MEGURI 2040
Safety Assessment Seminar
(2026.6.29)

Presentation 4:
Overview of Inspections Conducted by ClassNK in the MEGURI2040

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Progress to date

2017 2018 2019 2020 2021 2022 2023 2024 2025 2026

Autonomous Maritime Transport System Study Committee
- Business Model (RG-1)
- Technical Concept (RG-2)
- Institutional Framework for Development and Implementation (RG-3)

Safety Standards
(Ministerial Ordinance No. 61)

Inspection Methods, etc.
(Kokukaian No. 40 / Kokukaian No. 100)

Advanced Safety Ship Technology R&D Support Program (MLIT)
Research on ship collision risk assessment and autonomous navigation, etc.

Non-mandatory MASS Code

Autonomous Ship Demonstration Project (MLIT)
(1) Autonomous navigation functions (Oshima Shipbuilding and others)
(2) Remote navigation functions (MTI and others)
(3) Automated berthing and unberthing functions (Mitsui E&S Shipbuilding and others)

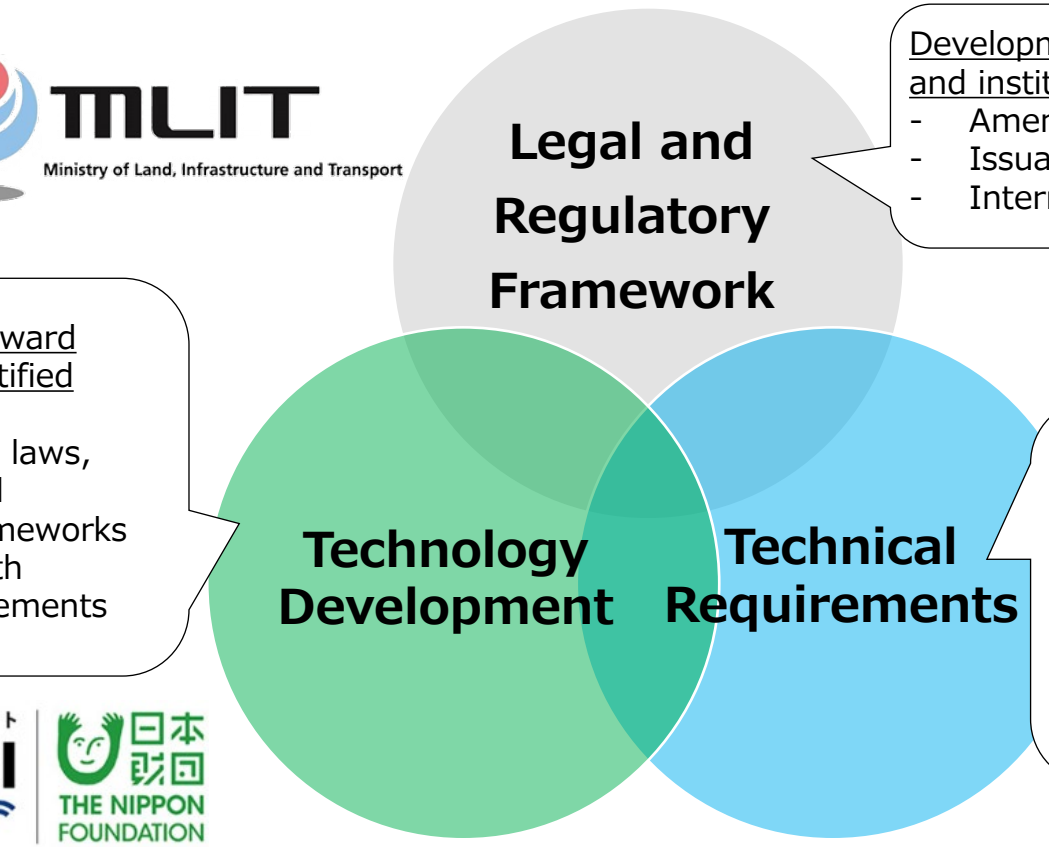
Unmanned Navigation Project "MEGURI 2040" (funded by The Nippon Foundation)
(1)Demonstration projects for technologies related to unmanned navigation
(2)Safety assessment projects for MEGURI 2040

(Concept Design)

(Ver. 1.0)

(Ver. 2.1)

Collaboration (Trinity Approach)



MLIT
Ministry of Land, Infrastructure and Transport

Development of laws, regulations, and institutional design
- Amendment of ministerial ordinances
- Issuance of notifications/circulars
- International coordination

Development toward addressing identified challenges
-Alignment with laws, regulations, and institutional frameworks
-Compliance with technical requirements

Role of ClassNK (NK)
- Establishment of technical requirements
- Development of evaluation methods and criteria
- Safety assessment (safety verification / approval review)

MASS Project Team

Cross-organizational project team

* Approval in Principle
**Technology Qualification

ClassNK MASS PT

Rule development
- ✓ Guidelines
- ✓ International regulations

IMO

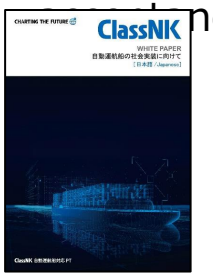
Safety evaluation
- ✓ Rice assessment
- ✓ Approval & Certification

AiP*

TQ**

Notation
(AUTO-XY(Z))

Info. sharing
- ✓ Neutral information to support social



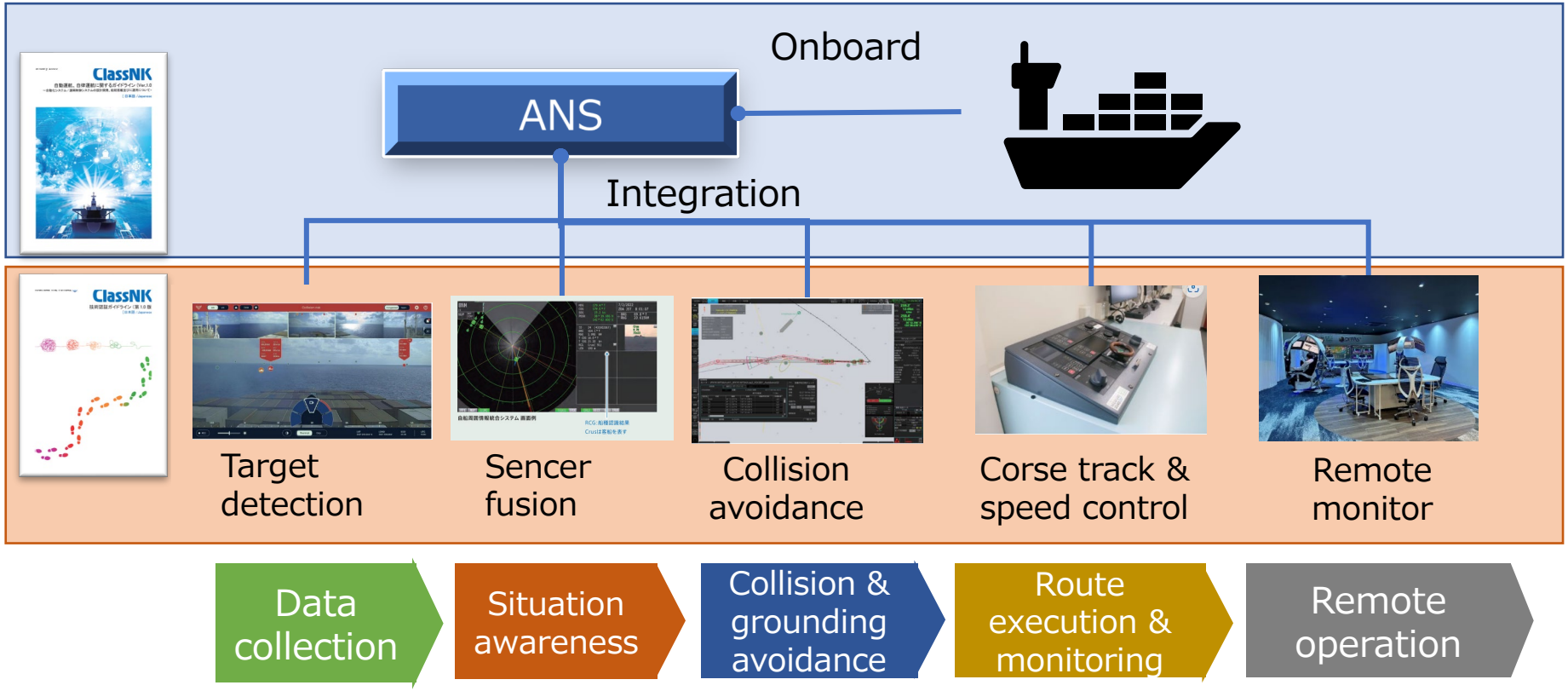
R&D
- ✓ Technologies applicable to autonomous ships
- ✓ Risk assessment methodologies and identification of functional requirements
- ✓ Safety assessment methods and safety standards

Inspection Policy

Inspection policy of Autonomous Navigation System (ANS)

- ✓ Verification of the safety of the overall autonomous navigation system and its constituent subsystems
- ✓ Evaluation of key functions recognized as novel ⇒ Technical Qualification Guidelines (TQ-GL)
- ✓ Evaluation as an autonomous navigation system ⇒ MASS Guidelines (MASS-GL)

Annex of MASS-GL (Ver2.0)



Source：DFFAS+（MEGURI2040）

Technology Qualification Guidelines

Applicant | System Integrator | NK

Step 1 Certification Framework

- Goal
- Scope

Confirm what the equipment/system is and what it is intended to do.

Step 2 Analysis of Tech. Elements

- Classification
- Novelty
- Risk Assess.
- Verification
- Review

Identify what is new and analyze potential failure scenarios and their consequences.

Step 3 Certification Plan

- Verification Plan
- Proto. Test
- Criteria
- Review

Examine the necessary items to achieve the objectives.

Plan approval

Step 4 Certification

- Proto. Test
- Test report
- Feedback
- Follow up
- Review & Survey

Conduct the tests considered necessary.

Plan approval

Guidelines for Automated/Autonomous Operation on ships

Ver. 1.0 : Copilot said: Structured as common requirements (2020)
Ver. 2.1 : Detailed requirements for automated navigation and remote machinery operation specified in the annex (2025)

Main bady (Ver. 2.1)

1. General
2. Terms and Categories of Systems
3. Design Development
4. Installation On Board
5. Operation
6. Risk Assessment
7. Remote Operation

Class Notation
Autonomous-XY(Z)
X: Automated function
Y: Level of autonomy
Z: Phase of navigation

Consistency with international conventions

MASS Code PART 2-level

Annex I : Autonomous Navigation Systems

Detailed requirements for ANS

Annex II : Remote Operation Systems

Machinery Monitoring and Control systems

- ✓ MASS Code PART 3-level
- ✓ Detailed requirements (Tier IV-level)

Inspection Achievements

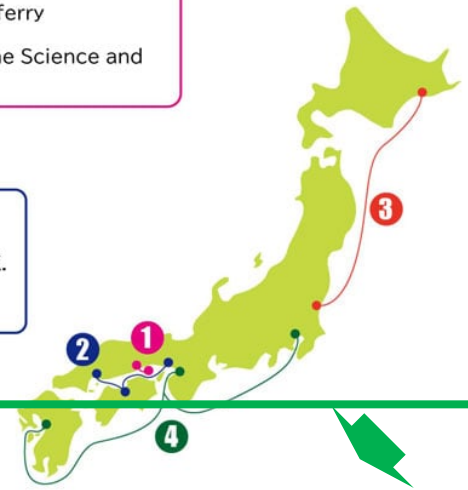
Stage 2
(2023~2026)

[1] The Nippon Foundation MEGURI2040 Fully Autonomous Ship Program | The Nippon Foundation

*Routes are as of July 2023, and are subject to change without notice

1 July 2025 ~
Remote island passenger ferry
Olympia Dream Seto
Development: Japan Marine Science and seven other companies

2 July 2025 ~
Container vessel *Mikage*
Development: Mitsui O.S.K. Lines and four other companies



3 September 2025 ~
RO-RO vessel *Hokuren Maru No. 2*
Development: Kawasaki Kisen Kaisha and three other companies

4 November 2025 ~
Container vessel (newly built)
Development: MTI and 15 other companies

ClassNK-classed vessels

Technology Qualification (TQ) issued

Class Notation (AUTO-Nav2) Granted

Class Notation

“AUTO-XY(Z)” is to be affixed in accordance with this Guidelines.

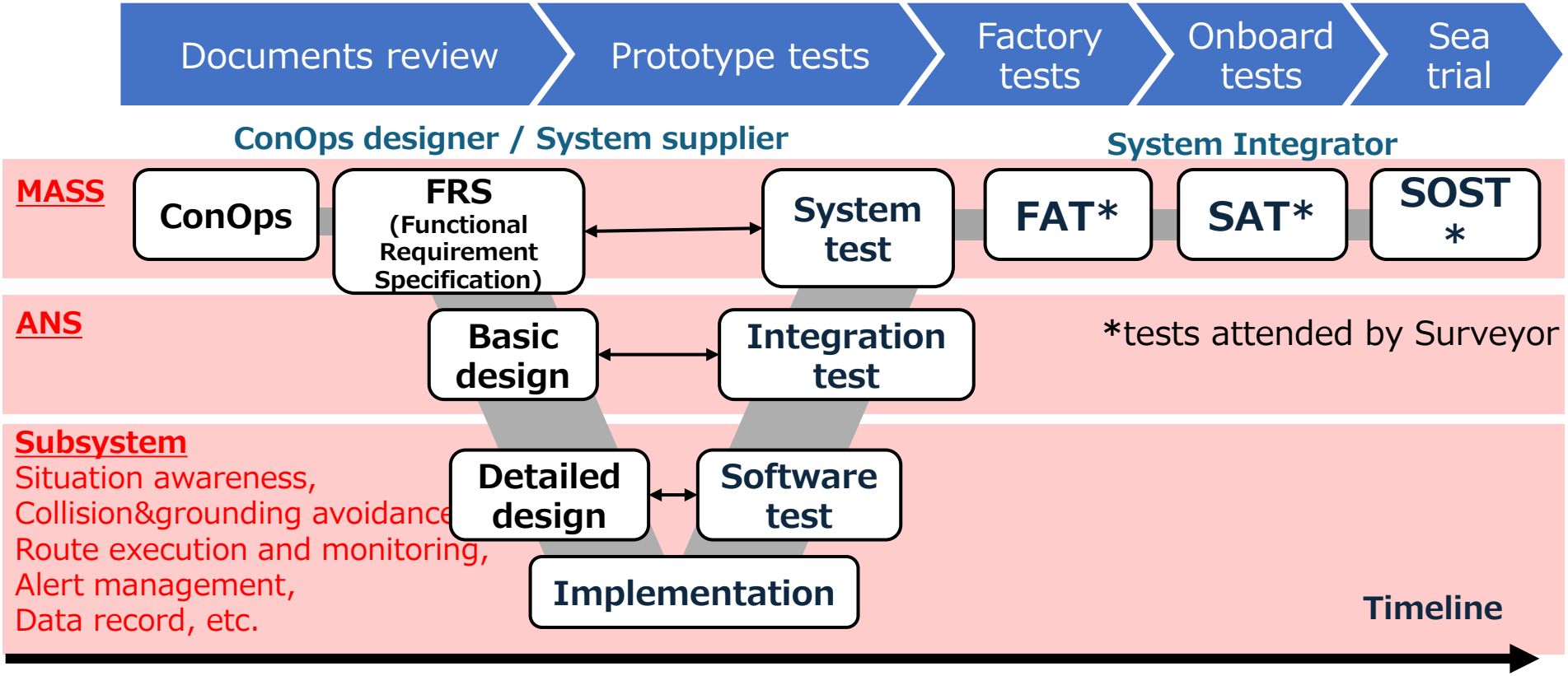
Notation: AUTO-XY(Z)

- X: Automated function
  - Navigation (Nav), Engineering (Eng), Safety (Saf), Operation(Ops)
- Y: Level of autonomy
  - 1: Support (partially automated with decision-making carried out by humans
  - 2: Conditional autonomous (system use monitored by humans)
  - 3: Advanced autonomous: Human intervention is basically* not necessary
- Z: Phase of navigation
  - Berth/Unberth (Be), Harbor (Ha), Coastal (Co) or and Open Sea (Os)
- Example: AUTO-Nav2(Os)
  - Ships equipped with systems available only in open sea that navigate automatically under human monitoring.

*The system is always capable of being overridden based on decision-making carried out by humans.

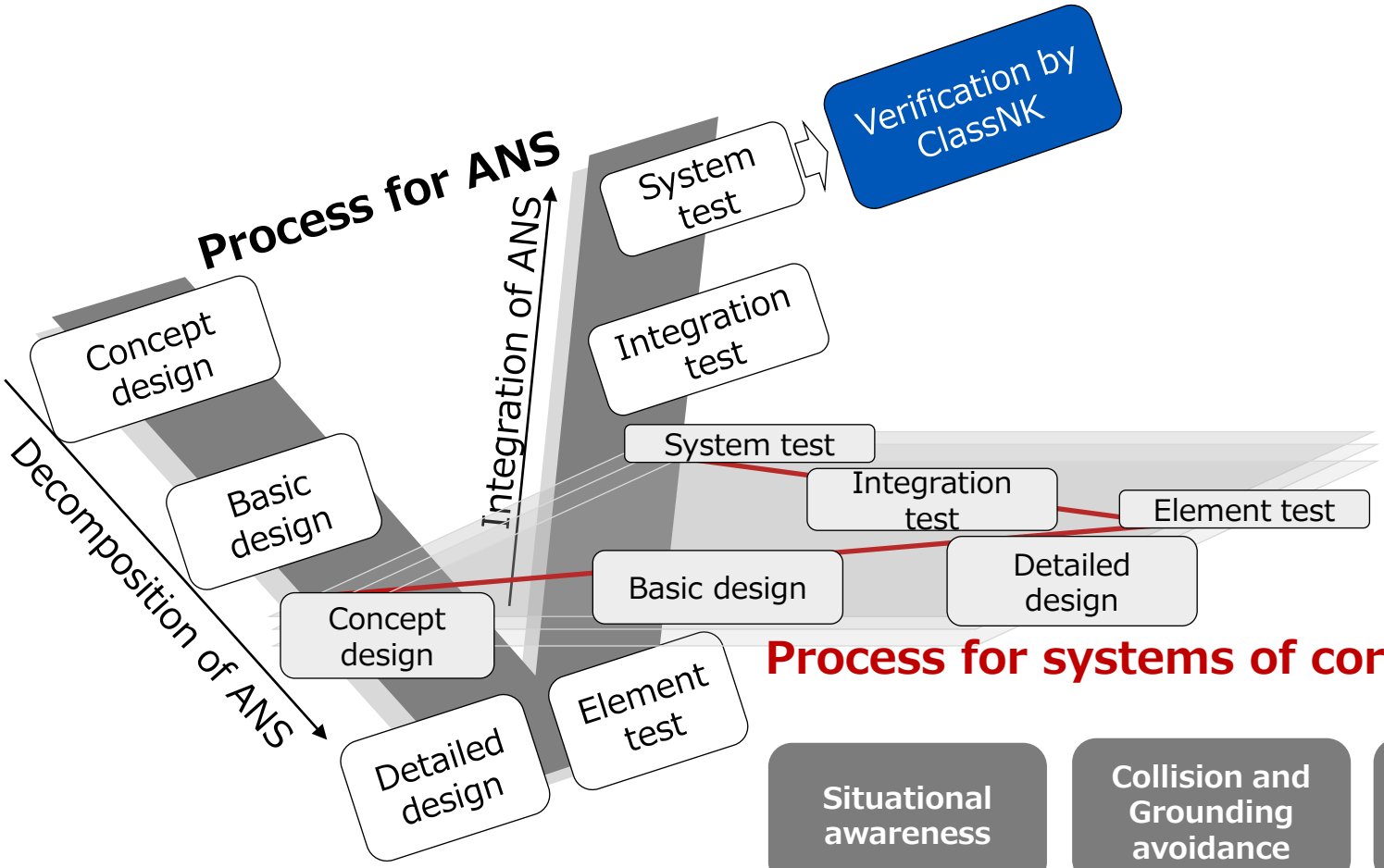
Inspection flow

Approval and Certification Process-Outlines



Inspection flow

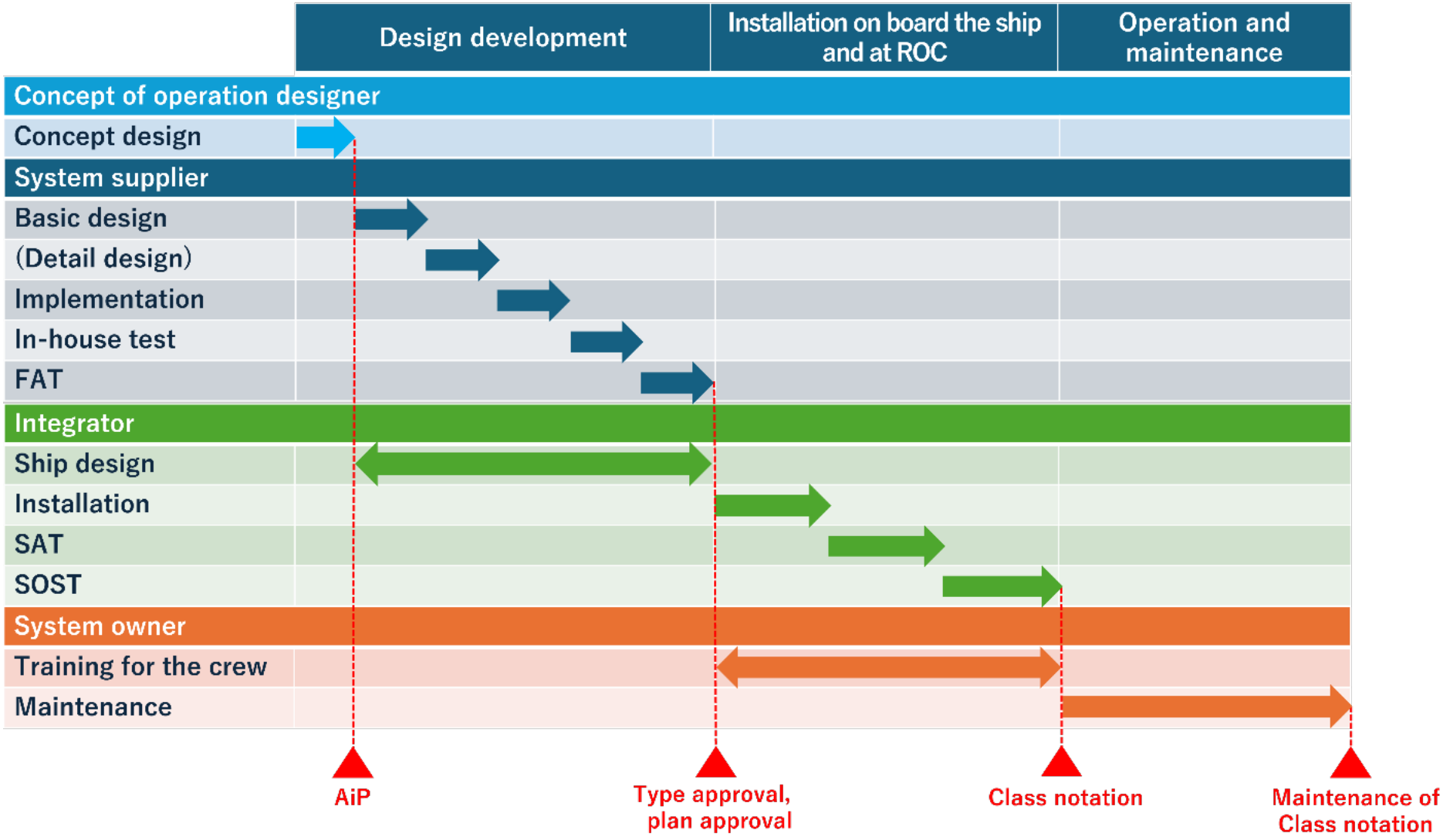
V&V at the subsystem level



Process for systems of core functions

- Situational awareness
- Collision and Grounding avoidance
- Route execution and monitoring

Initial Inspection and Subsequent Process (MASS-GL Chapter 1)



Document reviews (MASS-GL Chapter 3)

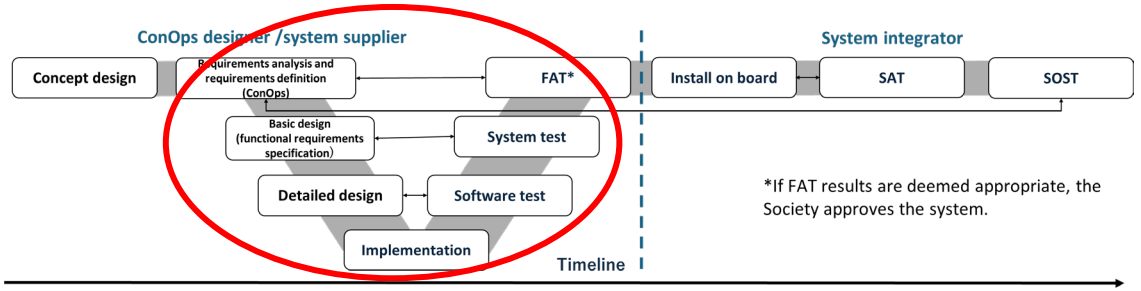
System supplier

<For approval>

(1) Concept of operation (ConOps)
(2) Functional requirements specification (FRS) for ANS
(3) Report of risk assessment
(4) Documentation related to the design and development system (quality system related)
(5) Documentation related to the design and development process
(6) Result of software test
(7) Result of system test
(8) Test plan for FAT
(9) Other documents deemed necessary by the Society

<For reference>

(1) Environmental compliance (ambient conditions)
(2) FAT report
(3) Manual for ANS
(4) Other documents deemed necessary by the Society



Concept of Operation (ConOps)

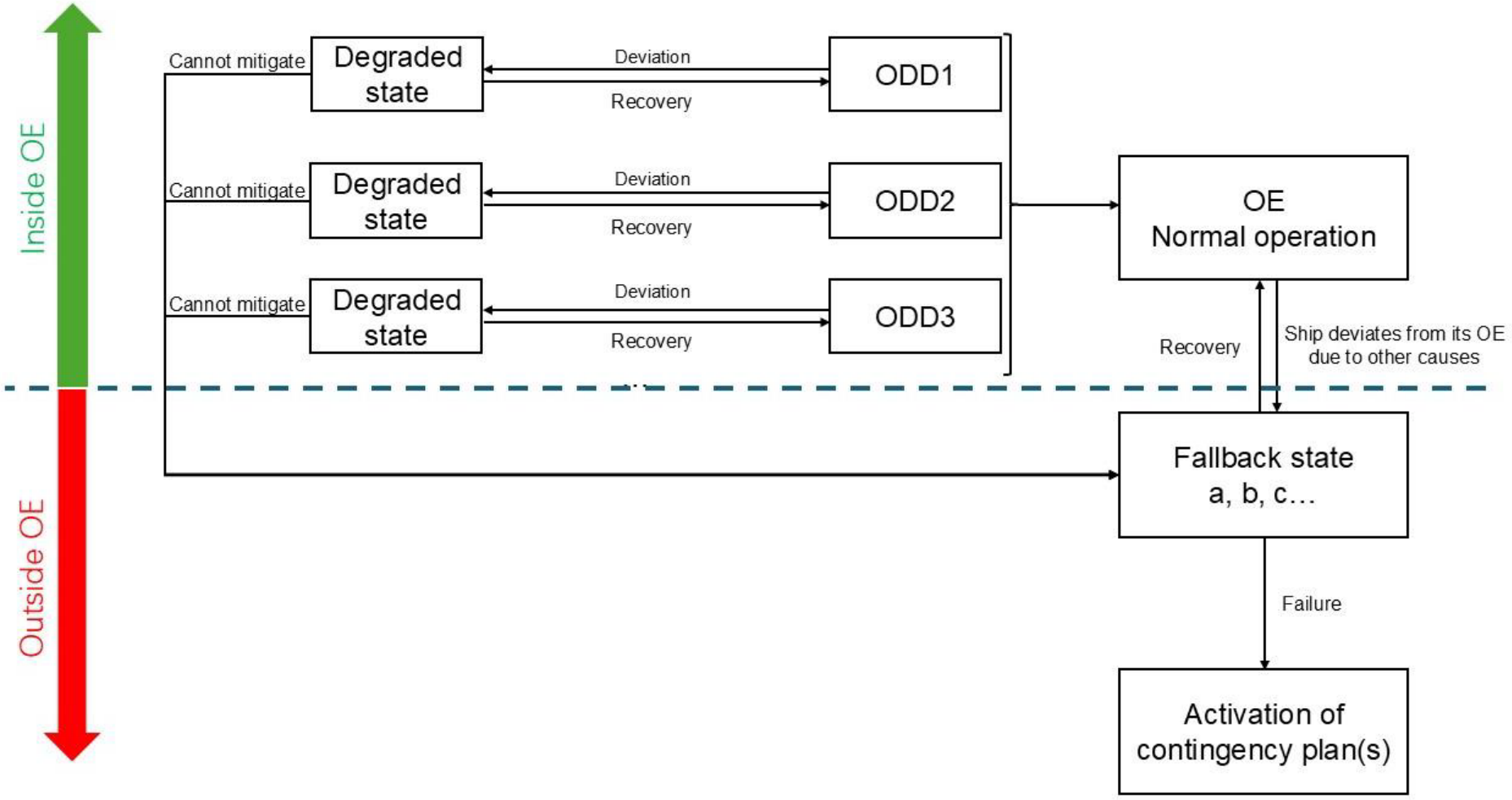
Source : MSC 111/WP.9
Annex 1, page 84-86

✓ A document summarizing the concept and overview of system use and operation (serving as a fundamental document for approval and operation).

1. **Overview of MASS Functions**
   Purpose, scope, and use cases of autonomous/remote functions, and their correspondence to navigation phases
2. **Technical Characteristics of MASS**
   ・Ship's Particulars（LBD, speed, cargo, propulsion, etc.）
   ・Key systems : Essential functions for MASS (e.g., security, alarm management, maintenance, etc.)
   ・Functions that are autonomous and/or remotely operated
   (e.g., navigation, communication, machinery, fire protection, etc.)
3. **Operational Envelope (OE)**
   ・Mode of Operation : Allocation of responsibilities (human/system), and monitoring and switching conditions
   ・Constraints: environmental (wind, waves, visibility, etc.), geographic, communication (connectivity, latency, redundancy), traffic, and operational conditions
4. **Fallback & Contingency Plan**
   ・Conditions for transition to a fallback state (for each navigation phase)
   ・Contingency plans in the event of deviations from the OE
5. **Remote Operations Centre (ROC)**
   Functions of the ROC, number/configuration/redundancy of systems, and control handover procedures between ROCs
6. **Human Involvement**
   Roles and involvement of personnel on board and at the ROC, minimum safe manning, and task allocation (automation vs. human)
7. **Rules & Regulatory Gap**
   Copilot said: Applicable regulations (international, national, and regional), deviations from regulations, and risk-based alternative measures

Relationship between Operational Envelope (OE) and Related Concepts

Source : MSC 111/WP.9
Annex 1, page 87



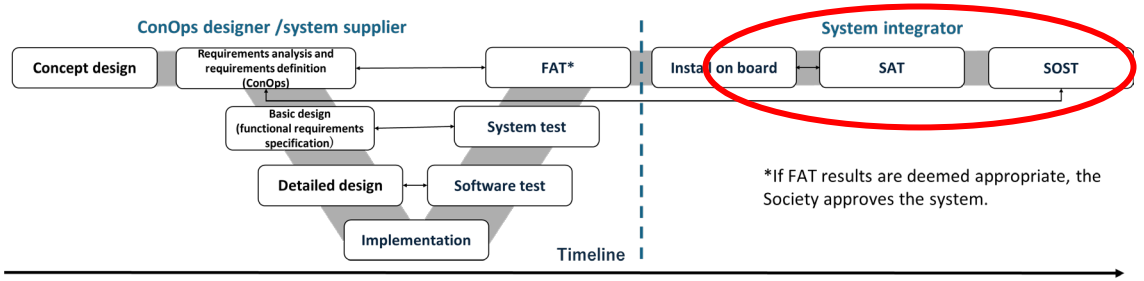
Document reviews (MASS-GL Chapters 4 and 5)

Integlator

(1)System architecture for the ship installed with the AOS
(2)Operation Design Domain (ODD)
(3)Report of risk assessment
(4)Documents on software version control related to the AOS
(5)Test procedure for SAT
(6)Test procedure for SOST
(7)Test report for SAT
(8)Test report for SOST
(9)Others deemed necessary by the Society

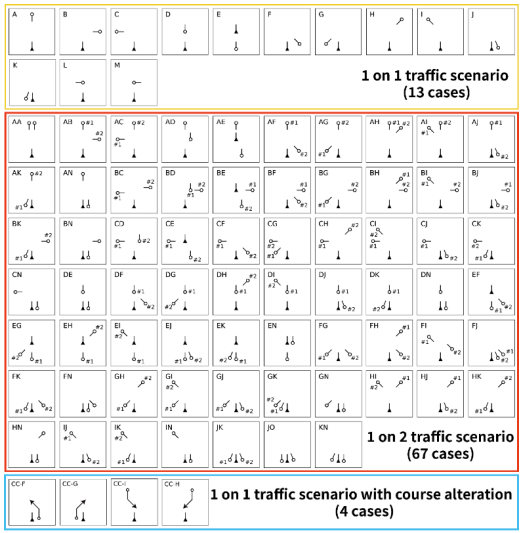
System owner

(1)Operational Manual for the ANS
(2)Maintenance and Management Manual for the ANS

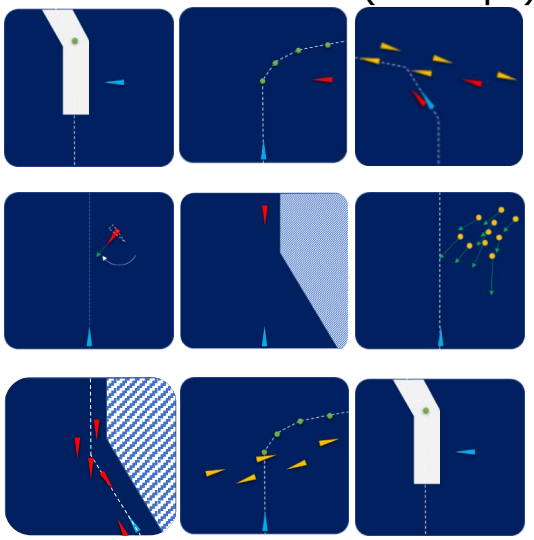


Software test (MASS-GL Annex I-Chapters 2 to 4)

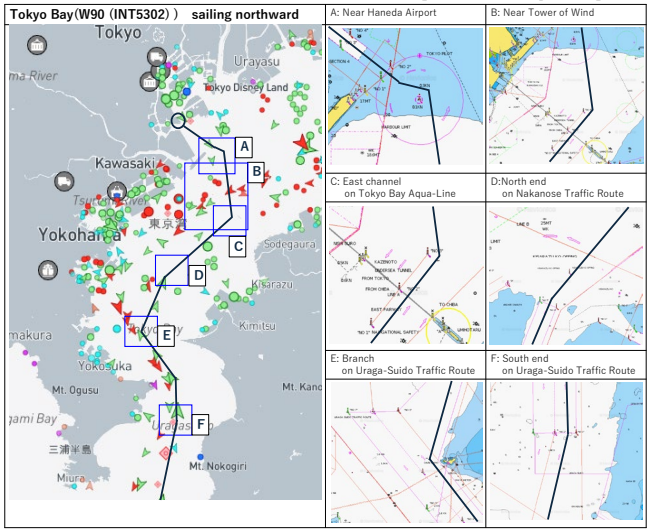
Basic scenario set



Practical scenarios (excerpt)



Real sea scenarios (example)



- ✓ Basic scenario set comprehensively covers the 1 on 1 encounter situations.
- ✓ Practical scenario is detailed extraction of practical elements that can occur in actual sea areas.
- ✓ Real sea scenario is created based on past AIS and Rader TT information.

Evaluation metrics

- Minimum relative distance
- Passing distance
- Rate of change of the bearings
- Track (incl. heading, rate of turn, and speed)

Expert-based judgment

- By experienced captains with extensive knowledge of navigation in the target area.

Software test (MASS-GL Annex I-Chapters 2 to 4)

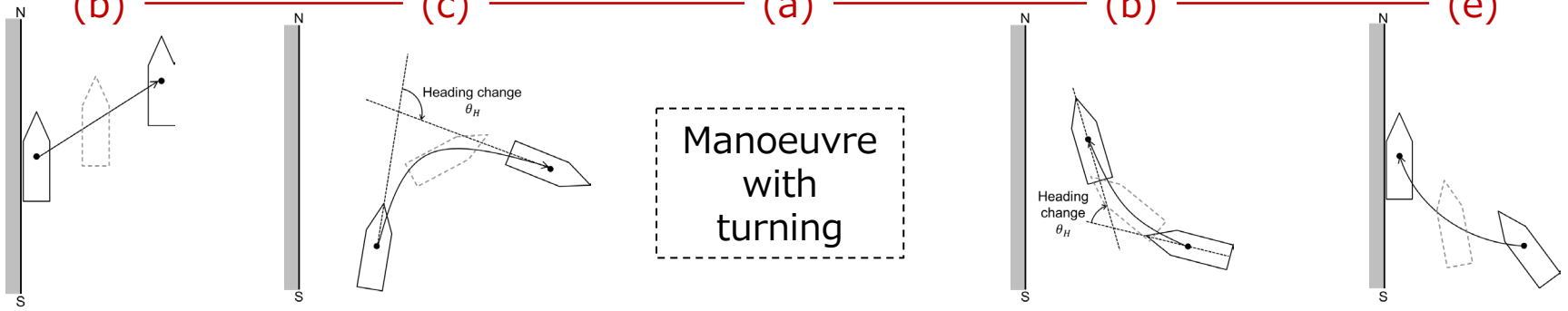
Scenarios are combination of passage plans and environment conditions.

Simulation scenarios = Passage plan X Environment condition

Unberthing	Leaving	Harbour in/out	Approaching	Berthing
Manoeuvring pattern (a)~(f)	Manoeuvring pattern (a)~(c)	Manoeuvring pattern (a)	Manoeuvring pattern (a)~(c)	Manoeuvring pattern (a)~(f)

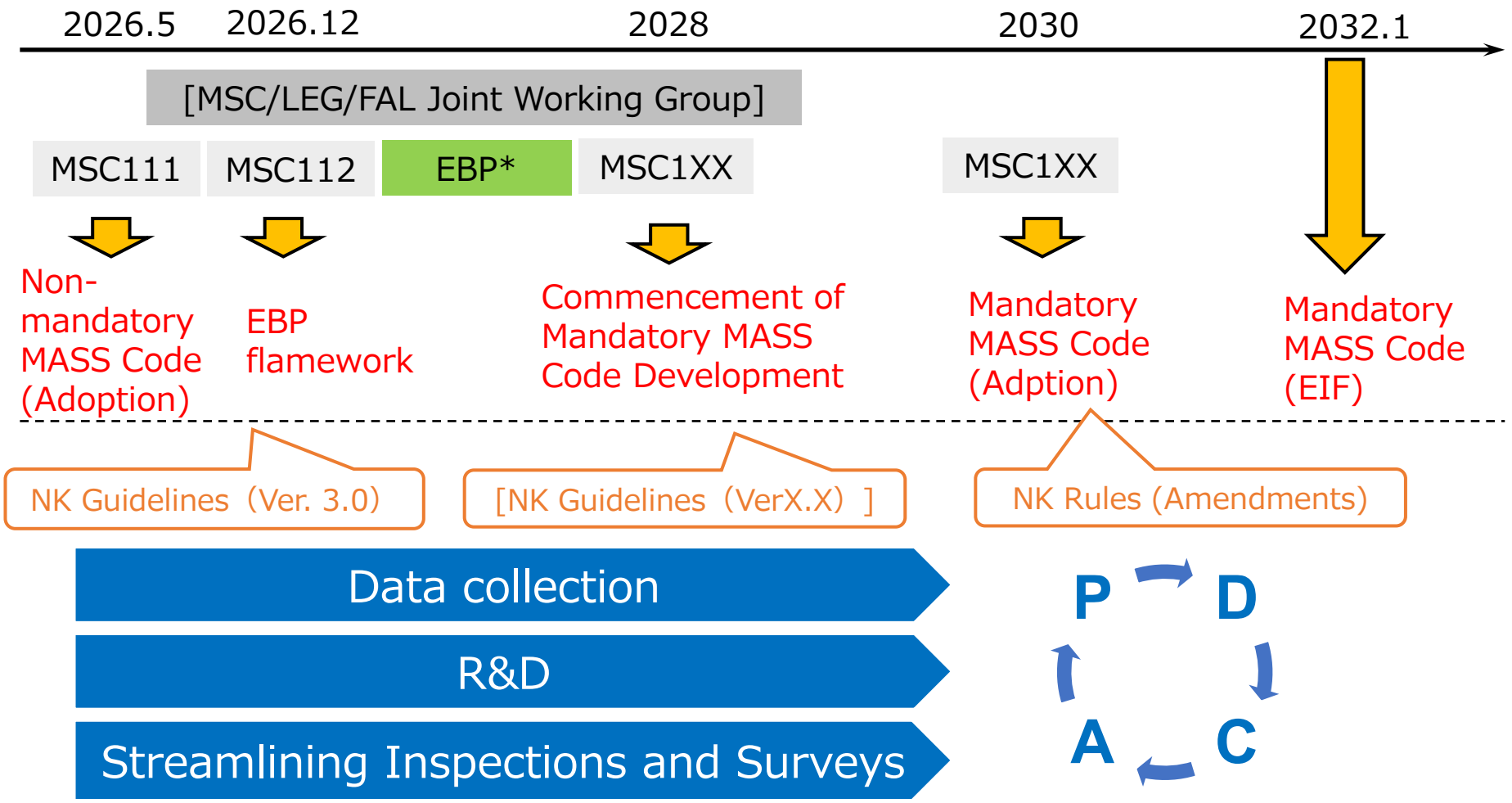
Example

(b) — (c) — (a) — (b) — (e)



Future work

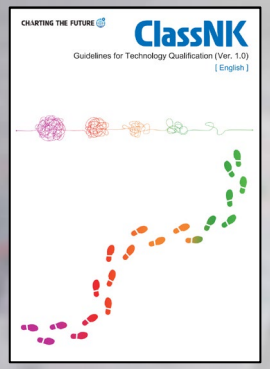
Continuous Improvement of Rules through the PDCA Cycle



無人運航船プロジェクト
MEGURI 2040
日本財団 THE NIPPON FOUNDATION

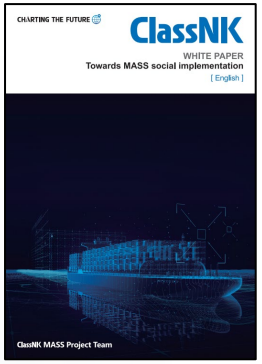
THANK YOU

for your kind attention



Guidelines for Technology Qualification (Ver. 1.0)

Guidelines for Automated/ Autonomous Operation on ships (Ver. 2.0)



ClassNK White paper