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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