MEGURI 2040
Safety Assessment Seminar
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Presentation 1:
Outline of the survey method for Maritime Autonomous Surface Ships (MASS)

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Safety standards and survey methods for ANS

In June 2024, the Maritime Bureau of the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) established the Study Group on Autonomous Ships. The purpose of the Study Group is to conduct comprehensive discussions involving both government and industry stakeholders on safety standards, inspection methods, crew arrangements, and other issues related to the commercial application of autonomous navigation and remote monitoring technologies.
This initiative was launched in recognition of the expectation that the application of rapidly advancing technologies, such as sensing systems and artificial intelligence (AI), to ship operations will improve maritime safety, as well as the urgent need to secure personnel for Japan's coastal shipping sector, which supports domestic logistics, improve seafarers' working conditions, and enhance the attractiveness of maritime careers.

- In June 2025, safety standards and inspection procedures were established for the Autonomous Navigation System (ANS), a key component of autonomous ships.

Safety standard

MLIT Ordinance No. 61 (dated May 30, 2025) amended the relevant ministerial ordinance and came into effect on June 1, 2025.

- Enforcement Regulation of the Ship Safety Act
- **Special Regulations for Automated Ship Equipment, etc**

Survey Method, etc.

- KOKU-KAI-AN No. 40 (dated June 30, 2025) revised the Guidelines for Ship Survey and set forth concrete measures for the requirements set forth in the Safety Standards.
- KOKU-KAI-SA No. 100 (dated June 30, 2025) newly defined the inspection method of the ANS, etc.

https://www.mlit.go.jp/notice/noticedata/pdf/20250715/20250715_kaiji_1.docx (from MLIT website)

Inspection policy for the automatic operation system

Inspection shall be conducted in addition to the existing ship inspection for conformity to the safety standards required for the ANS.

1. Conduct simulations or tests on actual equipment to verify compliance with the Functional requirements* specified in the safety standards.
2. Confirm through risk assessment the appropriateness of the Concept of Operations (ConOps), Operational Envelope (OE), and Operational Design Domain (ODD) of the ANS, etc.

※ Functional requirements: Situation awareness, collision and grounding avoidance, route execution and monitoring, handover by seafarers, data recording, alert management, etc.

Inspection policy

- Inspections of ANS, etc., are divided into four stages, from Step 1 (survey at the design phase) to Step 4 (operational survey), and are conducted in accordance with existing inspection procedures—namely, surveys at the design phase, prior to equipment installation, and onboard—as well as operational surveys.
- In verifying compliance with functional requirements and conducting risk assessments, we incorporated findings from a project commissioned by the MLIT and conducted by the Nippon Kaiji Kyokai (ClassNK), along with methodologies developed by the Japan Ship Technology Research Association (JSTRA).

Inspection process

<Contents of inspection of each step>

Step 1 Survey at the Design Phase

- Examination of documents related to the Autonomous Navigation System, etc., (e.g. ConOps, risk assessment report, safety management documents)
- Functional evaluation of collision and grounding avoidance, route execution and monitoring, and other relevant functions
- Risk assessment at the design phase

Step 2 Survey Prior to Installation of Equipment

- Performance verification of equipment constituting the Autonomous Navigation System, etc., (based on the documents inspected in Step 1)
- Verification of coordination among equipment constituting the Autonomous Navigation System, etc.
- Risk assessment (as required in case of modifications or other changes)

Step 3 Onboard Survey

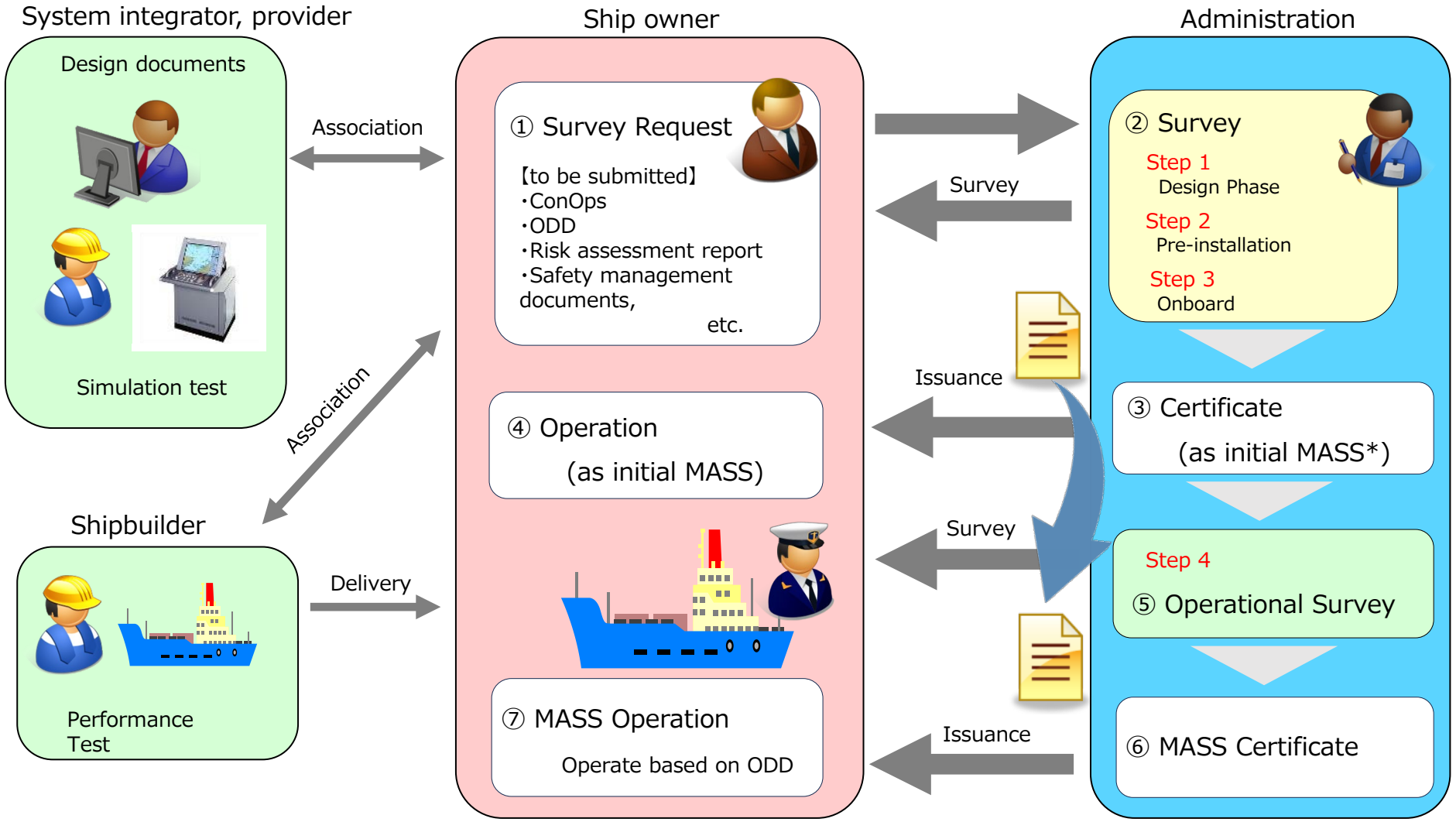
- Verification of documents related to the Autonomous Navigation System, etc.
- Risk assessment (as required in case of modifications or other changes)

Step 4 Operational Survey

- Survey of the Autonomous Navigation System, etc., in actual sea areas
- Risk assessment (as required in case of modifications or other changes)

Flow of Inspection Procedures for ANS, etc.

Inspection based on the Ship Safety Law



※ Initial MASS: systems in which human intervention is required for all tasks within the ANS.

Inspection of the ANS (1/2)

1. Functional Requirements Inspection Method (Functional Verification Test)

(Detailed description of the functional evaluation in Step 1 on p. 4)

(1) Checking the status recognition function

The applicant shall obtain confirmation from the ship inspector, through simulation testing or testing using actual equipment, that the situational awareness function of the ANS continuously monitors all information necessary for safe navigation, makes such information available to crew members and other relevant personnel in a timely manner, and performs the functions specified below.

- ODD function
- Fallback function
- Override function, etc.

Ambient monitoring camera device (from MEGURI 2040 website)

(2) Inspection of collision and grounding avoidance functions

The applicant shall conduct simulation tests of the collision and grounding avoidance functions of the autonomous navigation system under (1) basic scenarios, (2) practical scenarios, (3) real sea scenarios, and (4) accident scenarios. The results shall be evaluated by experts, and the expert evaluation results shall be submitted to the ship inspector.

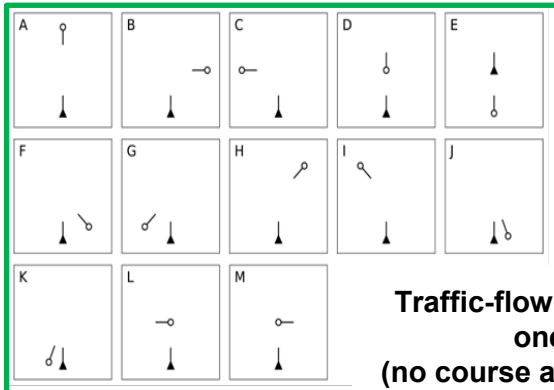
(1) basic scenarios: Scenarios designed to verify compliance with the collision avoidance and navigation rules prescribed by the Act on Preventing Collisions at Sea, assuming one-to-one and one-to-two vessel encounter situations in open sea.

(2) practical scenarios: Scenarios incorporating practical elements that may occur in actual maritime environments, assuming conditions such as complex waterways and various encounter situations.

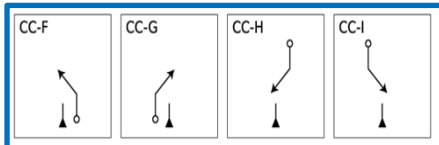
(3) real sea scenarios: Scenarios that include geographical and other relevant information for the intended area of operation, assuming waters in which the autonomous navigation system will be used.

(4) accident scenarios: Scenarios based on conditions derived from past maritime accident cases.

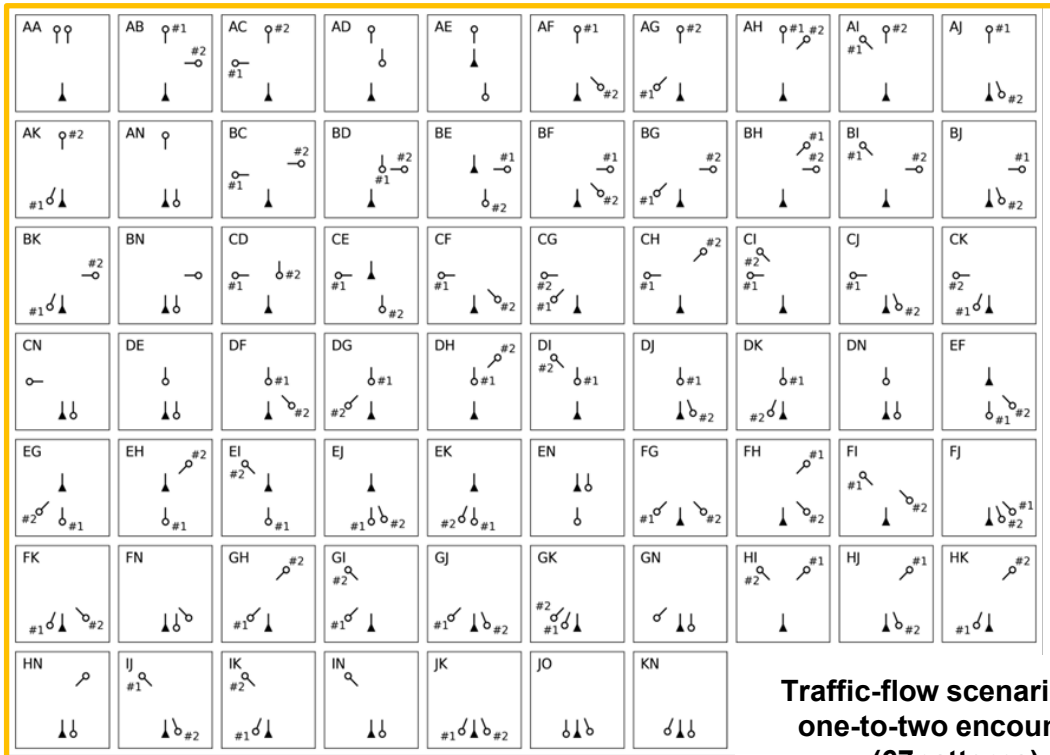
Basic scenario (84 patterns)



Traffic-flow scenarios for one-to-one encounters (no course alteration) (13 patterns)



Traffic-flow scenarios for one-to-one encounters (with course alteration) (4 patterns)



Traffic-flow scenarios for one-to-two encounters (67patterns)

Practical scenario (Common Scenarios, Selected Scenarios)

Table I-1: Pracatical Scenario Set (Common Scenarios)

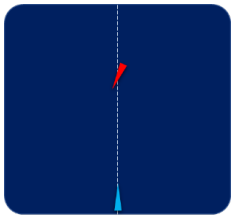
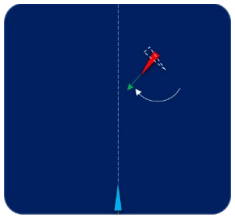
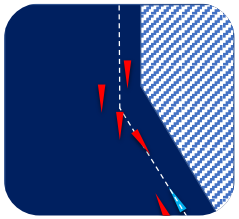
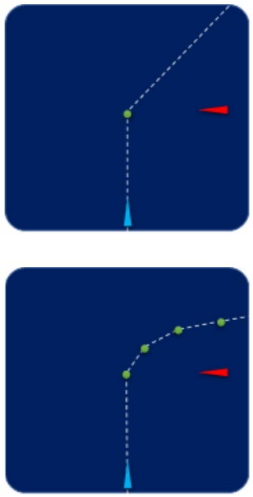
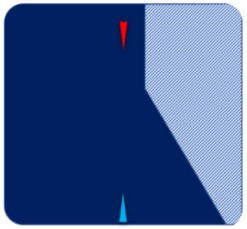
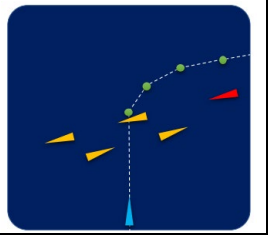
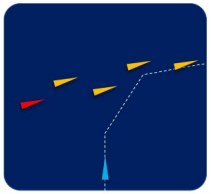
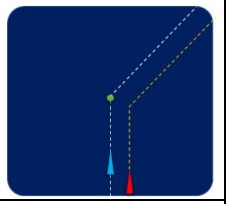
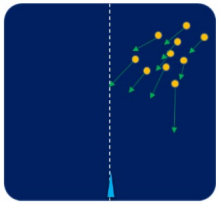
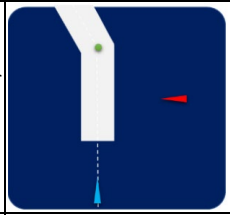
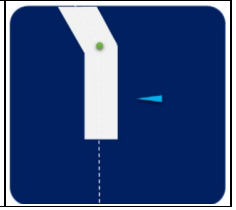
No	Practical Elements	Overview Diagram
1	The target vessel takes evasive action to avoid one's own ship	
2	The target vessel moves unexpectedly	
3	The deviation from the voyage plan is detected by the sensor abnormality, external forces effect, etc.	
4	It becomes impossible to plan an avoidance route	

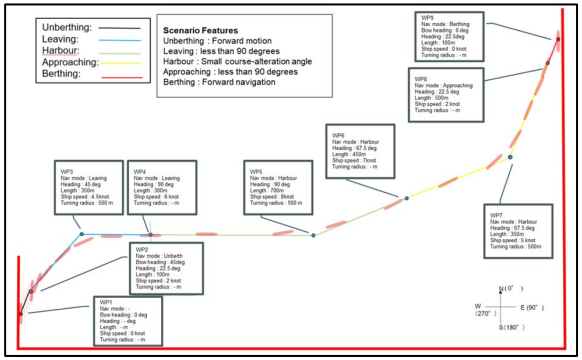
Table I-2 Practical Scenario Set (Selected Scenarios)

No	Practical Elements	Overview Diagram
5	Take evasive action near a waypoint	
6	Navigate near shallow areas	
7	Cross the traffic flow	
8	Navigate into or along a traffic flow	 
9	Navigate near fishing vessels	
10	Navigate within or near the shipping lane	
11	Cross the shipping lane	

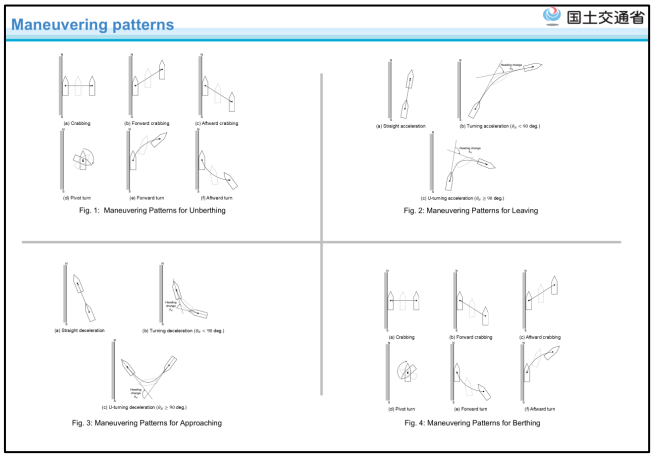
Inspection of automatic flight system (2/2)

(3)Inspection of the execution and monitoring of the route

The applicant shall prepare test scenarios incorporating maneuvering patterns for each navigation mode, such as departure from berth and berthing, with respect to the route execution and monitoring functions of the autonomous navigation system. The applicant shall then verify, through simulation testing, that a vessel equipped with the ANS can control the vessel in accordance with the routes specified in the test scenarios, and submit the results to the ship inspector.



Example of test scenario



2.Risk assessment

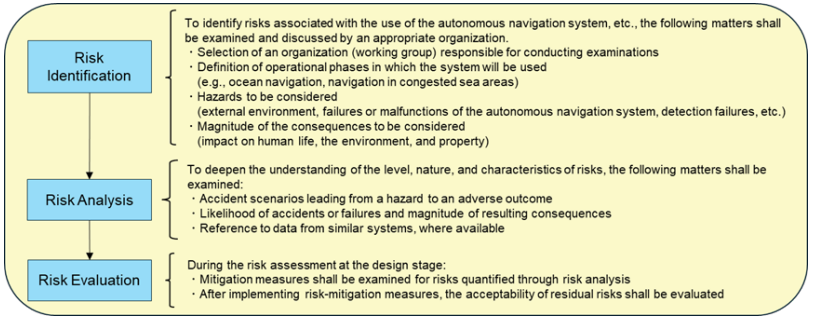
(Detailing the risk assessment steps 1-4 on p. 4)

○Risk assessment in step 1

The applicant shall conduct a review through a committee or similar body composed of subject-matter experts and identify hazards and other risks that should be taken into consideration. Subsequently, the applicant shall perform a risk analysis, including accident scenarios, the likelihood of failures, and the severity of potential consequences, and shall conduct a risk assessment, including risk mitigation measures for each identified risk. The applicant shall then submit the results of the assessment.

○Risk assessment after Step 2

The applicant shall verify that the results of the risk assessment conducted in Step 1 have been appropriately reflected in the detailed design of the autonomous navigation system and that there are no accident scenarios that were overlooked during the assessment. Where necessary, the applicant shall revise and repeat the risk assessment.



Risk assessment in step 1

Maneuvering patterns

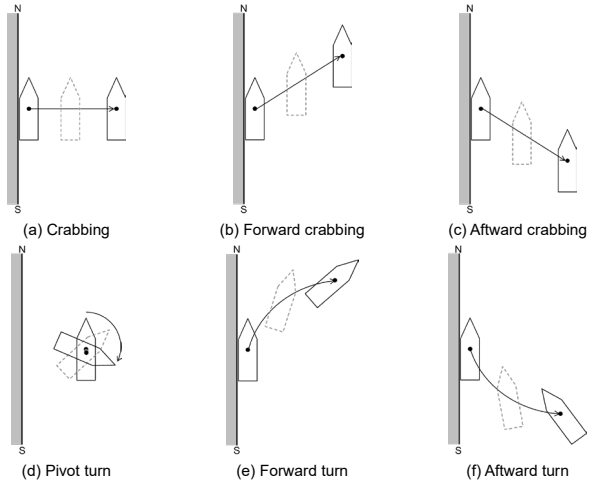


Fig. 1: Maneuvering Patterns for Unberthing

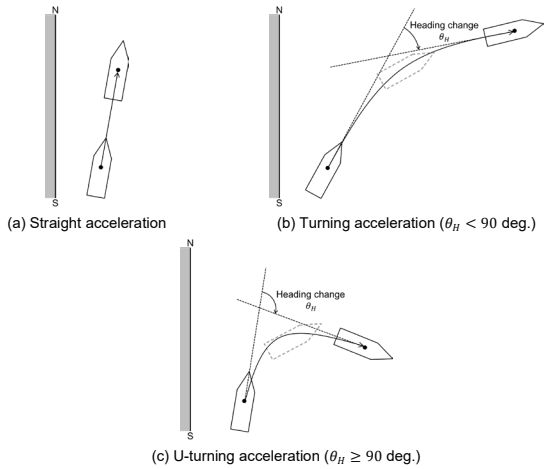


Fig. 2: Maneuvering Patterns for Leaving

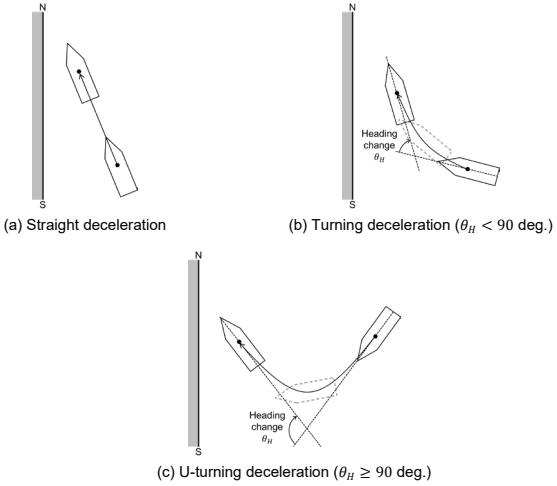


Fig. 3: Maneuvering Patterns for Approaching

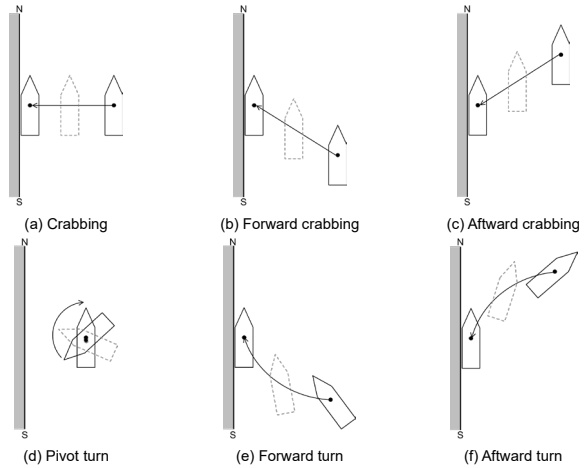


Fig. 4: Maneuvering Patterns for Berthing