MEGURI 2040
Safety Assessment Seminar
(2026.6.29)

Presentation 3:
Evaluation Method for Collision and Grounding Avoidance System (Planner)

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Introduction

MASS entering waters congested with manually operated ships

Navigation requirements for MASS: navigation in compliance with Convention on the International Regulations for Preventing Collisions at Sea
① All one-on-one encounters must be safely avoided
② Navigation that does not pose a danger to surrounding manually operated ships (good seamanship)

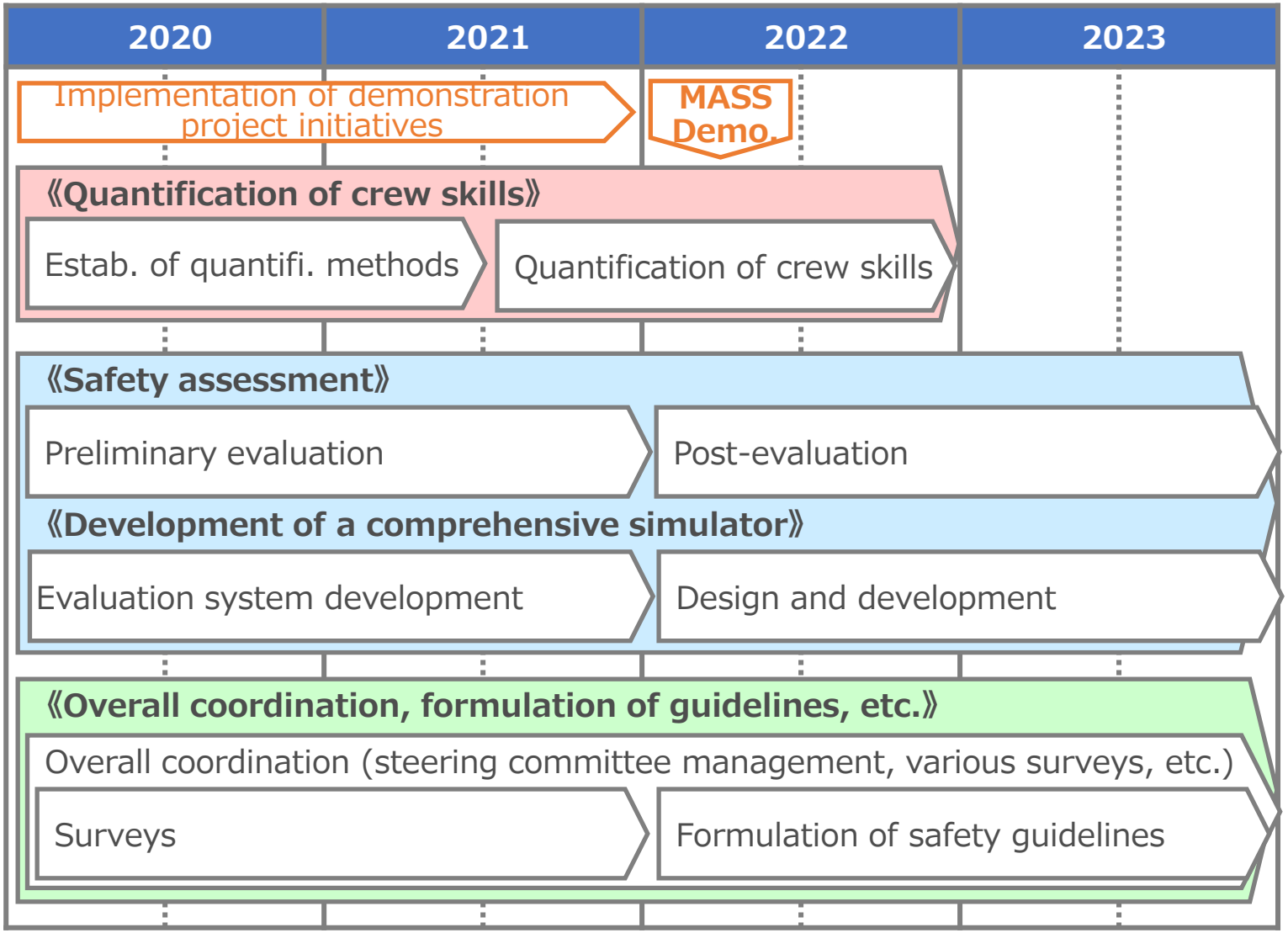
Currently, the numerical calculation results for points ① and ② from the planner are assessed by experts (Captains)

In the near future, point ① will be assessed automatically by accumulating expert assessment data
② will be assessed by experts

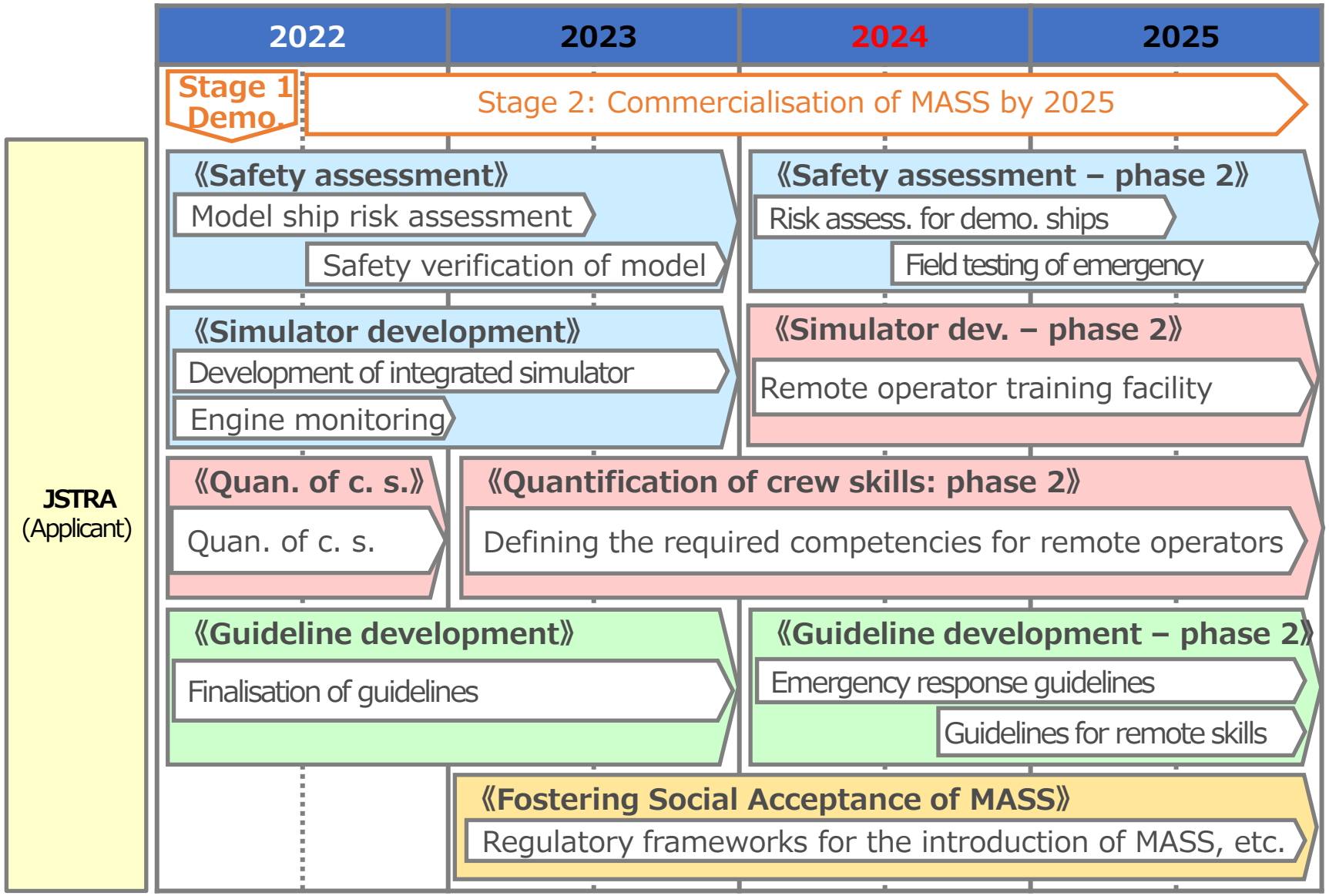
In the distant future, both ① and ② will be assessed automatically by accumulating expert assessment data

In the MEGURI2040 demonstration ship evaluation, the numerical calculation results (FTSS) for items ① and ② from each planner are animated for assessment by experts; cases where assessment is difficult via animation are judged using a shiphandling simulator (SHS) to reproduce the bridge view

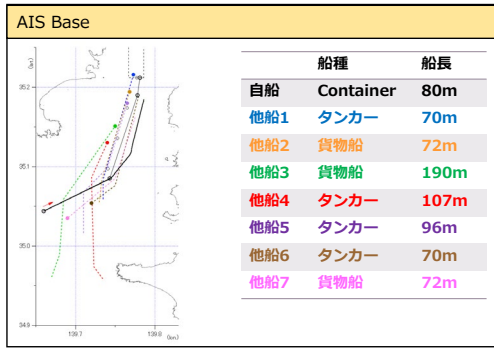
Schedule (Phase 1)



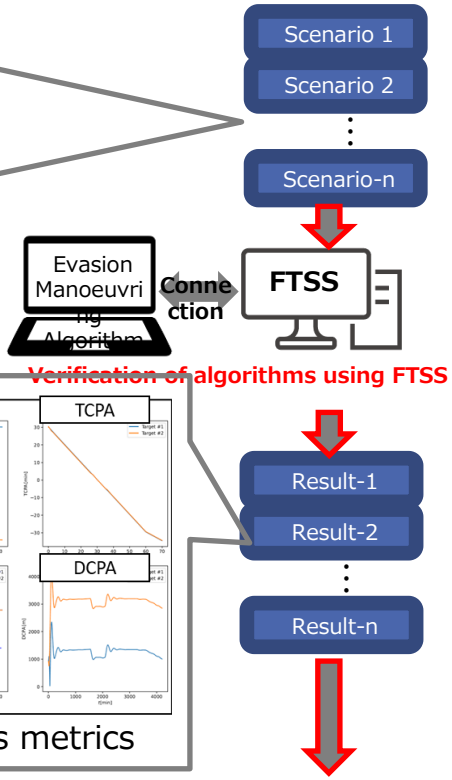
Schedule (Phase 2)



FTSS (Fast Time Ship Simulator)

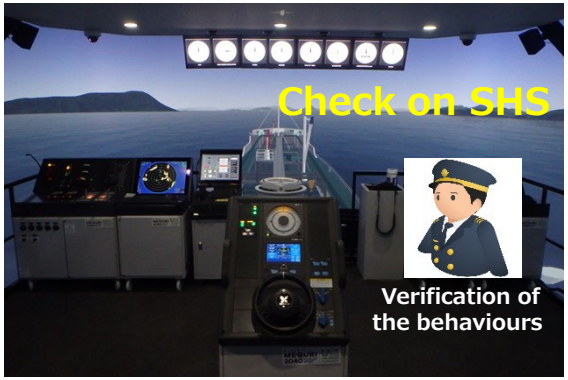


Evaluation scenario set for evasive manoeuvring algorithms



Planner: A device that calculates avoidance routes based on each company's avoidance algorithms

FTSS: High-speed numerical calculation device. Assuming that sensor data is complete and accurate, it connects to each company's planner to rapidly calculate avoidance routes and 13 evaluation metrics.



SHS (Ship Handling Simulator)

SHS: A ship handling simulator that replicates the view from the bridge. Experts evaluate the planner by reviewing the FTSS calculation results where the pass/fail judgement is unclear.

Annex I

Enacted by National Maritime Safety Agency Notice No. 100
(30 June 2025)
Methods for the Inspection of Autonomous Navigation Systems, etc.

Annex I: Testing of Collision and Grounding Avoidance Functions

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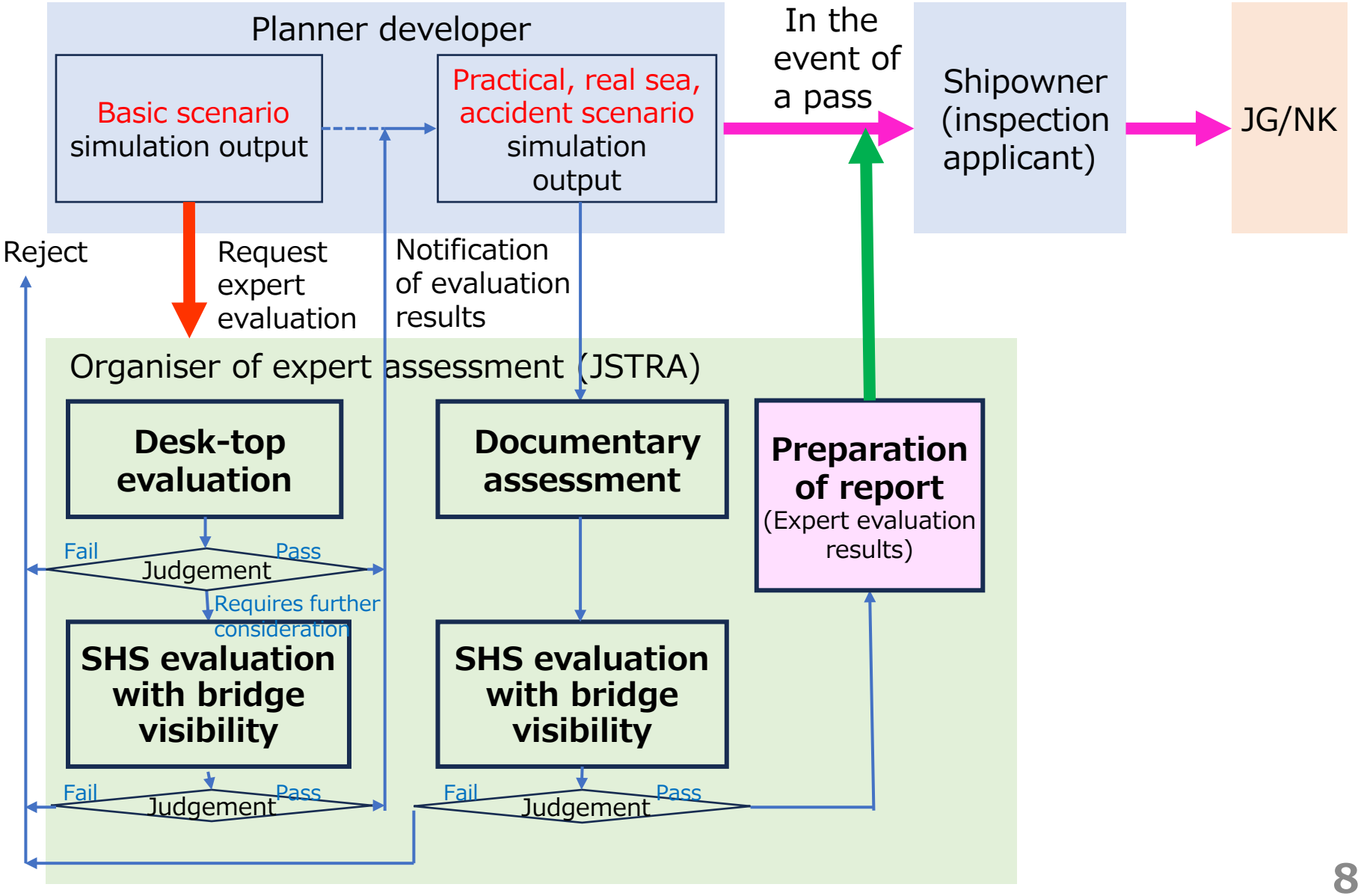
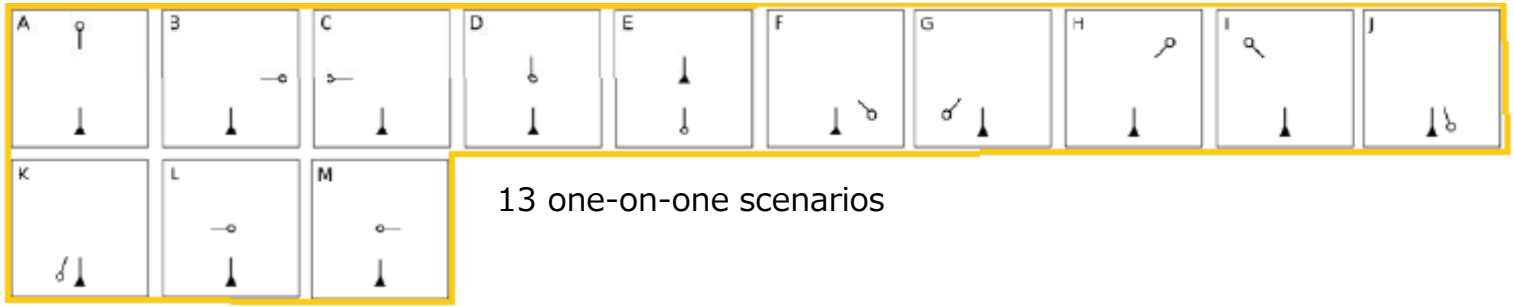
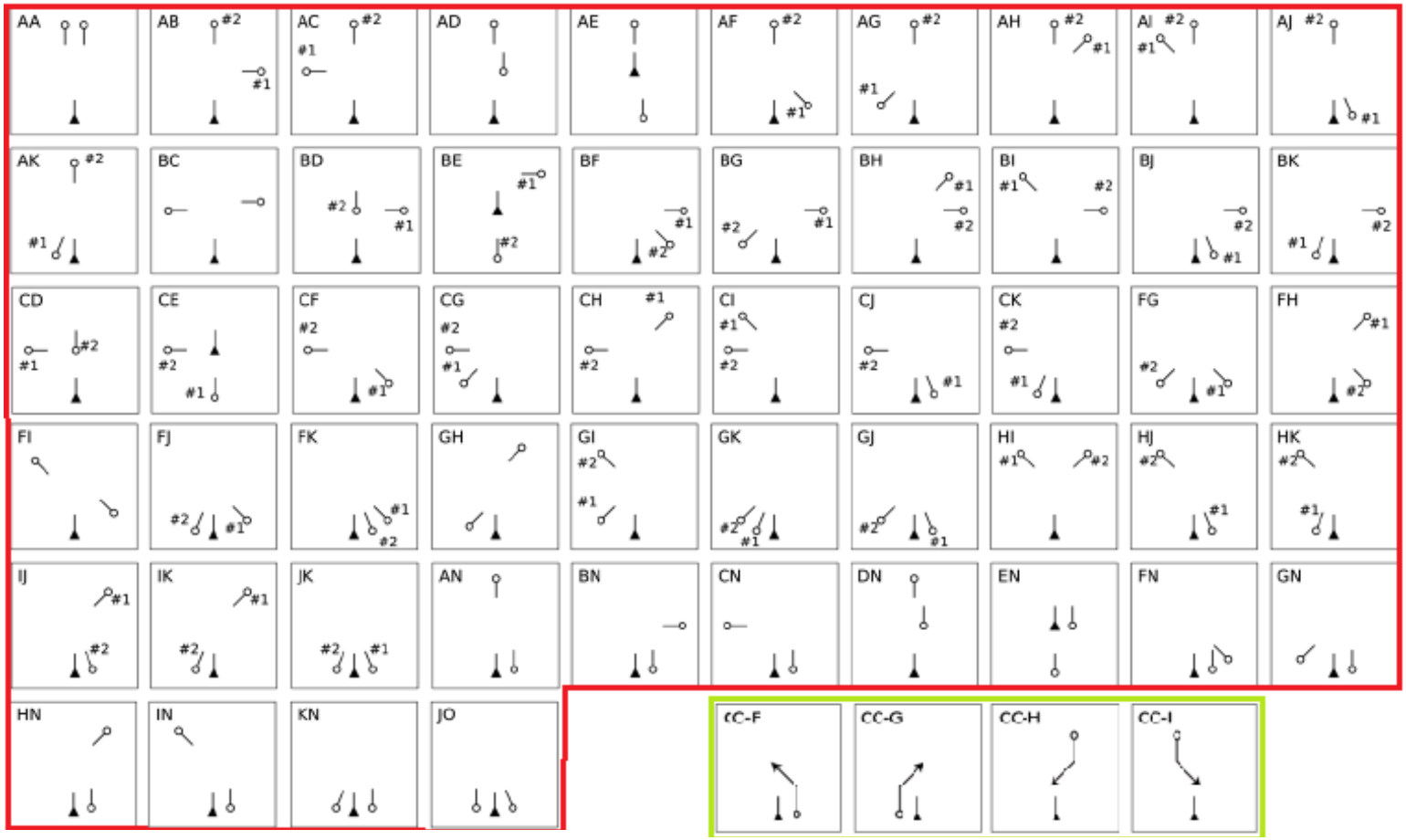
Assessment Flow



Assessment Scenarios (Basic Scenarios)



13 one-on-one scenarios

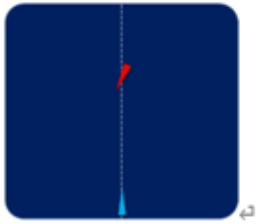
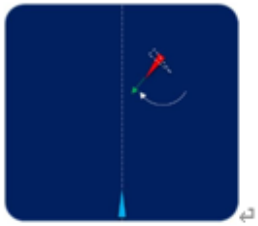
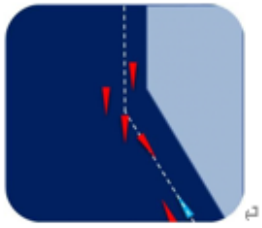


67 one-on-two scenarios

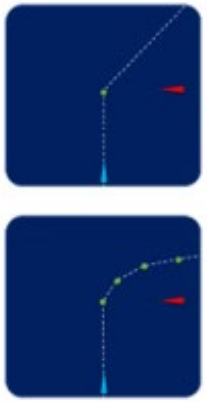
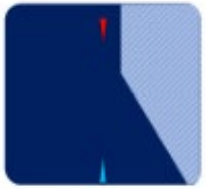
4 one-on-one scenarios involving a change of direction

Assessment Scenarios (Practical Scenarios)

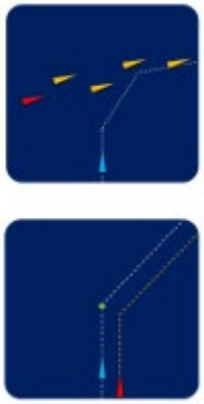
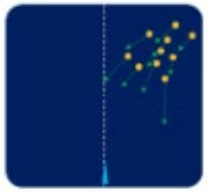
Common scenarios

No	Practical element	Overview diagram
1	The other vessel gives way to this vessel.	
2	The other vessel makes an unexpected maneuver.	
3	A deviation from the navigation plan is detected due to sensor malfunctions or external forces.	
4	It becomes impossible to generate an avoidance route.	

Selected scenarios

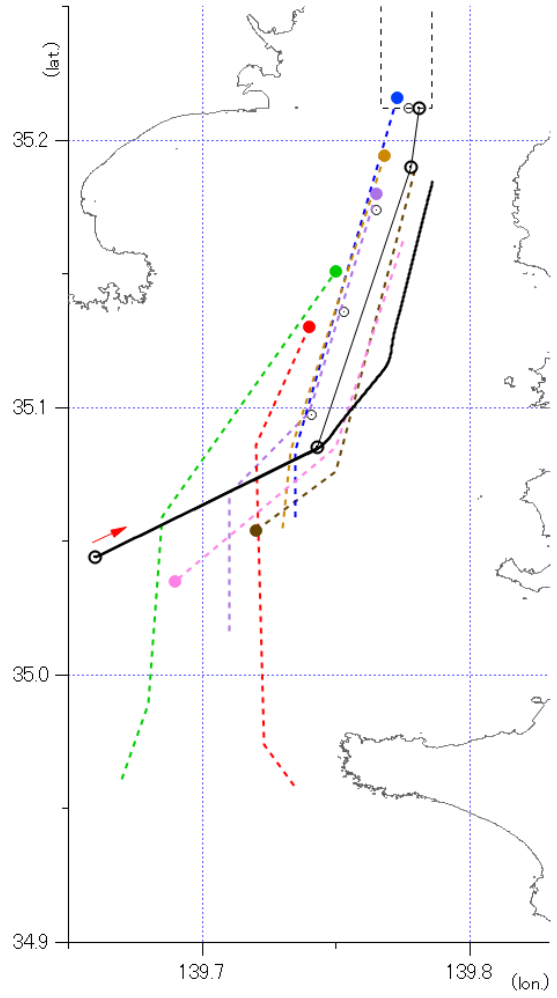
No	Practical element	Overview diagram
5	Maneuver to avoid collision near the waypoint.	
6	Navigating near the shallows.	
7	Crossing maritime traffic.	

Selected scenarios

No	Practical element	Overview diagram
8	Merge into the flow of maritime traffic or navigate alongside it.	
9	Navigating near a group of fishing boats.	
10	Navigating within or in the vicinity of the shipping lane.	
11	Crossing the shipping lane.	

Assessment Scenarios (Real-sea, Accident Scenario)

AIS Base



	Ship type	Length
Own	Container	80m
Other 1	Tanker	70m
Other 2	Cargo ship	72m
Other 3	Cargo ship	190m
Other 4	Tanker	107m
Other 5	Tanker	96m
Other 6	Tanker	70m
Other 7	Cargo ship	72m

Evaluation Metrics

Evaluation metrics

The results of the simulation of the evaluation scenarios shall be output as metrics (below), track plots and animations, and shall be evaluated by multiple experts.

① Minimum distance from the other ship
② Minimum passing distance ahead of the bow of the other ship
③ Minimum passing distance abeam of the other ship
④ Rate of change in relative bearing (to be presented in the format shown in Evaluation Area Diagram[1])
⑤ Maximum rate of turn per minute
⑥ Rate of change of heading per minute
⑦ Crossing distance from the side of the other ship
⑧ Time-series values of collision judgement (CJ)
⑨ Time-series values of subjective collision risk judgement (SJ)
⑩ Time-series values of blocking coefficient (BC)
⑪ Time-series values of environmental stress (ES)
⑫ Change in relative bearing
⑬ Time-series values of rudder angle, speed, DCPA and TCPA

1) Japan Captains' Association, Reports on Verification Tests for the Certification of Automatic Collision Avoidance Systems (in Japanese), https://captain.or.jp/?page_id=11561

Experts

Expert Judgement

Method

The expert judgement shall be conducted through deliberation by multiple experts who satisfy the following qualification requirements 1 and 2. The judgement shall include a determination of conformity with maritime traffic regulations, a decision based on the evaluation metrics and an assessment of the appropriateness of the system's behavior from the perspective of nautical experts. The experts conducting the evaluation shall not be nautical experts employed by the same company.

Qualification Requirement 1

The expert shall satisfy the following requirements and have ship handling experience on ships of the same type in fairways and waters where the navigation rules of the Maritime Traffic Safety Act and the Port Regulations Act apply, within the sea area in which the ship equipped with the ANS, etc. is intended to operate.

-1. When the ship to be equipped has 5,000 GT or more:
The expert shall have ship-handling experience on ships of 5,000 GT or more after obtaining a Third-Grade Maritime Officer (Navigation) license or higher.

-2. When the ship to be equipped has 200 GT or more but less than 5,000 GT:
The expert shall have ship-handling experience on ships of 200 GT or more after obtaining a Fourth-Grade Maritime Officer (Navigation) license or higher.

-3. When the ship to be equipped has less than 200 GT:
The expert shall have ship-handling experience on ships after obtaining a Fifth-Grade Maritime Officer (Navigation) license or higher.

Experts

Expert Judgement

Qualification Requirement 2

-1. A pilot

-2. A judge or investigator of Japan Marine Accident Tribunal (limited to those who hold a First-Grade Maritime Officer (Navigation) license, or professor, associate professor, or person with equivalent experience at the Marine Technical College or an equivalent institution)

-3. A maritime counsellor (limited to those who hold a First-Grade Maritime Officer (Navigation) license, or professor, associate professor, or person with equivalent experience at Japan Agency of Maritime Education and Training for Seafarers)

-4. A maritime education instructor

-5. A former Japan Coast Guard officer with experience working at a Maritime Traffic Centre

Demonstration Ships

Types of Ships and Overview	Overview & Goals	Route	Main Developers
Newly built regular domestic container ship 'Genbu'  (total length 134.9m)	A newly built inland container ship equipped with all the necessary systems for unmanned ships. Developed as an unmanned vessel from scratch, it features advanced autonomous navigation functions, remote monitoring of the engine section, and labor-saving technologies during mooring. We aim to maximize the reduction of crew burden through unmanned vessel technology.	Kobe — Osaka — Nagoya — Shimizu — Yokohama — Tokyo	MTI has 15 other companies
Remote Island Route Ship 'Olinpia Dream Seto'  (Total length: 65m)	While maintaining the routes of Japan's 400 manned remote islands remains a challenge, we aim to support crew shortages through the automation of our vessels and ensure stable transportation of people and goods for island residents.	Shin-Okayama Port — Tonosho Port (Shodoshima)	Japan Marine Science and four other companies

Source: https://www.nippon-foundation.or.jp/who/news/pr/2026/20260327-120768.html

Demonstration Ships

Types of Ships and Overview	Overview & Goals	Route	Main Developers
RORO ship 'Daini Hokuren Maru'  (total length 173.8m)	The RORO vessel carries agricultural products for a round trip of about 1,600 km from Kushiro to Hitachi. We aim to demonstrate commercial operation on routes that include crowded fishing vessel areas and areas with dense fog.	Kushiro — Hitachi	Kawasaki Kisen and 3 other companies
Domestic container ship 'Mikage'  (overall length 96.81m)	The 'Mikage,' which is also a demonstration vessel in the first stage, is the most widely used 749 gross ton container ship in Japan. By raising the automation of this vessel to a level of social implementation, we aim to promote the adoption of unmanned ships.	Kobe — Nagoya	Mitsui O.S.K. Lines and 3 other companies

Source: https://www.nippon-foundation.or.jp/who/news/pr/2026/20260327-120768.html

Demonstration Ship Evaluation Schedule

Demo. Ship	PD	'25 Aug.	Sep.	Oct.	Nov.	Dec.	'26 Jan.	Feb.	Mar.
Olinpia Dream Seto	*A*	Request			Pass				
	B		Request		Pass				
	C		Request		Pass				
Mikage	*D*		Request						Pass
	E		Request						Pass
Genbu	*F*	Request				Pass			
	G		Request			Pass			
Daini Hokuren Maru	*H*			Request			Pass		

Expert evaluation criteria

➢ Failure criteria

・Violation of regulations
・Unacceptable dangerous maneuvering

➢ Examples of failure

・When two opposing ships are approaching, attempting to pass between them.

・When encountering two opposing ships, narrowing the avoidance space for the second ship while avoiding the first.

・When encountering two opposing ships, proceeding into the path of the second ship while attempting to return to the original course after avoiding the first.

・Crossing directly behind a fishing ship that may be trawling.

Key opinions from the expert assessment

➢ Comments from experts

- As avoidance manoeuvres differ before and after a head-on situation, please calculate them separately
- Some metrics need not be mandatory

➢ Comments from Chair Imazu

- Each basic scenario requires three patterns: before and after the encounter, and a situation where the other ship behaves unexpectedly and the ship is forced into a corner
- An allowable angle that aids in confirming the fulfilment of obligations in the event of a collision should be added to the metrics

➢ Comments from JG/NK

- We would like to hear the experts' views on decision-making in cornered situations
- Both the planner developer and the experts should understand the intent behind the practical and real sea scenarios
- We would like the planner developer to prepare explanatory materials for each of the practical, real sea and accident scenarios

Key opinions from the expert assessment

➢ Comments from the JSTRA

- We would like the planner developer's representative to be on standby during the expert evaluation

➢ Comments from the planner developer

- We would like to avoid situations where experts give differing opinions on the same calculation results
- We would like the experts to understand the differences in practice between domestic and international shipping

Conclusion (2040 Forecast)

A 50-50 mix of manually operated ships and MASS

Navigation requirements for MASS: navigation in compliance with Convention on the International Regulations for Preventing Collisions at Sea
① All one-on-one encounters will be safely avoided
② Navigation that does not pose a danger to surrounding manned ships
③ Navigation that does not pose a danger to other ships in the vicinity equipped with another planner

Mechanical determination of ①, ② and ③ by accumulating expert judgement data
→ Standardisation of manoeuvres by the planner

Navigation required of ships operated by human crews: navigation in compliance with Convention on the International Regulations for Preventing Collisions at Sea
① All one-on-one encounters must be safely avoided
② Navigation that does not endanger other manned ships in the vicinity (good seamanship)
③ Navigation that does not endanger MASS in the vicinity (good seamanship)
→ Maneuvering in the same manner as surrounding MASS