**National Tsunami Warning Centre Competency Framework**

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**INTRODUCTION**

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 action on the text and graphical products from their Tsunami Service Providers (TSPs). For example, the Pacific Tsunami Warning Centre (PTWC), North West Pacific Tsunami Advisory Centre (NWPTAC) or other centres as they are established. NTWCs may also carry out independent earthquake and tsunami monitoring, detection and response. This document does not cover the Distaste Management Office (DMO) competencies but does cover the need to understand DMO requirements.

To be effective, the NTWC staff need a wide range of competencies in tsunami and earthquake science, as well as in performing 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 basic skills to perform the minimum necessary tsunami warning response tasks. Each Centre should have at least two roles that staff can be assigned to one of them, with each role requiring deferent levels (or tiers) of skills obtained by training, exercises and competency testing.

**TIERED COMPETENCY FRAMEWORK**

The competency framework is built on elements of competencies which can then be grouped into levels or tiers, each has a corresponding qualification for staff to earn upon completion of all required competency elements and the successful test against the predefined performance criteria. At least two tiers are recommended, 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 tier will have a set of core competencies and a set of optional competencies. Additional tiers 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:

***Tier 1: Tsunami incident controller (or manager)***

This tier 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.

***Tier 2: Tsunami incident assistant***

This tier 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.

**COMPETENCIES**

The competencies are listed below, covering the knowledge and skills required to operate in a tsunami warning centre. As it stands, it is a framework only, so additional detail is required if to become the complete competency requirements. Furthermore, some competencies will be generic across all NTWCs, while others (as indicated) will depend on local Member State policies, requirements and procedures. The requirements for each role (based on the examples above) can be defined by listing the required competencies from the list below. The competencies are grouped into five categories:

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

**1.0 Core science knowledge**

**1.1 Have basic tsunami science knowledge**

* + 1. List all known causes of tsunami.
		2. Describe how undersea earthquake cause tsunami.
		3. Explain the basics of tsunami propagation in deep water.
		4. Describe the process of tsunami attenuation.
		5. Explain why and how tsunami wavelength, amplitude and speed change as the tsunami enters shallower water.
		6. Identify the order of magnitude of tsunami properties in deep and shallow water in terms of speed, wavelength and period.
		7. Describe the difference between crest-first and tough-first tsunami in terms of first impacts on the coast.
		8. Describe how inundation is affected by the bathymetry, coastal properties and local tidal conditions.
		9. Explain run-up and the difficulties of forecasting the extent of tsunami runup.
		10. Explain how sea-level gauges measure tsunami.
		11. Outline the limitations of sea-level gauges.
		12. Describe the use and advantages of deep sea tsunameters (e.g. DART Buoys).
		13. Describe how tsunami amplitudes can be dampened or amplified.

**1.2 Have basic earthquake source knowledge**

* + 1. Describe the three earthquake fault types and where they are most likely to be found.
		2. Explain which earthquake fault types are most likely to cause tsunami.
		3. Explain the difference between the basic earthquake terms of epicentre, hypocentre, location and depth.
		4. Describe how earthquake intensity is measured and why it may be useful for tsunami.
		5. Explain how earthquake depth affects the potential for tsunami to be generated.
		6. Explain the earthquake magnitude scale, and the most important magnitude types for tsunami.
		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**

1. List all known causes of tsunami, and demonstrate a detailed knowledge of each.
2. Describe how undersea earthquake cause tsunami, providing detail of the mechanism.
3. Explain the basics of tsunami propagation in deep water and be able to describe dependencies.
4. Describe the process of tsunami attenuation and why it occurs.
5. Explain in detail why tsunami wavelength, amplitude and speed change as the tsunami enters shallower water.
6. Identify in detail the order of magnitude of tsunami properties in deep and shallow water in terms of speed, wavelength and period.
7. Describe in detail the difference between crest-first and tough-first tsunami in terms of first impacts on the coast.
8. Describe in detail how inundation is affected by the bathymetry, coastal properties and local tidal conditions.
9. Explain in detail run-up and the difficulties of forecasting the extent of tsunami runup.
10. Explain the principles and practicalities of how sea-level gauges measure tsunami.
11. Explain in detail the limitations of sea-level gauges compared with other methods of measuring sea level for tsunami.
12. Describe in detail how tsunami amplitudes can be dampened or amplified.
13. Describe the use and advantages of deep sea tsunameters (DART buoys), and how they can be used to calibrate tsunami forecast models.
14. Describe when the tsunami threat is likely to have passed, and what residual threat may remain.

**2.2 Advanced earthquake source knowledge**

1. Describe the three earthquake fault types and where they are most likely to be found, both within the Pacific and nationally.
2. Explain which earthquake fault types are most likely to cause tsunami, giving reasons and exceptions.
3. Explain the difference between the basic earthquake terms of epicentre, hypocentre, location and depth and their relationship to tsunami generation.
4. Describe how earthquake intensity is measured and why it may be useful for tsunami threat estimation.
5. Explain how strong motion amplitude and extent can be used to estimate likely earthquake magnitude and rupture dimensions and the resulting tsunami impacts.
6. Explain how earthquake depth affects the potential for tsunami to be generated.
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.
8. Outline the magnitude estimation types which are particularly useful for tsunami characterisation (MW, MWP, MWW, etc.), including advantages and limitations.
9. Describe the differences and importance of unilateral or bilateral slip of a fault and compare uniform slip with non-uniform slip.
10. Explain how magnitude, rupture length, rupture width and slip are related, and the importance for tsunami generation.

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

[list of competencies which will depend on local systems and procedures. Shall we include an example set in this document?] **HELP NEEDED TO COMPLETE**

1. Example competency 1
2. Example competency 2

**3.0 Core operational competencies**

**3.1 Can understand and use TSP text and graphical products**

[list of competencies. Will depend on TSP. Use PTWC as an example?]**HELP NEEDED TO COMPLETE**

1. Competency 1
2. Competency 2

**3.2 Can use a core set of decision support tools**

[list of competencies]

1. Acquire earthquake information from specified providers and/or website/applications such as NEIC website and CISN Display.
2. Apply earthquake source information to the predefined threshold table, factoring their limitations.
3. Calculate tsunami travel times at nationally specific locations by running own application or acquiring them from the provider, noting their limitations.
4. Understand how the scenario database is generated through pre-calculated tsunami forecast modelling.
5. Select from the scenario database the closest one to the current earthquake event and then make threat assessment.
6. List the available sources of real-time sea level observations and use them to confirm tsunami and monitor its propagation across ocean.

**3.3 Can perform all core activities in the National Tsunami Warning SOPs**

[list of competencies ***will depend on national SOPs*** – the main categories are listed below]

* 1. Continuously monitor and respond to TSP messages.
	2. Continuously monitor the seismic and tsunami situation.
	3. Observe and record seismic and tsunami events and parameters .
	4. Ensure the quality of the performance of systems and of seismic and tsunami information.
	5. Communicate significant earthquake information and tsunami information to internal and external users.

**3.4 Can identify potential regional and distant source tsunami threats**

[list of best practice competencies. ***Will depend on TSP and be locally tailored***]

1. Recognize TSP alert messages for distance and regional source events.
2. Identify each type of TSP message (information, watch, warning, advisory).
3. Quickly and accurately locate from the TSP messages or other providers the earthquake location, depth, and magnitude.
4. Apply TSP tsunami advisory products to threshold table to initiate tsunami threat SOPs.
5. Issue national messages, check that they were transmitted, and manually retransmit them if necessary.
6. Check that national messages are displayed on the national website and correct it if necessary.
7. Demonstrate knowledge and ability to confirm and evaluate a tsunami with all available information, including getting additional seismic data, accessing and measuring sea level data, reviewing historical data, assessing models, monitoring news reports, and getting reports from countries.
8. 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. ***Will depend on TSP and be locally tailored***]

* 1. Use shaking intensity to identify possible local source tsunami threat.
	2. Recognize alerts for local events including natural signs.
	3. Recognize TSP alert messages that indicate a local source events, including using TSP products to identify possible local tsunami threat.
	4. Use of threshold tables to initiate local tsunami threat SOPs.
	5. Determine when to issue a heads-up message.
	6. Execute the call down list for a local event.
	7. Confirm and evaluate a local tsunami with all available information.

**4.0 Advance operational competency**

**4.1 Can understand and produce tsunami threat maps**

[list of example competencies ***will depend on national SOPs*** – perhaps include a model set in this document?] **HELP NEEDED TO COMPLETE**

* 1. Competency example 1
	2. Competency example 2

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

[list of example competencies ***will depend on national evacuation maps and plans*** – perhaps include a model set in this document?] **HELP NEEDED TO COMPLETE**

1. Example competency 1
2. Example competency 2

**4.3 Can use a comprehensive set of decision support tools**

[list of competencies, ***some will depend on decision support tools in use***]

1. List potential sources of earthquake information and acquire earthquake information from specified providers and/or website/applications such as NEIC website and CISN Display.
2. Apply earthquake source information to the predefined threshold table, factoring their limitations.
3. Calculate tsunami travel times at nationally specific locations by running own application or acquiring them from the provider, noting their limitations.
4. Understand and use pre-calculated tsunami forecast models, including being able to choose the earthquake location and size closest to that reported. Explain how these models are generated, and the limitations.
5. Describe the use of sea level observation tools and how they can be used to confirm tsunami generation, and calibrate tsunami forecast models.
6. List potential sources of sea level information, and use them in real-time to monitor tsunami generation and propagation.

 **4.4 Advanced practical seismology: Can locate and characterise earthquakes**

[list of competencies which ***will depend on local systems and procedures***. Shall we include an example set in this document?] **HELP NEEDED TO COMPLETE**

1. Demonstrate the ability to correctly identify earthquake phases and pick phase arrival times.
2. Demonstrate the ability to correctly identify earthquake phase amplitudes and pick appropriate amplitudes.
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.
4. Demonstrate the ability to use an earthquake analysis tool to estimate at least three types of earthquake magnitude.
5. 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**

[list of competencies which ***will depend on local systems and procedures***. Shall we include an example set in this document?] **HELP NEEDED TO COMPLETE**

1. Demonstrate the ability to use sea level observation tools to time the arrival of defined tsunami waves.
2. Demonstrate the ability to use sea level observation tools to identify and measure tsunami amplitude and period.
3. Demonstrate the ability to use sea level observation tools to confirm tsunami generation, and calibrate tsunami forecast models.

**5.0 Core agency competencies**

[list of competencies which ***will depend on local systems and procedures***. Examples are included below]

1. Describe the role of NTWC in the end-to-end tsunami warning system.
2. Evoke internal communication and notification protocol including escalation to senior staff (e.g. the Chief Meteorologist).
3. Brief and liaise with the National Disaster Management Office (NDMO) and other response agencies.
4. Perform the post-event activities – record event logs, prepare significant event report, recreate timeline, archive sea level and other event data.
5. Issue and disseminate warning messages, conduct the message transmission and website check, and invoke timely remedial measures if necessary.
6. Monitor news and reports of the event from traditional and social media channels.
7. Manage media inquiries and organise TV/Radio interviews when necessary.
8. Monitor enquiries from the general public and alike, then prioritise response.

**References**

**IOC Tsunami Glossary**, Intergovernmental Oceanographic Commission, Technical Series 85, 2016, latest version can be found at: <http://itic.ioc-unesco.org/index.php?option=com_content&view=article&id=1328&Itemid=1142&lang=en>

Global Tsunami SOPs <http://ioc-tsunami.org/index.php?option=com_oe&task=viewDocumentRecord&docID=18862>

TSP Operational Manuals…various…