



Australian Government

**MARH040 Apply knowledge of core
Autonomous Underwater Vehicles (AUV)
operations**

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Modification History

Release	Comments
1	This unit of competency was first released in MAR Maritime Training Package Release 12.0.

Application

This unit involves the skills and knowledge required to apply knowledge of core Autonomous Underwater Vehicles (AUV) operations.

This includes identifying key working components of an AUV, applying safe handling techniques, determining requirements for optimal mission planning, explaining control theory in relation to performance, conducting safe launch and recovery, assessing mission data, optimising performance and explaining control theory relating to AUV performance.

It also includes hydrostatics to optimise ballasting, surface piloting techniques, tracking technologies and principles of mission planning software.

This unit applies to people working in the maritime industry in the capacity of:

- AUV Operator
- AUV Technician.

This unit applies to AUV operations being conducted in Near Coastal (NC) waters within the limits of the operators Australian Maritime Safety Authority Certificate of Competency.

Licensing/Regulatory Information

No licensing, legislative or certification requirements apply to this unit at the time of publication.

Pre-requisite unit(s)

No prerequisite units.

Competency field(s)

H - Navigation

Unit sector(s)

Autonomous Maritime Sector

Elements and Performance Criteria

Elements		Performance criteria	
Elements describe the essential outcomes.		Performance criteria describe the performance needed to demonstrate achievement of the element.	
1	Identify key working components of an AUV	1.1	Communication and navigation systems are identified
		1.2	Power, control and propulsion systems are identified
		1.3	Sensor payloads and data transfer system are identified
		1.4	Ballasting system is identified
2	Apply safe handling techniques for an AUV	2.1	Location of safe lifting points and sensitive ('no touch areas') are identified
		2.2	AUV is transitioned from storage to operational area safely and according to operational procedures
		2.3	Process for initialising, shutting down and recharging AUV is conducted safely and according to operational procedures
		2.4	Process for data transfer of mission and payload data is conducted according to operational procedures
3	Conduct safe launch and recovery (LAR) of an AUV	3.1	Critical factors required for safe launch and recovery systems (LARS) operations are outlined
		3.2	Deck-handling skills and equipment used to support AUV LAR are outlined

		3.3	AUV LAR from stationary platform and moving vessel using a seal launch is conducted according to operational procedures
		3.4	AUV LAR from a stationary vessel using a davit is conducted according to operational procedures
4	Apply hydrostatics to optimise AUV ballasting	4.1	Local oceanographic conditions relevant to AUV ballasting are identified and described
		4.2	Optimal AUV 'pose' at the surface and behaviour during a shallow ascent when correctly AUV ballasted is described
		4.3	AUV ballasting is conducted safely and correctly according to operational procedures
5	Apply principles of AUV mission planning software	5.1	Process for loading navigational charts into the mission planning software is outlined
		5.2	Start and end points are set using mission planning software according to operational requirements
		5.3	Mission waypoints and transects are set using mission planning software according to operational requirements
		5.4	Optimal depth and speed control are set using mission planning software according to operational requirements
		5.5	Total mission timing and distance are estimated manually and using mission planning software
		5.6	Mission files are uploaded from mission planning software to the AUV following operating procedures
6	Determine requirements for optimal mission planning AUV mission scenarios	6.1	Limitations on AUV performance, including maximum dive and climb angles and minimum turning radius, are determined
		6.2	Best practise mission planning for surveying over submerged riverbeds is outlined

		6.3	Best practise mission planning for steep terrain is outlined
		6.4	Best practise mission planning for strong currents is outlined
		6.5	Best practise mission planning for surveys around maritime infrastructure is outlined
7.	Apply AUV tracking technologies	7.1	AUV is located using hydrophone
		7.2	Acoustic beacons are located using ranger modem
		7.3	Best practises for focusing AUV search and rescue operations are described
8.	Apply AUV surface piloting techniques	8.1	Remote control of the AUV at the surface is established
		8.2	AUV piloting to and from the support vessel and around obstacles through the adjustment of course and speed is conducted
9.	Conduct assessment of AUV mission data	9.1	Key information within master mission log file and operator logbook are accessed and interpreted
		9.2	Post-mission analysis is conducted to assess the success of the mission relative to payload objectives
		9.3	Vehicle performance analysis is conducted to assess the engineering behaviour of the AUV
10.	Conduct missions to assess optimised performance of AUV	10.1	AUV mission to assess improved navigation with acoustic transponders is conducted
		10.2	AUV mission to assess the impact of payloads on hydrodynamics is conducted

		1 0. 3	AUV mission to optimise sensor data coverage is conducted
1 1 .	Explain control theory in relation to AUV performance	1 1. 1	Concepts of input, output, error, feedback and gain for a simple control system are described
		1 1. 2	Principle of tuning the three components of proportional-integral-derivative (PID) control to improve the achievement of an AUV depth goal is outlined
1 2 .	Plan and evaluate an AUV mission	1 2. 1	AUV mission is designed and planned according to operational requirements
		1 2. 2	AUV mission is conducted following a standard operating procedure
		1 2. 3	Post-mission analysis, including vehicle performance analysis, is completed with a post-mission debrief

Foundation Skills

Foundation skills essential to performance are explicit in the performance criteria of this unit of competency.

Range of conditions

Range is restricted to essential operating conditions and any other variables essential to the work environment.

Unit Mapping Information

Current Code and Title	Previous Code and Title	Comments	Equivalence
MARH040 Apply knowledge of core	MARH030 Apply knowledge of core	This unit replaces and is not equivalent	Not equivalent

Autonomous Underwater Vehicles (AUV) operations	Autonomous Underwater Vehicles (AUV) operations	to MARH030 Apply knowledge of core Autonomous Underwater Vehicles (AUV) operations.	
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Assessment Requirements for MARH040 Apply knowledge of core Autonomous Underwater Vehicles (AUV) operations

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1	This unit of competency was first released in MAR Maritime Training Package Release 12.0.

Performance Evidence

Evidence required to demonstrate competence in this unit must be relevant to and satisfy all of the requirements of the elements and performance criteria and include:

- completing an AUV ‘walk-around’ identifying key components, including safe lifting points and ‘no-touch’ areas
- conducting a ‘seal’ launch and recovery (LAR) from stationary and moving platform safely
- correcting AUV ballast for optimum pose and buoyancy
- initialising an AUV on ‘shore’ power, determining current battery levels and safely completing charging operations
- planning, executing and analysing three operational AUV missions in NC waters under supervision, including a minimum of:
 - completing an AUV logbook and post-mission analysis report which includes preliminary post-mission analysis and vehicle performance analysis for each mission
 - one mission specific to a target acquisition mission
 - one mission specific to an acoustic bathymetry survey
 - one mission specific to an optical camera survey
- planning, executing and analysing two diagnostic AUV missions in Near Coastal (NC) waters under supervision, including a minimum of:
 - completing an AUV logbook and post-mission analysis report which includes preliminary post-mission analysis and vehicle performance analysis for each mission
 - one mission specific to impact of re-configuring sensor payloads on hydrodynamic performance
 - one mission specific to improved navigation using acoustic beacons

- surface piloting an AUV in a realistic maritime environment with obstacles that inhibit direct line of sight
- unpacking an Autonomous Underwater Vehicles (AUV) from storage and preparing for transportation to operational area safely
- using a hydrophone and acoustic modem to track and locate an AUV which does not surface.

Knowledge Evidence

Evidence required to demonstrate competence in this unit must be relevant to and satisfy all of the requirements of the elements and performance criteria and include knowledge of:

- application of hydrostatics on AUV ballast, including:
 - AUV behaviour at shallow descent
 - environmental conditions relevant to ballasting
 - optimal AUV pose
 - safe ballasting of AUV
- commonly used mission planning software packages, including processes to:
 - estimate total mission length and timing
 - set start and end mission points
 - set waypoints and transects
 - source and load a navigational chart
 - specify depth-control vs altitude-control
- critical AUV performance parameters, including:
 - maximum dive angle, climb angle, speed and revolutions per minute (RPM)
 - minimum turn radius
- key elements of a post-mission briefing, including:
 - lessons learnt
 - recap of objectives
 - sensor performance
 - summary of outcomes
 - vehicle performance
- key elements of a pre-mission briefing, including:
 - objective

- operational timing
 - payload
 - region of interest
 - risk assessment and mitigation
 - team roles
- key working components of an AUV, including:
 - ballasting system
 - communication and navigation systems
 - data transfer system
 - power, control and propulsion systems
 - sensor payloads
- oceanographic and environmental factors for consideration in AUV mission planning, including:
 - obstacles
 - steep terrain
 - strong currents
 - submerged riverbeds
 - uncertain bathymetry
 - wind
- optimal mission planning for AUV missions in consideration of:
 - maximum dive and climb angles
 - minimum turning radius
 - surveying over submerged riverbeds, steep terrain, strong currents and maritime infrastructure
- proportional-integral-derivative (PID) control:
 - error
 - gain
 - input
 - K_p , K_i and K_d coefficients
 - output
- safe handling techniques for an AUV, including:
 - process for transferring data of mission and payload data
 - safe lifting points and sensitive ('no touch' areas)
 - safely transitioning an AUV from storage to operational area

- safe launch and recovery (LAR) techniques for AUV operations, including:
 - critical factors for safe LAR operations
 - davit AUV LAR from stationary vessel
 - deck-handling skills and equipment
 - 'seal launch' AUV LAR from stationary platform and moving vessel
- surface piloting techniques, including:
 - adjusting AUV speed and course to negotiate obstacles
- tracking technologies, including:
 - process for using a ranger modem to locate an acoustic beacon
 - strategies for focusing AUV search and rescue operations
 - techniques for using a hydrophone.

Assessment Conditions

Assessors must hold credentials specified within the Standards for Registered Training Organisations current at the time of assessment.

Assessment must satisfy the Principles of Assessment and Rules of Evidence and all regulatory requirements included within the Standards for Registered Training Organisations current at the time of assessment.

Assessment processes and techniques must be appropriate to the language, literacy and numeracy requirements of the work being performed and the needs of the candidate.

Assessment must occur in workplace operational situations, and where this is not appropriate, assessment must occur in simulated workplace operational situations that replicate workplace conditions.

Simulated workplace may be used to augment real-world operational situations and does not replace real-world operations in prescribed water conditions.

Resources for assessment must include access to:

- applicable documentation such as workplace procedures, regulations, codes of practice, operation manuals, manufacturer instructions and procedures
- tools, equipment, machinery, materials and relevant personal protective equipment (PPE) currently used in industry, including:
 - AUV aligned with the required size and class that a seafarer will need to operate
 - AUV with minimum depth rating of 100 m and inertial navigation system (INS)

- water conditions consistent with mission requirements as outlined in this unit of competency and must include access to water in excess of 100 m, high energy tidal waters and permanently stratified waters.

Links

Companion volumes, including implementation guides, are found in TGA - <https://training.gov.au/training/details/MAR/summary>