.
SATISFACTORIO	70% - 79%	➢ Aceptable nivel de capacidad de operar en equipo y una adecuada ejecución de los objetivos del ejercicio.
BAJO ESTÁNDAR	50% - 69%	➢ Inadecuado nivel de ejecución de los objetivos del ejercicio.
NO SATISFACTORIO	1% - 49%	➢ Inaceptable nivel de ejecución de los objetivos del ejercicio.
NO EVALUADO	0%	➢ Durante su ejecución, el ejercicio debe ser suspendido y/o reprogramado.

Ecs/Jcp/Jgv/2023

PAUTA PARA EVALUACIÓN TÉCNICA
ZAFARRANCHO: OFICIAL DE GUARDIA SNAM

OBSERVACIONES

Ecs/Jcp/Jgv/2023

PAUTA PARA EVALUACIÓN TÉCNICA
ZAFARRANCHO: OCEANOGRAFO DE GUARDIA

EVENTO: Pichilemu Personal Evaluado: _____ Fecha: _____

	OBJETIVO	ACCIONES EVALUADAS	Fallas Observadas			
			SAT	(M)	(C)	(S)
1.	Manejo claro y priorizado de la información recibida.	• Demarcación del Epicentro y Determinación de referencia geográfica. • Clasificación de procedimiento aplicable según demarcación del Epicentro. • Evaluación SIPAT oportuna.				
2.	Seguimiento al flujo de acciones.	• Demarcación del Epicentro y Determinación de referencia geográfica. • Efectúa evaluación SIPAT. • Activa Clave Tango en SAVTEC. • Recomienda difusión de boletín de horas de arribo cuando sea pertinente.				
3.	Conocimiento de procedimientos alternativos de emergencia, con dominio pleno de ventajas y limitaciones.	***Perdida de enlace de Internet:*** • Evaluación SIPAT. • Dictado de Evaluación. • Visualización App V2 en VideoWall. • Activación de internet satelital en pc Tweb para visualización de mareas.				
4.	Hace uso de las herramientas disponibles en el SNAM.	• Cierre de aplicación SEISCOMP. • Activación de enlace Satelital en Pc Tweb. • Visualización de Mareas en Pc Tweb.				
5.	Comunicación con el mando (transmite novedades o decisiones).	• Manejo de comunicaciones sin interrumpir otras informaciones importantes. • Uso de Procedimiento FLASH. • Lectura eficiente de Estados de Amenaza.				
6.	Apego al Protocolo / Normativa vigente.	• Promueve recopilación de información sísmica en caso de demora en recepción por correo. • Efectúa Evaluación SIPAT cuando corresponde.				
7.	Se mantiene enfocado en el proceso, asesorando correctamente al Jefe de Servicio en caso de que sea conveniente.	• Sugiere al JS contactar CSN en caso de demora en la recepción de información. • No descarta información recibida a pesar de discrepancias en Fase W. • Asesora al JS en caso de que se requiera difundir por VHF. • Descarta Productos del PTWC para evento de campo cercano				

% de Aprobación:	**80%**	**SAT**	**NO SAT**
% Obtenido:			

_____

FIRMA CALIFICADOR

Ecs/Jcp/Jgv/2022

PAUTA PARA EVALUACIÓN TÉCNICA
ZAFARRANCHO: OCEANOGRAFO DE GUARDIA

ESTADO	EVALUACIÓN DE ENTRENAMIENTO	EVALUACIÓN SR. DIRECTOR	Penalización %
(C) CRÍTICO	Una falla, por acción u omisión que impide el cumplimiento de la acción evaluada.	Deficiencia u omisión de procedimientos que afectan al SNAM en el cumplimiento de su función de evaluar y difundir la Amenaza de Tsunami. Se debe realizar la corrección de la observación en forma inmediata.	35
(S) SIGNIFICATIVO	Una falla, por acción u omisión que retrasa el cumplimiento de la acción evaluada o se aparta de la normativa aplicable.	Deficiencia u omisión de procedimientos que podrían afectar al SNAM en el cumplimiento oportuno y/o correcto de acuerdo los protocolos establecidos. Se deberá garantizar la corrección de la observación.	15
(M) MENOR	Una debilidad que por acción u omisión, es poco probable que impida el cumplimiento de la acción evaluada dentro de la normativa aplicable.	Deficiencia u omisión de procedimientos que no son frecuentes y su corrección está dentro de las capacidades del SNAM. Es poco probable que obstaculice el cumplimiento de los protocolos establecidos.	5

TABLA DE EVALUACIÓN DE ACUERDO A PORCENTAJE:		
EVALUACIÓN:	**PORCENTAJE NUMÉRICO**	**DESCRIPCIÓN**
MUY BUENO	95%-100%	➢ Sin deficiencias detectadas y haber alcanzado un desempeño sobresaliente en todas las áreas evaluables del ejercicio.
BUENO	80% - 94%	➢ Alto nivel de capacidad de operar en equipo y una sólida ejecución de los objetivos del ejercicio.
SATISFACTORIO	70% - 79%	➢ Aceptable nivel de capacidad de operar en equipo y una adecuada ejecución de los objetivos del ejercicio.
BAJO ESTÁNDAR	50% - 69%	➢ Inadecuado nivel de ejecución de los objetivos del ejercicio.
NO SATISFACTORIO	1% - 49%	➢ Inaceptable nivel de ejecución de los objetivos del ejercicio.
NO EVALUADO	0%	➢ Durante su ejecución, el ejercicio debe ser suspendido y/o reprogramado.

Ecs/Jcp/Jgv/2022

INDIA - NTWC TRAINING

From: **srinivas** <srinivas@incois.gov.in>
Date: Thu, Jun 30, 2016 at 11:43 PM
Subject: RE: TWC Staff Competency Requirements/ New Staff Training
To: Laura Kong - NOAA Federal <laura.kong@noaa.gov>, Tony Elliott <t.elliott@unesco.org>

Dear Laura,

…

At INCOIS we have two high-level checklists that describe what the operators at the tsunami warning centre should do during an event and during non-event. These checklists are attached with this email. The detailed procedure for each step in these checklists is in turn described in a low-level operations manual. This operations manual is a restricted document since it contains the server IPs, network details, user names and passwords. This operational manual is used during the training sessions when new operators are assigned to the watch standing duties.

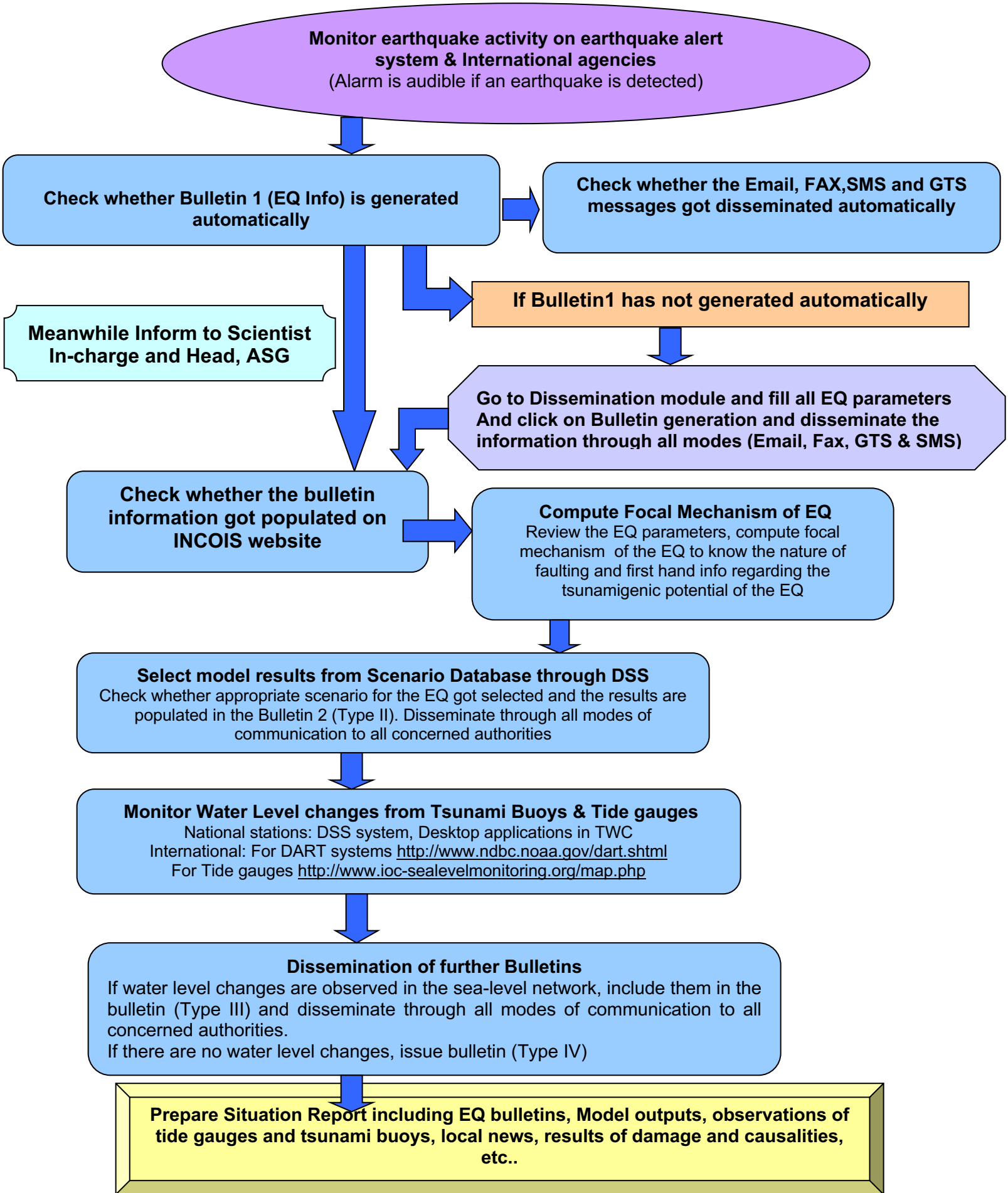
We have watch standers at 2 levels: First level is those people who have a bachelors degree in science or a diploma engineering and the second level comprises of people having a post-graduation/Ph.D in science or graduate/post graduate in engineering. We generally take people from Geology, Geophysics, Oceanography, Physics, Mathematics, Computer Science and Electronics backgrounds. We provide them intensive training on the warning centre operations before posting them as watch standers. Training is a continuous activity.

I hope you find this information useful.

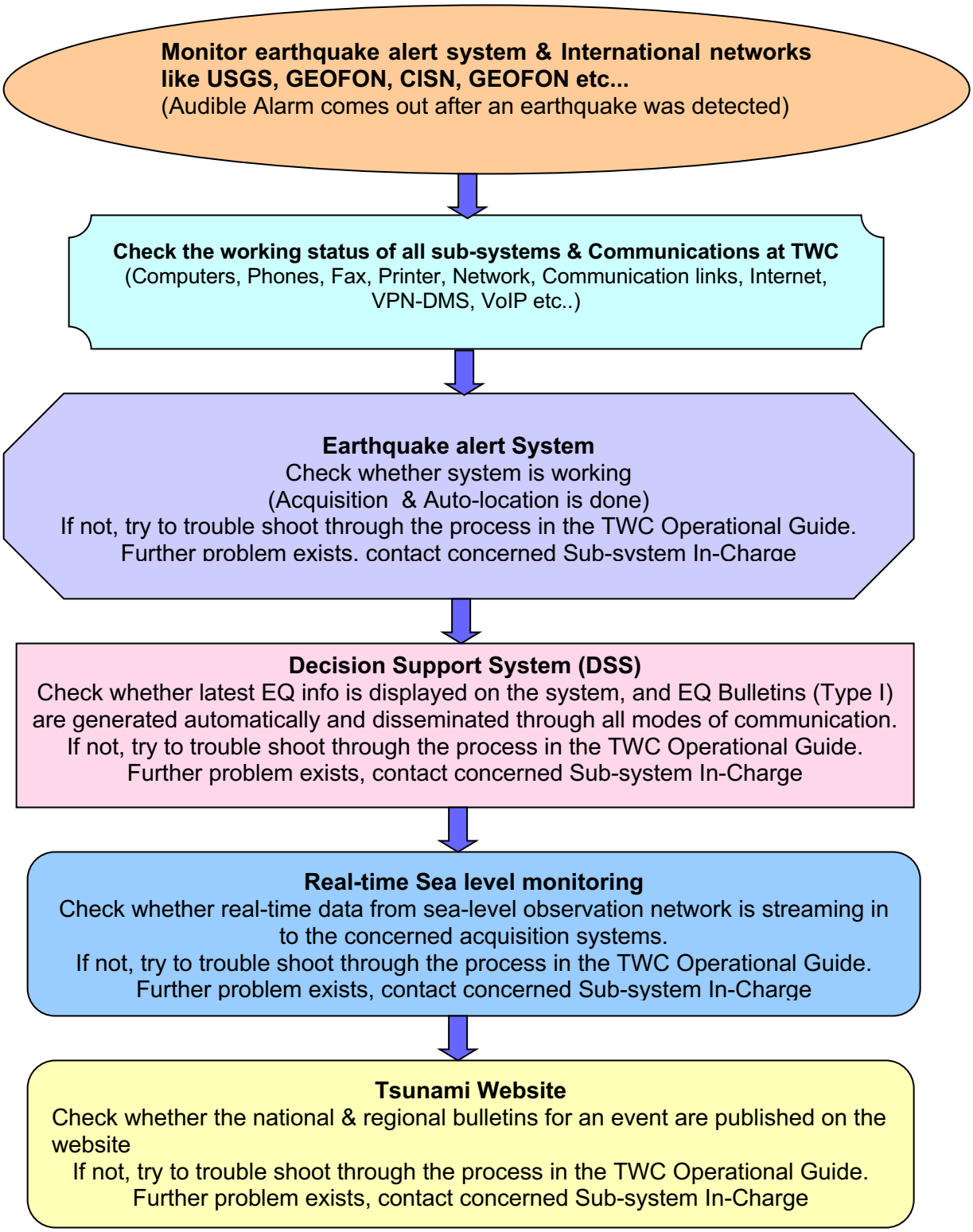
Best regards,

Srinivas

Flow chart of the actions to be taken during major events (Mag ≥ 6.5 for all events in the Ocean & Near Coast (INCOIS, version 2016)



Status checking flow chart for the sub-systems in the Tsunami Warning Centre (INCOIS, version 2016)



NEW ZEALAND – NTWC TRAINING

From: **Lara Bland [NEMA]** <Lara.Bland@nema.govt.nz>
Date: Sun, Aug 6, 2023 at 11:58 AM
Subject: NZ - NTWC Competency Framework
To: Laura Kong - NOAA Federal <laura.kong@noaa.gov>

Hi Laura,

Apologies I couldn't get this any sooner – it took a while to coordinate the information from the various teams.

As you might be aware, in NZ NEMA is the NTWC, issuing warnings. However the scientific monitoring and assessment is performed by GNS and we work closely together in tsunami events, effectively 'sharing' the NTWC role. This obviously impacts what training staff receive (eg there is much more emphasis on science competency at GNS). I've therefore collected info from both GNS and NEMA to answer the questions about training as they're both relevant here.

National Geohazards Monitoring Centre/GNS Science ***(Monitoring and Assessment)***	**Monitoring, Alerting and Reporting Centre/NEMA** ***(Warnings)***
Profile of staff - background, experience for the staff you hire (degrees, topic, etc)	
• Degree in Earth Science • Willingness to learn • Professional experience preferred (ie experience outside of academic/educational environments)	· Ability to work in a challenging and time-critical environment • Experience operating in a systems-based environment utilising standard operating procedures • Experience communicating with diverse audiences and presenting to senior decision makers • Experience applying the Intelligence Cycle and producing a range of Intelligence products · Knowledge/experience of emergency management processes and planning • Experience working in a 24/7 operational environment, including shifts • Experience using common social media platforms • Experience operating a geospatial information system • Attention to detail · Knowledge of the Machinery of Government • Initiative and problem-solving abilities • Flexibility and ability to adapt in constantly changing circumstances • Professionalism and integrity • Personal reliability and resilience • Ability to quickly pick up systems or technology

	• Risk assessment capability • Proactive approach • Enthusiasm and eagerness • Customer focus/service industry mindset
Length of NTWC training before they are 'live'	
• 3-9 months	• 4 weeks to go on shift as a watch officer • Another 4 – 6 weeks once on shift to be assigned a 'sub function' role as either 'Intelligence' or 'Publisher' (supported/led by Watch Leader)
Syllabus of Training - topic, length, how to assure ready (tests, practicum, or ?), medium used for training (live, offline software, observer, hands-on, classroom, online, etc)	

Tsunami training comprises:
• A general introduction to tsunami science and hazards involving readings such as the Bell et al 2014 paper on slow rupture events, and recorded lectures from scientists on tsunami causes and mechanisms etc.
• Reading and understanding the TOAST guidelines and relevant SOPs
• 'Hands on' training using the TOAST tsunami simulation tool in local, Kermadec, and regional scenarios
• Following training, a competency assessment where the trainee has to produce the correct maps for a variety of scenarios as listed above, each within 5 minutes, to the satisfaction of their Shift Leader
• For operation of the DART buoy system, there is background reading, and study of SOPs and guidelines concerning DARTs, then the trainee works through a series of SimTutor modules and exercises, which discusses the function and operation of the DART system and its CDDS interface in great detail. Their Shift Leader then
	Training comprises:
	• 2 weeks initial training (Monday to Friday) focussing on
	  ○ our agency
	  ○ key working relationships (including GNS Science – Geological Hazards advice and Metservice – Weather advice)
	  ○ Introduction to hazards and hazard monitoring systems
	• 1 week of drilling (multiple per day)
	• 1 week shadowing a watch team
	• Once 'sub- function' role is identified, further specific training is completed
	Training utilises:
	• record of learning/training log,
	• in-person exercises
	• in-person training of SOPs
	• in-person training of tools
	• in-person training of software
	At first, there is a specific trainee/trainer environment and then after 4 weeks the learning continues 'on shift' with their Watch Team and overseen by their Watch Leader.
	At the handover from Trainer to Watch Leader a development plan is set and tracked thereafter.

assesses their competence through less formal assessment and observation.
 	
Tests:
 	
• Written
• In-person observation of
  • Picking
  • Exercising
• Online software where available	

National Certification - do you have a formal certification, or not? how long? how to re-certify?	
• Internal certification only • After completion of their initial training, each Analyst has to recertify every year, to prove ongoing competence and prevent skill fade. This involves completing a TOAST competency assessment (similar to the one conducted during initial training) twice a year, and also carrying out a range of DART buoy operations • Regular exercises/drills	• Internal validation process only. • When deemed ready by the Watch Leader, the staff will go through a validation process consisting of two supervised drills. Areas in need of further development areas are noted and resolved. • Once validated in one subfunction (Publisher or Intelligence), the Watch Officer will then begin development/training for the other subfunction, repeating the validation process. • Regular exercises/drills

A couple of other points that might be relevant:

- Both parties also fill these duties for other hazards (volcanic activity, landslides, earthquake) and NEMA also plays a role in severe weather response - therefore the NTWC is not solely a Tsunami-focussed facility
- The NEMA Monitoring, Alerting and Reporting (MAR) Centre has a three-person Watch Team comprising a Watch Leader, Watch Officer (Publishing) and Watch Officer (Intelligence). The GNS NGMC runs a three to four person team, including a Shift Leader.

I hope this is what you were looking for.

Thanks
Lara

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Emergencies can happen any time, anywhere. You can take steps to be prepared

Operational Competency Requirements for PTWC Watchstanders (version 2016)

Distant Events:

1. Recognize pager messages for distant events
2. Quickly, and with sufficient accuracy, determine the earthquake location, depth, and magnitude
3. Know which TWC is authoritative for any earthquake location and how the earthquake parameters are coordinated between TWCs for messages.
4. Know the criteria for each type of message product (information, watch, warning, advisory) for each ocean basin (Pacific, Indian, Caribbean) and for Hawaii.
5. Know how to issue messages, including checking that they were transmitted, and manually retransmitting them if necessary.
6. Know how to check the website and correct it if necessary.
7. Know how to execute the call down list for each ocean basin, including contacting threatened countries when necessary.
8. Know how to confirm and evaluate a tsunami with all available information, including getting additional seismic data, accessing and measuring sea level data, reviewing historical data, running the Whitmore and SIFT models, monitoring news reports, and getting reports from countries.
9. Know procedures for issuing supplemental messages, including cancellations.
10. Know how to deal with media inquiries.
11. Know how to deal with other telephone inquiries (public, country, NOAA, NWS).
12. Know the role of the WFOs and how to interact with them.
13. Know how to interact with Hawaii State and County Civil Defense Agencies.
14. Know how to operate as the backup for WC/ATWC.
15. Know the follow-up activities – paper file, significant event report, timeline, saving sea level data, etc.

Hawaii Events

1. Recognize pager messages for Hawaii events.
2. Know when to issue a heads-up message
3. Quickly and accurately determine the earthquake location, depth, and magnitude.
4. Know the criteria for each type of message product (information or warning) and which counties each applies to.
5. Know how to issue messages, including checking that they were transmitted, and manually retransmitting them if necessary.
6. Know how to check the website and correct it if necessary.
7. Know how to execute the call down list for a local event.
8. Know how to confirm and evaluate a local tsunami with all available information.
9. Know procedures for issuing supplemental messages, including cancellations.
10. Know how to deal with media inquiries.
11. Know how to deal with other telephone inquiries (public, state and counties, NOAA, NWS).
12. Know the role of the HFO for a local event and how to interact with the HFO.
13. Know how to interact with Hawaii State and County Civil Defense.

14. Know the follow-up activities – paper file, significant event report, timeline, saving sea level data, etc.

Additional Competencies for Senior Watchstanders

1. Have strategy for assigning operational tasks to duty staff during events
2. Know how to collect information and make decisions regarding products, especially warnings and cancellations

Specific Process Competencies:

1. TeleEQ
2. LocalEQ
3. nquake
    a. location
    b. depth
    c. map
    d. historical data
    e. observatory message
4. wneic
5. pick
    a. P
    b. Pp
    c. Hypocenter
6. Mwp
7. SMAG
8. PMAG
9. Mm
10. Theta
11. tttool
12. tsueta
13. Messaging Software
    a. pacbul
    b. indbul
    c. carbul
    d. hawaii
14. Watertool
15. Tide Station Interface (TSI)
16. Web Interface to Trigger DARTs
17. Whitmore model
18. SIFT
19. WC/ATWC Messaging

PTWC Lead Watchstander Assessment

Version of 12/8/2009

The purpose of these questions is to test a watchstander's knowledge of PTWC procedures and systems to make sure they are ready to accept and carry out the responsibilities of a lead watchstander. The results of the examination should also illuminate areas of weakness which can be remedied by further study.

Part 1: Procedures

A. Local (Hawaii) Events

a. How does a watchstander know that a local earthquake requires some official response from the PTWC? Explain the rationale for this.

b. If an official response is required, what is the first thing the watchstander should do?

c. Describe the steps needed to determine the hypocenter and magnitude of a local event.

d. Summarize what procedure should be followed for an earthquake on the Big Island with a magnitude of 6.0?

e. Summarize what procedure should be followed for an earthquake on the Big Island with a magnitude of 7.0?

f. Is a conference call with State Civil Defense needed?

g. How would your answer to “d” change if the earthquake occurred near Maui?

h. How would your answer to “e” change if the earthquake occurred near Maui?

i. Describe how depth and location (offshore or inland) affect which product is issued.

j. Under what conditions would the entire state of Hawaii be placed in a warning with the initial PTWC message?

k. You have issued an initial limited warning to the state of Hawaii for an earthquake on the Big Island. What conditions would cause you to upgrade to a State-wide Warning?

l. Same as question k, but you initially issued a Tsunami Information Statement instead.

m. You have issued a Urgent Local Tsunami Warning to Hawaii. Under what conditions do you cancel the warning?

B. Pacific Events

a. List seven situations in terms of earthquake magnitude, depth and location for issuing Tsunami Information Bulletin to the Pacific.

b. Explain the difference in criteria between a Fixed Regional Tsunami Warning and an Expanding Tsunami Warning and Watch.

c. What area is covered by a Fixed Regional Tsunami Warning?

d. What area is covered by an Expanding Regional Tsunami Warning and Watch?

e. Explain the rationale for having the Fixed Tsunami Regional Warning product.

f. A TIB is issued to the Pacific for a shallow underwater earthquake. What can you say about the earthquake's magnitude and location? What does it say in the evaluation section?

g. A Pacific Basin Earthquake (outside of Hawaii) has occurred. List the conditions under which a Tsunami Advisory Bulletin is issued to the State of Hawaii.

h. A Pacific Basin Earthquake (outside of Hawaii) has occurred. List the conditions under which the State of Hawaii is placed in a Watch.

i. You have just issued a Tsunami Warning Bulletin to the Pacific Basin. Write an outline of the contents of the bulletin including all headers for the international Bulletin. What does it say in the evaluation section?

j. Describe the region of the Pacific for which WC/ATWC has the primary resoponsibility for the earthquake parameters.

k. Describe the region of the Pacific for which JMA has the primary responsibility for the earthquake parameters.

l. A Pacific Basin earthquake has just occurred. Under what conditions do we coordinate with WC/ATWC? Under what conditions do we coordinate with JMA? How do we coordinate with JMA?

m. A Magnitude 7.0 earthquake occurs off of the west coast of Oregon. What is PTWC's procedure in this case? What type of Bulletin does PTWC issue internationally and to the State of Hawaii? What is Alaska's procedure in this case?

n. A Magnitude 7.5 earthquake occurs off of the west coast of Oregon. What is PTWC's procedure in this case? What type of Bulletin does PTWC issue internationally and to the State of Hawaii? What is Alaska's procedure in this case?

o.

p. Under what conditions should a Pacific-Wide Tsunami Warning Bulletin be the initial bulletin issued?

q. You have previously issued a TIB. List three scenarios under which you would elevate the TIB to a Fixed Tsunami Regional Warning. Are their any scenarios in which a TIB could be upgraded to an Expanding Regional Warning?

r. What is the maximum time that should elapse between the issuing of supplemental international bulletins? You can issue supplemental bulletins more frequently than going by the clock. List conditions that would lead you to do that.

s. When should a conference call with the State Civil Defense and its Tsunami Advisors be initiated?

t. You have issued a Pacific Regional Tsunami Warning and Watch for your initial bulletin. List three scenarios depending on wave height data or other information (or lack thereof) as to what bulletin may need to be issued next.

u. Under what conditions should a Pacific warning be cancelled?

v. By what time must a decision to issue a Warning to the State of Hawaii be made for a Pacific Basin event outside of Hawaii?

w. You have issued a Tsunami Warning Bulletin for the Pacific. Who or what should get called?

x. Under what circumstances is it necessary to notify NWS Headquarters regarding an event?

y. A second earthquake has occurred. How do you handle two earthquakes in ops?

z. You have issued an Expanding Tsunami Warning and Watch to the Pacific for a large earthquake in the Southwest Pacific. On the basis of the geography and available data, i.e., Dart and/or coastal tide gauge data, you conclude that the tsunami presents no danger to the Northwest Pacific, what action might you take with respect to the Warning Bulletin?

aa. In the context of Tsunami Warning, what is considered a deep earthquake without the potential to generate a significant tsunami?

bb. A shallow earthquake with a magnitude of 7.4 has occurred off the coast of Oregon. Twelve minutes have elapsed and you have not seen ATWC's bulletin. Describe what you should do.

C. Indian Ocean Events

a. List the four type of bulletins issued to the Indian Ocean and the criteria for issuing them.

b. Under what conditions is the U.S. State Department contacted?

c. You have issued a Regional Tsunami Watch Bulletin for an Indian Ocean event. What will it say in the evaluation section?

d. Why is there no official warning product for the Indian Ocean?

e. Who is our primary backup for the Indian Ocean?

f. A large earthquake happens in the Andaman Islands. Give the most probable sequence of events starting with the earthquake itself leading up to issuing the first bulletin.

D. Caribbean / Atlantic Events

a. Describe PTWC's and WC/ATWC's AOR in the Caribbean and Atlantic.

b. An earthquake with a magnitude of 7.7 occurs on the Ascension fracture zone. What type of official message product is issued by PTWC?

c. An earthquake with a magnitude of 6.6 occurs off the coast of Puerto Rico. Describe PTWC procedures for such an event.

d. An earthquake with a magnitude of 8.1 occurs in the South Sandwich Arc. Describe PTWC procedures for such an event.

e. An earthquake with a magnitude of 7.0 occurs in the Caribbean Basin. Describe PTWC procedures for such an event.

Part 2. Earthquake Processing

A. Local Events

a. Describe the nature and origin of SPLERT's pick streams.

b. What program lists the last 50 or so hypocenters generated by SPLERT?

c. What two systems contribute hypocenters to the above program?

d. On what basis do you select a hypocenter from the aforementioned list?

e. Name three broadbands on the Big Island that PTWC receives data from.

f. What is the name of the program that executes the interactive local magnitude calculations? What type of magnitudes does it calculate?

g. A large local earthquake has occurred. SPLERT is not working. How do you generate a hypocenter and compute a magnitude?

h. What is pMag? Of what use is it in operations?

i. What program is run to ascertain SPLERT's status?

j. SPLERT has a problem. You shut it down with what program? You restart it with what program? If you don't know offhand the name of the program that starts SPLERT, how would you go about finding it?

k. How do you check the latency of the local seismic streams?

l. PTWC is missing local data on both loading docks. How do you figure out whether the problem is the PDC link or the Crest link? Once you figure out which link is down, what do you do next? (Note: Make believe Stuart W. or Nathan are far, far away.)

B. Teleseismic Events

a. On what systems is the teleseismic picker running?

b. In what workspace is the associator running? Within what suite of software is it running?

c. The program _____ takes hypocenters from the _____ and writes them to a file.

d. Clicking on the Tele-Eq GUI results in what actions?

e. nquake gets its picks from the files _____ and _____. Nquake gets station information from what file?

f. You have received picks from our automatic solutions. You notice that the wneic program shows that NEIC has developed a preliminary location. How would you combine the automatic/manual picks with NEIC's picks? By the way, when is the wneic started? How can you start it manually?

g. You just made a number of manual picks. Somebody else clicked on an automatic solution. What problem might this cause?

h. The PICK GUI has what inputable fields? What affect do they each have on PICK? What location program does PICK execute? How do you make a pP pick on the pick GUI?

i. What are the three curves on a Mwp station plot? What is the best guideline for picking a magnitude on the Mwp station plot?

j. Describe the clickable functions on the SMAG, MM and BMAG GUIs. How do you write their respective magnitudes to the COMF file? What does “PEND” mean next to a station name? “COMP” ?

k. What is Theta? Describe the elements of the Theta graph. How can theta be used in operations?

l. BMAG exceeds SMAG by .5 units. What can you say about the earthquake with some degree of confidence?

m. Where do you go to get an idea of what seismic data outages exist (if any)?

n. Somebody pulled the plug on a loading dock. The system has come back up. What must you do to bring that loading dock completely back to life so that all of the available data is being funneled to the twseis computers?

o. How many DigitalAlarm programs are running on each system? What is their function?

p. What 4 curves are present on the MM graph? What guidelines do you use for picking a good Mantle Magnitude? What would indicate a slow earthquake on the MM graph?

q. How do you send an observatory message? How do you issue a QDDS revision or retraction?

r. Four curves are plotted on the MM GUI graph. What are they? A slow earthquake occurs. What do you suppose the MM GUI graph would look like?

s. How do you add or delete a channel to a Sentinel?

t. A. seismic station is imported from NEIC only to ewb. Explain how this station eventually winds up for use on both lulu and kaku. Name and state the softwares involved and what they do.

u. What is NEXUS?

v. Give 5 station codes for broadbands in the Western Pacific, Caribbean, South America, Indian Ocean, Western US. The stations must be ones currently received by the PTWC.

Part 3. Sea-level Processing / Tsunami Forecasting

A. Watertool/Tide Tool/Coastal Gauges/DARTs

a. PTWC acquires GTS data how and from where? Where is it logged?

b. Tide Tool requires 4 files (I'm not proud of that by the way). Can you name them? Ok, can you name any of them?

c. How do you startup Watertool?

d. What are the mouse clickable functions on the Watertool display widget? (They are the same for Tide Tool)

e. You are told that the GTS feed will be interrupted for a period of time. What backup (imperfect though it may be) do we have? (Hint: It is in the One GUI) Where does this backup get the data from? What else can we do to get sea-level information?

f. Name three agencies outside of the US that contribute sea-level data over the GTS.

g. How do you record tsunami wave parameters with Watertool? What are the parameters that can be recorded? Bonus question: Where are those parameters recorded?

h. You're not sure to what extent a sea-level station has open access to the ocean or in what direction the mouth of the harbor is facing. How do you find out using Watertool?

i. PTWC receives sea-level data from sources other than GTS. How does local, real-time sea-level get ingested into our system? Foreign near real-time sea-level data?

j. What are the advantages and disadvantages of coastal sea level gauges versus deep ocean gauges for detecting and measuring tsunamis and for forecasting tsunami impacts?

k. What is the range of periods for tsunami waves? What might the period of a tsunami wave be indicative of?

l. What is a DART and what does the acronym DART stand for? What organization developed the DART? What organization is responsible for deploying and maintaining the DARTs?

m. The DART system has two modes of transmission, standard and trigger mode. In the standard mode, what is the sampling interval? What is the transmission interval?

n. In DART trigger mode there are three different transmission intervals. What are they, and what is the sampling mode and number of data in each? Once triggered, how long does a DART stay in trigger mode?

o. Describe how to manually put a DART into trigger mode (at least two ways). What constraints are there? Why don't we test manual triggering frequently?

p. How might a DART otherwise go into trigger mode (two ways). What is the most common way that a DART is triggered (not considering internal technical problems).

q. Describe what you can about the size of a tsunami signal on a DART gauge. What size signal do you think might indicate a destructive teletsunami?

r.

B. Travel Times / Whitmore Model / SIFT

a. What are two ways tsunami travel-times can be computed on the PTWC system?

b. Describe the limitations/weaknesses of PTWC's travel times in how they are calculated and how they might be used.

c. When should you compute travel-times?

d. Which method creates a map? Which is the preferred method used to generate travel-times for bulletins?

e. Because both methods for generating travel-times write to the same file, what do you need to be careful about?

f. Tsunami travel-time are computed for sea-level station locations and for _____ locations.

g. Where can you find the location information used in travel-time computations?

h. How can you start either of the two methods?

i. Describe in principle how the Whitmore forecast model works.

j. Where do you find the Whitmore model in PTWC operations?

k. For what coastal locations does the Whitmore model make a forecast (general answer)?

l. How do you constrain the Whitmore model with the seismic parameters and sea level data?

m. What does the acronym SIFT stand for?

n. How does SIFT work? I'm just looking for the most basic description from entering eq information to execution and presenting results.

o. SIFT has a number of GUIs. Can you name four and state the purpose for each?

p. What products does SIFT produce?

q. On the main map with all of the layers that SIFT produces for each simulation, describe as many of the features plotted on this map as you can. What mouse clickable functions can you perform on the map?

r. You decide you need to adjust the source parameters used for the simulation. How do you do it? How do you bring up the GUI that allows you to do the adjusting? What can you adjust?

s. Describe the GUI that lists the maximum wave heights for each location in the database. What is this GUI titled? What mouse clickable functions can be performed?

t. You notice that SIFT tended to grossly underestimate the wave hights observed at the DART buoys. What might you consider doing with respect to forecasts for coastal areas?

Part 4. Messaging Details

A. Messaging Software

a. List the names of the four messaging software programs PTWC uses to send official bulletins? List three ways they may be invoked.

b. For teleseismic events, list all of the communication pathways over which a bulletin is sent from PTWC for A) a Pacific event B) an Indian Ocean event, and C) a Caribbean Event.

c. How can a watchstander make sure that a product was successfully issued via each communication pathway?

d. What program updates the website?

e. PTWC utilizes the GTS of the WMO as its primary recommended method to communicate its products internationally. What do the acronyms GTS and WMO stand for?

f. PTWC products have unique WMO Product IDs. Can you name any of them and what products they correspond to?

g. What is the four letter code in all of PTWC's WMO Product IDs that indicates the product came from PTWC? What do each of those four letters represent?

h. How are PTWC products disseminated domestically? For example, how do they get to the Honolulu forecast office? How do they get to the media?

i. In the software for issuing products to the State of Hawaii, there are two main categories of product choices in the main menu. What are those two categories?

j. How are the Hawaii products from PTWC

k. What program composes the Observatory message?

l. You need to edit a bulletin. How do you do that?

m. The last pop-up for the observatory message comes with 4 options. What are they? Explain what course of action each option leads to.

n. Why should you never edit the hypocenter parameters in an observatory message?

o. Is the lettering in a Bulletin case sensitive? What case? What are the only punctuation marks you should ever use?

p. Because they have a local earthquake problem, but no local tsunami warning system, which US territories will key off of our observatory message.

B. Circuits

a. What does AFTN stand for? GTS? IDN?

b. Which messaging circuits are only available in the US?

c. What circuits involve communications through the Port-Servers?

d. The sending of test messages on the GTS fails, however, we are receiving messages. What are the possible causes? How do you troubleshoot?

e. The AFTN computer crashed. How do you restart the AFTN? By now, you should know the procedure by heart.

f. Restarting the AFTN doesn't fix the problem, who do you call and where do you find the number?

g. The socket-2-socket software that handles the GTS data, receives the data from where? This software is comprised of two programs; the one that receives the data is called _____ runs on the computers _____ and _____, and listens on what port #? The program that sends messages from PTWC to _____ is called ?

h. Describe the functions of the FAA, GTS and NWW logging windows.

i. Faxes are sent how?

j. How do you update the FAX list?

Part 5. Event Management

a. Describe the types of information available on the plasma display?

b. On what types of information would you base your decision to cancel a warning or upgrade a warning?

c. Describe your general approach to handling the media and questions from the media during warning events.

d. Describe your general approach to interacting with Hawaii Civil Defense during warning events.

e. When would you call in other watchstanders to help during events? What assignments would you make to the other watchstanders?

f. What other parts of our own organization (NOAA, NWS) might we interact with during events and why?

g. As lead, what will be your main areas of concern during events? What do you need to monitor and ensure it gets done?

h. Describe activities that need to be done after a warning event?

US National Tsunami Warning Center (2016)
(formerly West Coast and Alaska Tsunami Warning Center, WC/ATWC)

Tsunami Duty Scientist training plan (WC/ATWC version)

NOTE: Sections 0-5 are common to both PTWC and WC/ATWC. Sections 6-11 have some items which are unique to each center.

Goal: To prepare new personnel for shift or standby duty at a Tsunami Warning Center

Instruction:
Sections will be taught either by existing personnel who are focal points for that subject, by invited experts, or be self-taught from reference material. The TWC Video-Teleconferencing Equipment will be used to connect training sessions as appropriate.

Validation:
Each TWC director or Tsunami Warning Science Officer will certify the new personnel have completed all aspects of the training and demonstrated their competency prior to the start of operational duty.

Section 0: New Employee Training

1. IT Security
2. Government vehicle use
3. Purchasing
4. Travel (travel card)
5. Duty hours
6. Ethics, etc.

_____ New employee training completed

Section 1: Facility Orientation

1. Building security
2. Fire alarms
3. Emergency Action Plan
4. Disaster Preparedness Plan
5. Mechanical systems
6. Safety/environmental briefing

_____ Facility orientation training completed

Section 2: The Tsunami Warning System

1. History
2. Mission
3. Components
    a. The TWCs
    b. Communications
    c. Emergency Response Agencies
    d. Research
    e. Outreach and education
4. Organizational Structure
    a. Dept. of Commerce
        i. NOAA/NWS
        ii. NWS Regions

b. UNESCO/IOC/ICG/ITSU-IOTWS
c. NTHMP
d. TTRC

5. TWS Partners
    a. NOAA
        i. PMEL
        ii. NESDIS
        iii. NGDC
        iv. NOS
        v. NWS-WFOs
        vi. Joint Institutes
    b. Emergency Management
        i. FEMA
        ii. State Agencies
        iii. County/Local Agencies
    c. USGS
        i. NEIS
        ii. Volcano Observatories
        iii. CREST
        iv. Regional Networks
    d. IRIS
    e. FEMA
    f. IOC/GLOSS
    g. GEOSS
    h. TWEAK
    i. Universities
    j. Professional Societies

_____ Tsunami Warning System organization training completed

Section 3: Earthquakes 101

1. Basics
    a. Fault sources and types
    b. Plate tectonics
    c. Wave types and properties
    d. Phases and earth interior
    e. Location/magnitude basics
        i. Location techniques
            1. WC/ATWC
            2. Local/regional methods
        ii. Associators
        iii. Magnitudes
            1. Ml
            2. Ml (WC/ATWC)
            3. Md
            4. Mb
            5. Ms
            6. Mw
            7. Mwp
            8. Mm
            9. New techniques
    f. Fault plane solutions
    g. Synthetic seismograms
    h. Inverse models
        i. CMT

        ii. Finite fault models
    i. Strong motion seismology and shake maps
2. Seismogram Interpretation
3. Important Historic Earthquakes
4. Earthquake Prediction/Seismic gap hypothesis
5. Signal Processing
    a. Digitization – Nyquist frequencies
    b. Convolutions/Correlations
    c. Filtering
    d. Spectral analysis

_____ Basic seismology training completed and competency demonstrated

Section 4: Tsunami 101

1. Tsunami Generation
    a. Mechanisms
        i. Earthquakes
            1. Magnitude influence
            2. Depth influence
            3. Focal Mechanism
            4. Slip Distribution
            5. “Slow” Earthquakes
            6. Static displacement formulae
        ii. Landslides/Slumps
        iii. Volcanoes
        iv. Meteor Impacts
    b. Source Zones
        i. Pacific Basin
        ii. Pacific Marginal Seas
            1. Bering Sea
            2. Sea of Japan
            3. South China Sea
            4. Indonesia Seas
            5. Tasman Sea
        iii. Indian Ocean
        iv. Caribbean Sea
        v. Atlantic Ocean
        vi. Mediterranean Sea
    c. Source Characteristics
        i. Wave Period
        ii. Directionality
        iii. Size
        iv. Complexity
            1. Slip Distribution
            2. Segmentation
            3. Water Depth
            4. Land masses
2. Wave propagation
    a. Speed
    b. Amplitude
        i. Deep Ocean
        ii. Spreading
        iii. Bathymetric focusing
        iv. Reflections
        v. Barriers

1. Continents
2. Islands
3. Island Chains

vi. Attenuation

c. Currents
d. Dispersion
e. Number of Waves

3. Shoreline Impact
    a. Range of Impacts
    b. Islands
        i. Wrap Around
        ii. Multiple Waves
        iii. Edge Waves
            1. Islands
            2. Continental Shelf
    c. Local resonance
4. Wave Observations
    a. Tide gage records
    b. DART records
    c. Altimetry records
    d. Video/Photo
5. Long wave theory
6. Hydro-dynamic equations of motion and continuity
7. Modeling basics
    a. Finite difference approach
    b. Source definition
        i. Earthquake
        ii. Landslide
    c. Propagation – terms in equations
    d. Inundation
    e. Other approaches – finite element, scale models, 3D volume of fluid
8. Tsunami travel times
    a. Equation derivation
    b. WC/ATWC technique
9. Tide prediction
    a. Basics
    b. Techniques
10. Bathymetric data
    a. NGDC
    b. TIME center
    c. Other sources
11. Tsunami History
    a. US – Pacific
    b. Rest of Pacific
    c. US – Atlantic
    d. Rest of Atlantic
    e. Indian O.
    f. Caribbean
    g. Other
12. Paleotsunami studies
13. Historical tsunami data bases

_____ Tsunami science training completed and competency demonstrated (1-9)

_____ Historical tsunami training completed (10-12)

Section 5: Data acquisition

1. Seismometry
    a. Seismometer principles
    b. History of the instruments
    c. Types:
        i. Short period
        ii. Long period
        iii. Broadband
            1. Operating Principles
            2. Models
        iv. Strong motion
            1. Operating Principles
            2. Models
    d. Seismometer installations
        i. Vault design principles
        ii. Vault construction
    e. Seismic digitizers
        i. Principles
        ii. Models
    f. Instrument Response
        i. Response basics
        ii. Complex representations
        iii. Application of response to data
        iv. Dataless SEED files
2. Seismic data transmission and system operation
    a. Analog
    b. Digital
        i. VSAT
        ii. Satellite Internet
        iii. Leased Line
        iv. Internet
    c. Seismic lab interconnections (Crestnet, Internet)
3. Seismic Networks
    a. WC/ATWC
    b. PTWC
    c. TWC cooperating networks
4. Sea Level
    a. Coastal gages
        i. Basics
        ii. Types
            1. Bubbler
            2. Float
            3. Sonic
            4. Radar
            5. Pressure transducer
        iii. Frequency response
        iv. Data transmission
            1. Different options
            2. Paths to TWC
        v. Networks
    b. Deep Ocean Pressure Sensors
        i. Basics
        ii. Pressure sensor
        iii. Surface buoy
        iv. Dart 1/2 designs

v. Data transmission

5. Other data
    a. Satellite altimetry
    b. GPS

_____ Data acquisition training completed and competency demonstrated

Section 6: Data Processing

1. Seismic Analysis
    a. TWC data processing history and background
    b. Earthworm platform and ring structure
    c. Signal acquisition and transmission format
        i. Naqs2ew, for example
        ii. Import/export
        iii. Ring2coax
    d. Earlybird: Overall architecture and interconnectivity
    e. Disk writing format
    f. P-picking and Alarms
        i. Single Station
        ii. Regional
    g. Earthquake locations and associations
        i. Hands-on training with EarlyBird
        ii. Special tips and techniques
    h. Magnitudes and mechanisms
        i. Ml
        ii. Mb
        iii. Ms
        iv. Mw
        v. Mwp
        vi. Mm
        vii. NEIC CMT
    i. Alarm types and notifications
    j. Graphical Interfaces
        i. Develo
        ii. LPProc
        iii. Hypo_display
        iv. Mm
        v. NEICCMT
        vi. Latency monitor
        vii. Analyze
        viii. Locate
        ix. Summary
        x. Messages
    k. Other centers' parameters
        i. CISN Display
        ii. RegionVu
        iii. NADIN2
        iv. Others – NEIC, HRV, AEIC, etc.
2. Geographical Information System
    a. EarthVu
        i. Connectivity with EarlyBird
        ii. Overlays
            1. Historical Data Bases
            2. Others
        iii. Options

        iv. CloseVu
        v. RegionVu
        vi. TTVu
        vii. WebVu
    b. Web site updates
3. Sea level processing
    a. Signal acquisition
    b. Filtering
    c. Tide prediction
    d. Display programs
    e. DART alarms
    f. Dial-up backup
    g. After-event data retrieval
4. Tsunami modeling software
    a. Present forecasting method
        i. Data base
        ii. Application during events
        iii. Pros and cons
    b. Upgraded local methods
        i. Application to IOT
        ii. Future applications
    c. PMEL SIFT
        i. Background
        ii. Application during event
5. Tsunami Travel time software
    a. Travel time data bases and their creation
    b. Software description
6. Miscellaneous routines
    a. TsunamiWatcher
    b. QDDS
    c. Daily SEISMO evalutations
    d. Others
7. System startup and reboot procedures

_____ Competency demonstrated in all aspects of TWC data processing

_____ 200+ events have been post-processed (WC/ATWC)

_____ 50+ events have been processed in real-time (WC/ATWC)

Section 7: Procedures

1. Directives
2. Area-of-Responsibility
    a. Breakpoints
    b. ETA points
3. Communications Plan (ITSU/IOTWS)
4. Operations Manuals (PTWC-WC/ATWC)
5. Thresholds
    a. Atlantic
    b. Pacific
    c. Indian Ocean
6. Event flowcharts
7. Notification lists
8. Instructions
    a. Ops manual

    b. Hypocenter Summary
    c. Printed message header
9. Performance Goals
10. Backup activation
    a. PTWC procedures
    b. Notifying PTWC backup is necessary

_____ Tsunami Warning Center procedures are mastered

_____ Scenarios have been practiced for all areas within the area-of-responsibility

Section 8: Products

1. Atlantic
2. Pacific
3. PTWC
4. “Public”
5. Web-based
6. NWS format
7. UG codes
8. VTEC
9. QDDS

_____ TWC products training completed and competency demonstrated

Section 9: Message dissemination

1. Primary
    a. NWWS
    b. NADIN2
    c. NWSTG – Line 225
    d. NAWAS
2. Secondary
    a. Email
    b. Pager
    c. VHF radio
    d. Web page
    e. TsunamiWatcher
    f. Phone lists
    g. Fax service
    h. CISN Display
    i. Satellite phone
3. Communication tests
4. Retractions, manual web updates, etc.
5. AWIPS
6. MILITARY

_____ Message dissemination training completed and competency demonstrated

Section 10: IT Architecture

1. Overall plan
2. Internet access
    a. MTA
    b. MPLS
    c. Starband

3. Crestnet
4. Local seismic network communications
5. Message dissemination communications
6. System and personal backups
7. Security
    a. IT Security plan
    b. Harris
    c. Firewall protection/logging

_____ IT architecture training completed

Section 11: Outreach and TsunamiReady

1. Weekly open houses
    a. Powerpoint presentations
    b. Rotation
2. External speaking
3. Dealing with the media
4. Community visits
    a. Normal protocol
    b. Partners
5. TsunamiReady
    a. History
    b. Basis
    c. Criteria
    d. Communities attaining recognition and those near
    e. Tsunami strengthening plan enhancements

_____ Outreach and TsunamiReady training completed

Tsunami Training requirements for Meteorology and Coast Radio Staff (version 2016)

No	**Basic Theory** (COMET online course done locally)	No	**Specialized Training** (local/overseas)	No	**Competencies** (on the job – local and overseas)
1	Tsunamis (1.5 – 2hr)	1	Early Warning and Alert Systems	1	Demonstrated knowledge of Tonga Met Service Forecast, Alert and Early Warning System (Local)
2	Tsunami Warning System (1 – 1.25hr)	2	Tsunami Standard Operating Procedures	2	Demonstrated knowledge of PTWC Tsunami Products and Services
3	Near Shore Wave Modeling (1 – 1.25)	3	Communication of Tsunami Information	3	Demonstrated knowledge of Tonga Met Service Tsunami Procedures
4	Introductions to Ocean Tides (45min)	4	Attachment to Regional Tsunami Warning Centre's (overseas)	4	Demonstrated knowledge of Tonga GSU tsunami and earthquake procedures
5	Rip Current Forecasts (1.5 – 2hr)	5	Attachment to Geological Survey (local)	5	Demonstrated knowledge of NEMO tsunami and earthquake procedures
6	Shallow Water Waves (1 – 1.25hr)	6	Attachment to NEMO (local)	6	Demonstrated ability to disseminate tsunami warning information including dealing with media competence
7	Wave Life Cycle 1 - Generation (1 – 1.25hr)	7	Earthquake Monitoring and Tsunami Observation Systems (overseas)	7	
8	Wave Life Cycle 2 – Propagation & Dispersion (1 – 1.25hr)	8	Tsunami modeling (overseas)	8	
9	Low Level Coastal Jets (1 – 1.25hr)	9		9	
10	Wave Type and Characteristics (1 – 1.25hr)	10		10	
11		11		11	