



SEASTARS

DATE: September 3, 2026

SUSTAINABLE EMISSION ABATEMENT STRATEGIES & TECHNOLOGIES
FOR ADVANCED REVOLUTION SHIPS

D2.1

Guide on CAPELLA and SPEC
tool



Project Acronym	SEASTARS
Project Name	SUSTAINABLE EMISSION ABATEMENT STRATEGIES & TECHNOLOGIES FOR ADVANCED REVOLUTION SHIPS
Project Number	101192901
Type of Action	HORIZON-CL5-2024-D5-01
Project Coordinator	University of Strathclyde (UoS)
Project Duration	January 2025 - December 2027 (36 Months)
Website	https://seastars-project.eu/
Deliverable No.	2.1
Deliverable Title	Guide on CAPELLA and SPEC tool
Work Package	WP 2
Deliverable Leader	MARIN
Author(s)	BM Krijgsman, BJ Sustronk, A Grasman YJC Klinkenberg
Reviewed by	MAR
Due Date	30/06/2025
Submission Date	30/06/2025
File Name	D2.1_Guide_for_tools.docx
Version	0.x for draft version 0.6 for final version 1.0 for revised version (if requested)
Status	Final
Dissemination Level	PU

REVISION HISTORY

Date	Version	Description	Edited by
10/06/2025	0.1	Table of Contents circulated and input required	YJC Klinkenberg
	0.2	First draft	YJC Klinkenberg
23/06/2025	0.3	Comments & Feedback on First Draft	Reviewd by BJ Sustronk, A Grasman, BM Krijgsman
23/06/2025	0.4	Version for WP2 Review	YJC Klinkenberg
27/06/2025	0.5	Version for Peer review	Georgia Palioudaki
27/06/2025	0.6	Final version submitted to coordinator for submission to ECAS	Panagiotis Louvros, Evangelos Stefanou

DISCLAIMER:

The project has received funding from the European Union's Horizon Innovation Actions programme under grant agreement No 101192901. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor CINEA can be held responsible for them.



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Abbreviations and Terminology

Partners - Abbreviations	
AMC	ALFA MARIN TECHNIKH SYMVOULEYTIKH MELETON KAI ERGON EPE
ATHINA	ATHINA KENTRO NAFTIKIS KATARTISIS KAI EXELIXIS ANONYMI ETAIREIA
AURELIA	AURELIA DESIGN B.V.
Bound4Blue	BOUND 4 BLUE SL
COMPOSITE RECYCLING	COMPOSITE RECYCLING SA
DG TWIN	DG TWIN SRL
Erma First	ERMA FIRST ESK ENGINEERING SOLUTIONS SA
HEMEXPO	ELLINES KATASKEVASTES NAFTILIAKOU EXOPLISMOU ASTIKI MI KERDOSKOPIKI ETAIREIA (HEMEXPO)
QUADRISE	QUADRISE INTERNATIONAL LIMITED
MARIN	STICHTING MARITIEM RESEARCH INSTITUUT NEDERLAND
MERCURIUS	MERCURIUS SHIPBUILDING BV
METACON	METACON MONOPROSOPI ANONYMI ETAIREIA
MINERVA	MINERVA MARINE INC. TRUST COMPANY COMPLEX,
NEPTUNE LINES	NEPTUNE LINES SHIPPING AND MANAGING ENTERPRISES S.A.
RINA	RINA HELLAS ETAIRIA PERIORISMENIS EVTHINIS NIOGNOMONAS
UoB	THE UNIVERSITY OF BIRMINGHAM
UOS	UNIVERSITY OF STRATHCLYDE



Partners - Abbreviations	
VERTORO	VERTORO BV
Voyex	Voyex B.V.

Abbreviations	
ARCADIA	ARChitecture Analysis and Design Integrated Approach
EPBS	End Product Breakdown Structure
ICE	Internal Combustion Engine
IVVQ	Integration, Validation, Verification, Qualification
MBSE	Model Based System Engineering
MEC	Marin Efficiency Calculator
PE	Propulsion Engine
PPE	Power, Propulsion and Energy
SPEC	Ship Power and Energy Concepts

Terminology	
Concurrent Design	



Executive Summary

This document serves as a practical guide to use Arcadia Capella for model based systems engineering (MBSE) approaches for ship design. As well as for the use of the Ship Power & Energy concepts (SPEC) tool in the early phases of the design process. It is suited for anyone interested in the use of Arcadia Capella and SPEC during the ship design process, but especially for ship owners and ship designers.



12 References

1. **Roques, Pascal.** *Systems Architecture Modeling with the Arcadia Method: A Practical Guide to Capella.* s.l. : Elsevier, 2017.
2. **Ship Power and Energy Concepts (SPEC).** [<https://www.marin.nl/en/news/recording-ship-power-and-energy-concepts-webinar>] Wageningen : MARIN, 2021.
3. **Let yourself be guided with Arcadia.** [<https://mbse-capella.org/arcadia.html>]
4. **MARIN. ZERO | MARIN.** [Online] November 2022. [Cited: 25 June 2025.] <https://www.marin.nl/en/jips/zero>.