International Student Design Competition 2020

ITS Institut Teknologi Sepuluh Nopember

Department of MARINE ENGINEERING

Nawasena ITS Team

First Prize Winner Presentation

Innovation and development for new generation of cruise ships:

An Integrated And Responsive Design for Safety System and equipment

Designed and Created by

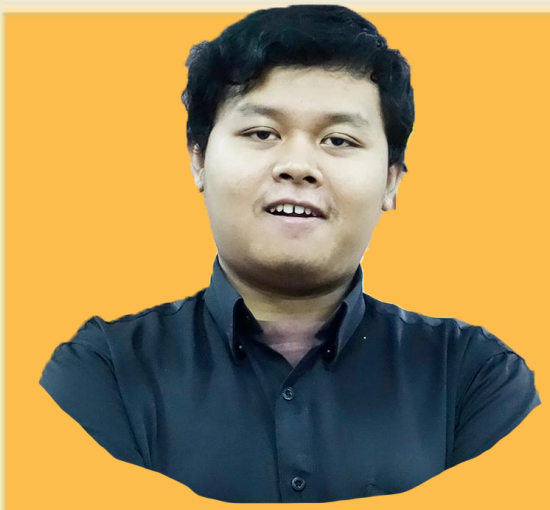
NAWASENA ITS TEAM DELEGATION **FOR CLIA Competition**

Bima Surya Wicaksana

Yohanes Pangestu Timur

Contact Team Official :

nawssenaits@gmail.com



Imam Anthony Muslim

Kevin Rizqul Habib

NAWASENA ITS TEAM
AT GLANCE

Faculty Advisor

DR.IR. AGOES SANTOSO, M.SC., M.PHIL. MRINA.,

- Professional Expert in Naval and Ship Design
- Lecturer of Marine Engineering Department ITS
- Expert field in Ship and Offshore machinery and automation system

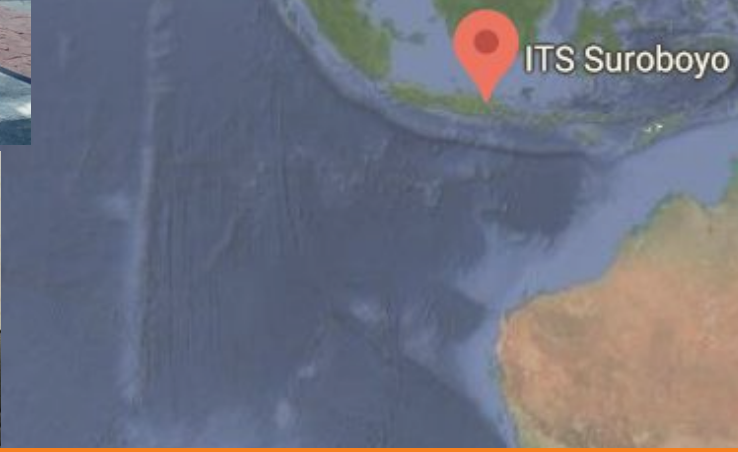
DR. ACHMAD BAIDOWI, S.T., M.T.
Professional Expert in Naval and Ship Design
Lecturer of Marine Engineering Department ITS
Expert field in ship construction, ship hydrodynamics, and offshore renewable energy

ITS Department of MARINE ENGINEERING

INDONESIA ITS NAWASENA

Indonesia is an maritime archipelago nation, where maritime culture running throught our vein.
Granted with many potential of maritime and nature based tourism, Indonesia tourism resource has no limit.

INSTITUT TEKNOLOGI SEPULUH NOPEMBER



MARINE ENGINEERING DEPARTMENT

NAWASENA ITS TEAM AT GLANCE

NAWASENA ITS TEAM is established to be the leading student-based research team in Indonesia and the world with a focus on design and innovation in water transportation that is affordable, safe, reliable, efficient and go-green

TEAM MEMBERSHIP CONSISTING THE UNDERGRADUATE STUDENTS OF MARINE ENGINEERING

In collaboration between

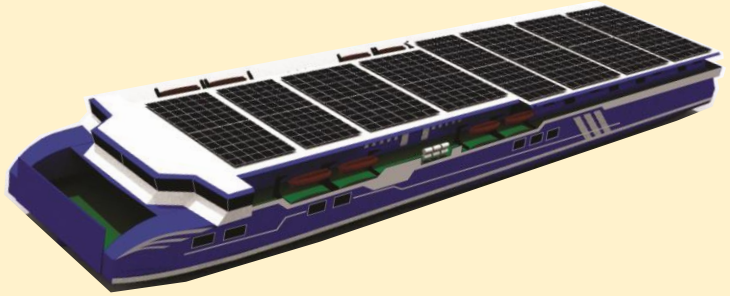
ITS Department of MARINE ENGINEERING

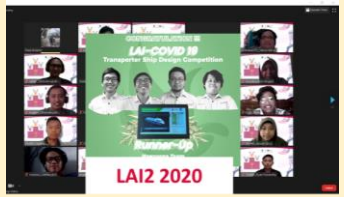
MMD Marine Manufacturing and Design MARINE ENGINEERING DEPARTMENT FACULTY OF MARITIME TECHNOLOGY ITS

HOCHSCHULE WISMAR UNIVERSITY OF APPLIED SCIENCES TECHNOLOGY, BUSINESS AND DESIGN

NAWASENA ITS TEAM

ACHIEVEMENTS AND PROJECTS





Event	Title	Place
Worlwide Ferry Safety Association(WFSA) Design Competition 2018	2nd Winner	New York, USA
Worlwide Ferry Safety Association(WFSA) Design Competition 2019	2nd Winner	Bangkok, Thailand
Worlwide Ferry Safety Association(WFSA) Design Competition 2020	Honorable Mention	New York, USA
LAI2 COVID – Ambulance Design Comp	2nd Winner	Indonesia
KKCTBN (National Autonomous Ship Competition) 2020	1 Gold medal, 2 silver medal	Indonesia
CLIA – International Student Design Competition 2020	1ST Winner	-

Design Background

Design Requirement

- Design for Cruise Ship with length 340 m and capacity 7000 persons
- Design operating area for global and non-polar
- Design Service life for 40 years
- Compare with references in IMO SOLAS and LSA Code
- Seaworthiness and post-evacuation survivability

Problem Design

- Cruise ship accident mostly occur on the slow evacuation process
- Uncoordinated and limited handful crew to manage the passenger make it worst
- Inefficient safety procedure induction to the passenger
- Human sense of panic during accident being one of worst cause of casualties

Life Saving System Overview

LIFE BOAT

LIFE RAFT

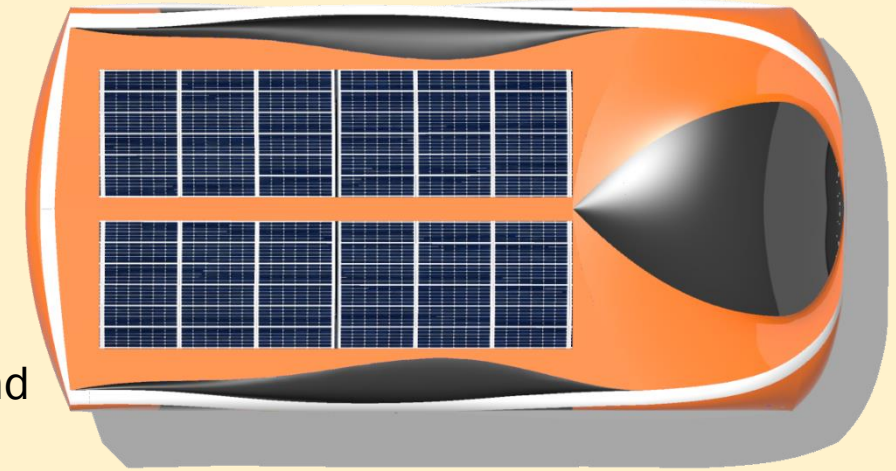
SKY LIFT

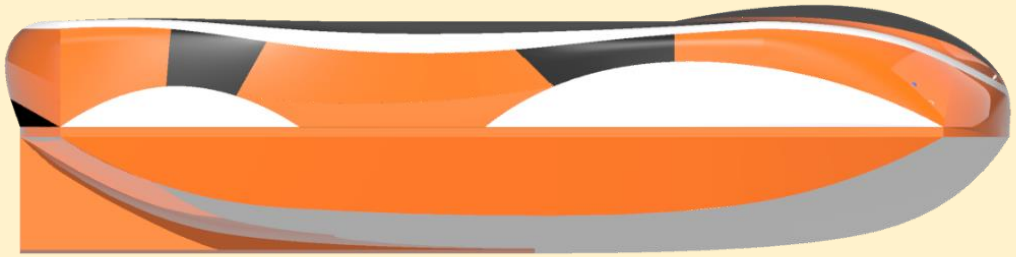
ESCAPE CHUTE

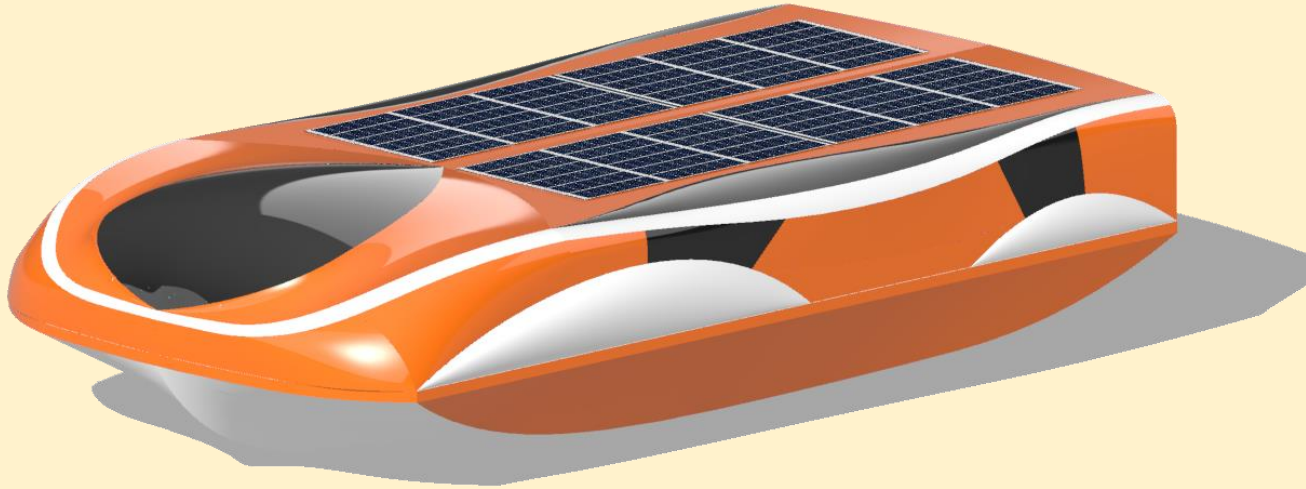
EVACUATION MANAGEMENT

Life-Boat NWB01

- Monohull concept
- Electrical propulsion twin's screw
- Power Supply for navigation and lighting from solar panel
- The used material is fiberglass because it has a lighter density and strong

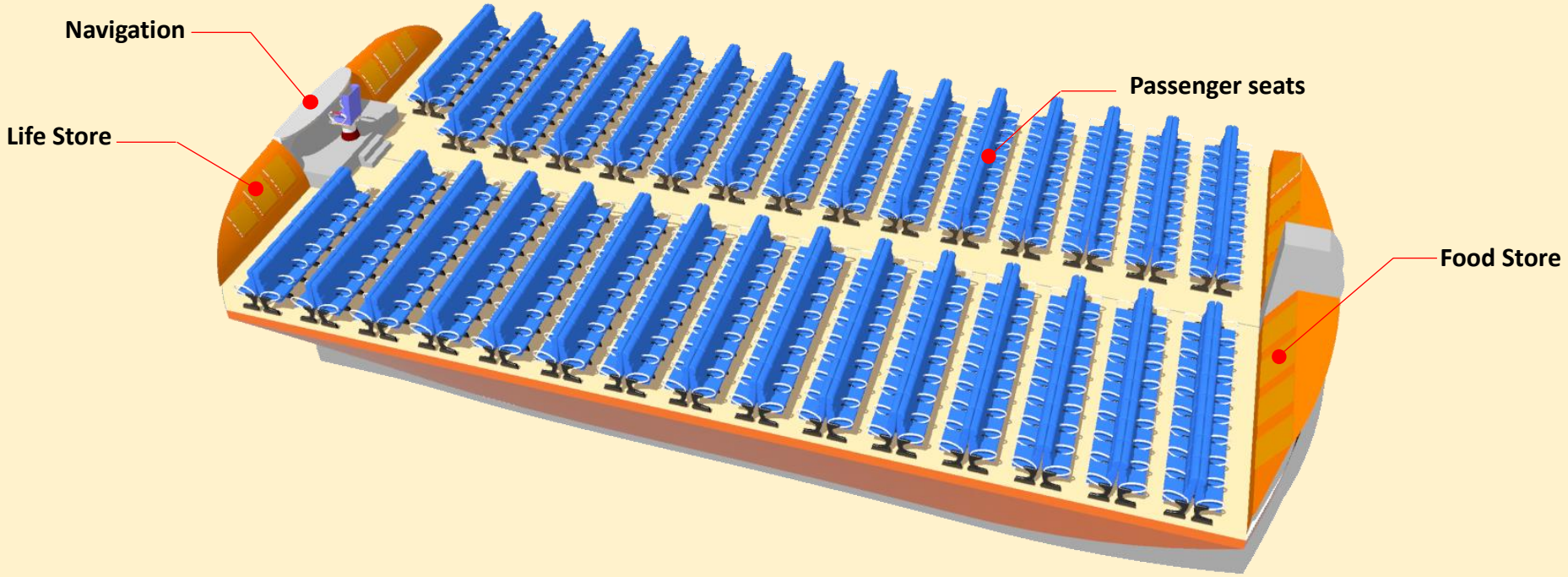






Life-Boat NWB01

Length	20 m
Beam	10 m
Draft	1 m
Hight	3,9 m
Vs	10 knot
Capacity	533 p
Light Weight	62,8 ton



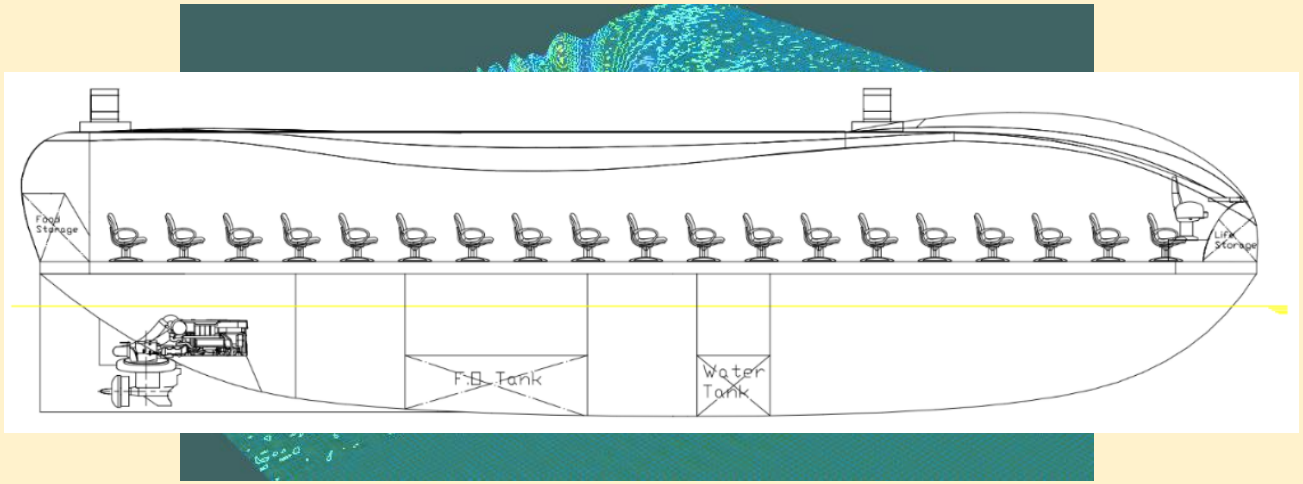
- NWB01 is designed with long seats and short seat
- There are 15 row with 14 long seats and 1 short seat each side.
- Each long seat has 18 space for each person.
- The short seat has 14 space for each person.

Life-Boat NWB01

Propulsion and Machinery System

- Lifeboats are needed to simulate resistance in order to determine the power to be applied at NWB01.

- Lifeboat is designed to be able to sail for 3 days so that fuel needs must be sufficient and the need for clean water must also be fulfilled.

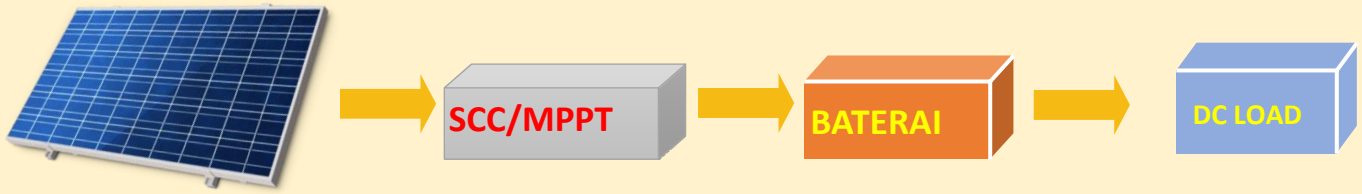


Resistance	54,2 kN
BHP	557,48 kW
Engine	2 x 311 kW

Endurance	3 days
F.O Tank	12,6 ton
Water Tank	3,6 ton

Life-Boat NWB01

Power Source for electric equipment



Total Power Electrical	12,52 kWh
AH Requirement	1210 AH
Battery Capacity	14 x 90 Ah

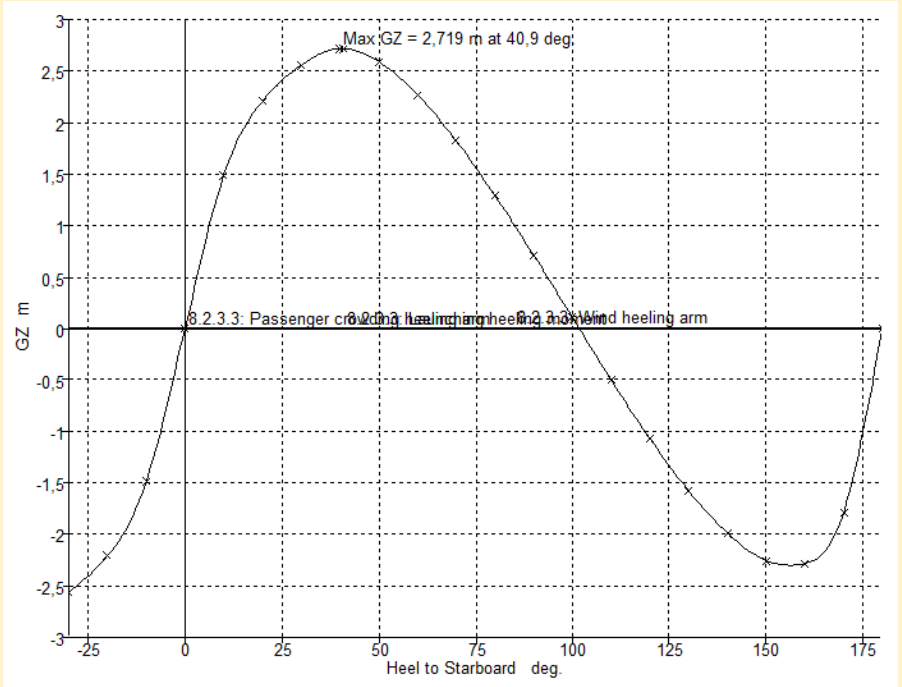
- The source of electricity used comes from solar panels that are placed on the top deck of Lifeboat.

Life-Boat NWB01

Sea Worthiness

- Calculations are made in 3 conditions of load case.
  1. Load 1 : Full Passenger and full tank
  2. Load 2 : No Passenger and full tank
  3. Load 3 : No Passenger and empty tank
- Each condition has a safe value for seagoing based on the criteria SOLAS II-1/8.

Code	Criteria	Value	Units	Loadcase 1	Loadcase 2	Loadcase 3	Status
SOLAS, II-1/8	8.2.3.3: Maximum residual GZ (method 1)						Pass
	8.2.3.3: Passenger crowding heeling arm	0,040	m	2,719	2,650	3,013	Pass
	8.2.3.3: Launching heeling moment	0,040	m	2,719	2,650	3,013	Pass
	8.2.3.3: Wind heeling arm	0,040	m	2,705	2,634	2,982	Pass
SOLAS, II-1/8	8.2.4.a Maximum GZ (intermediate stages)	0,050	m	2,719	2,650	3,013	Pass
SOLAS, II-1/8	8.2.4.b Range of positive stability (intermediate stages)	7,0	deg	101,7	98,7	104,1	Pass
SOLAS, II-1/8	8.6.3: Margin line immersion - GZ based (EquilAngle ratio)	100	%	0,04	0,03	0,01	Pass



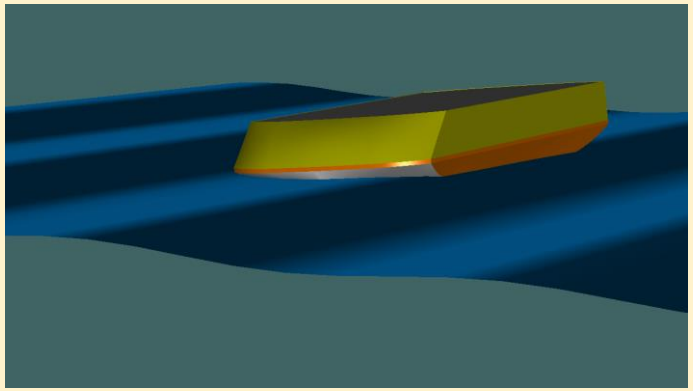
(graph GZ for Load 1)

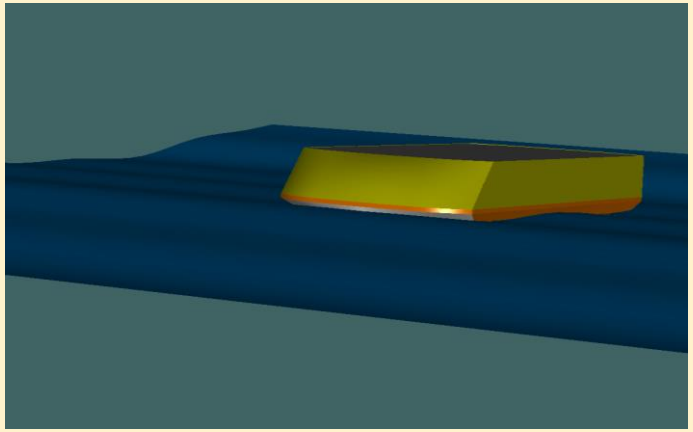
Life-Boat NWB01

Seakeeping

- The design is tested with motion and seakeeping simulation in the such sea condition (sea-state)
- Overall, for testing Beaufort sea-state 4- Beaufort sea-state 8, the discomfort level are below the maximum discomfort passenger in evacuation scenario

Test on 10 knot Speed					
Seastate	Wave heading			Wind Speed	Limit Check
	Head	Beam	Quarter		
4	0,557	0,205	0,087	16	Safe
5	0,926	0,342	0,144	21	Safe
6	1,295	0,478	0,202	27	Safe
7	1,665	0,615	0,26	33	Safe
8	2,036	0,751	0,318	40	Safe
9	3,701	1,366	0,578	47	Safe

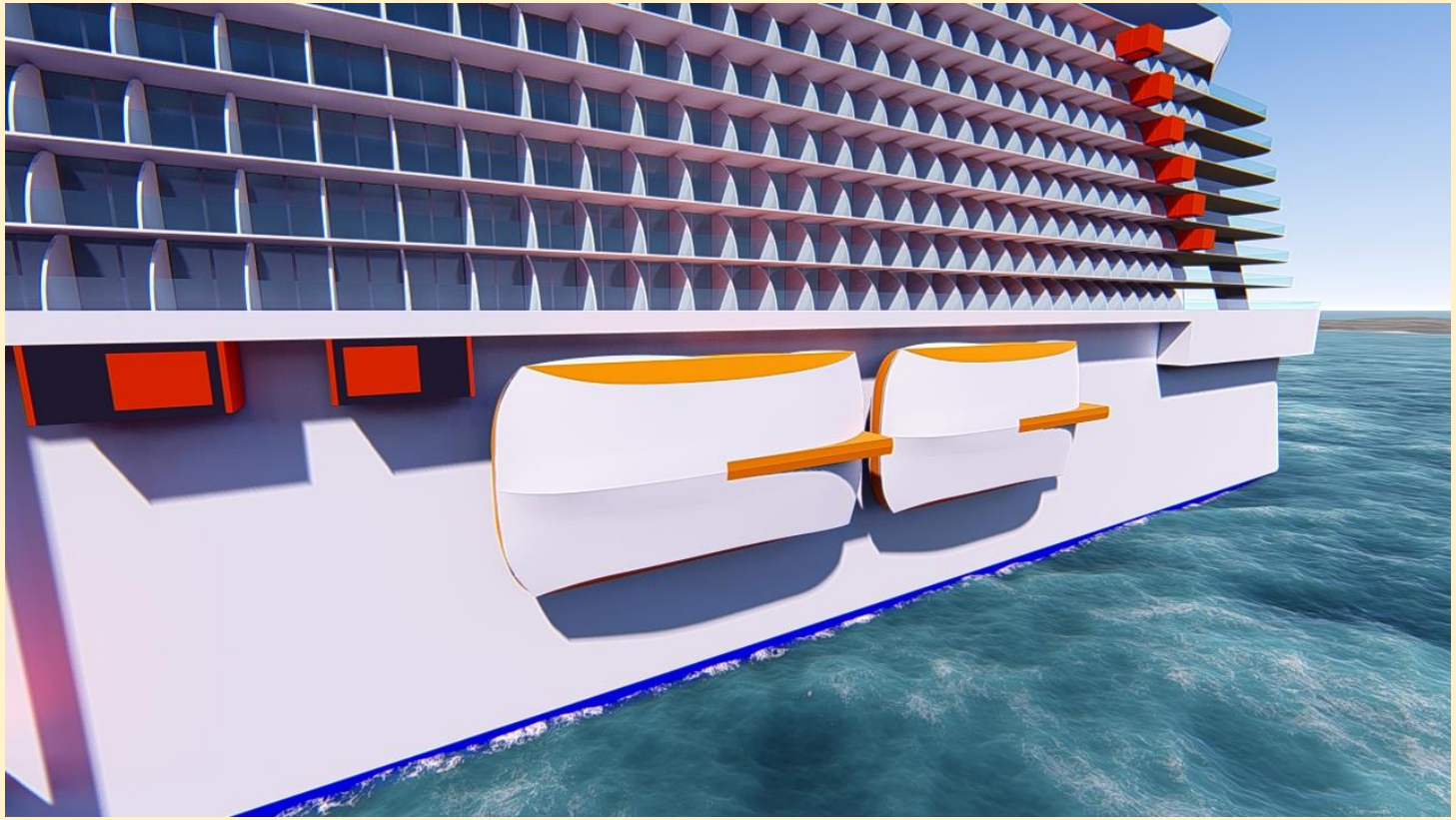




Life-Boat NWB01

Interface of NWB01

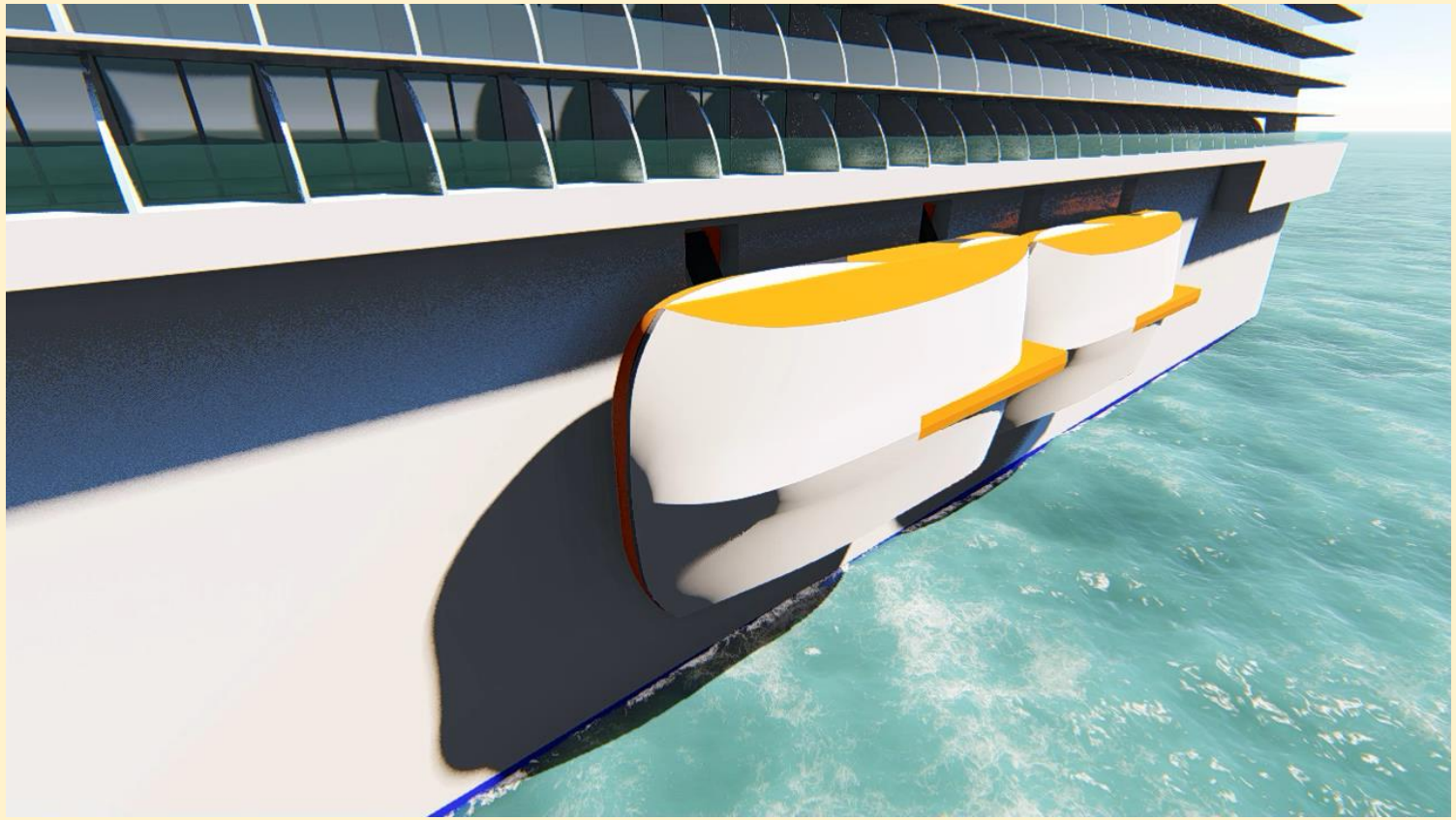
- Position where the lifeboat not used.
- Roll 90 degrees so not make large footprint
- There are 4 lifeboats each side



Life-Boat NWB01

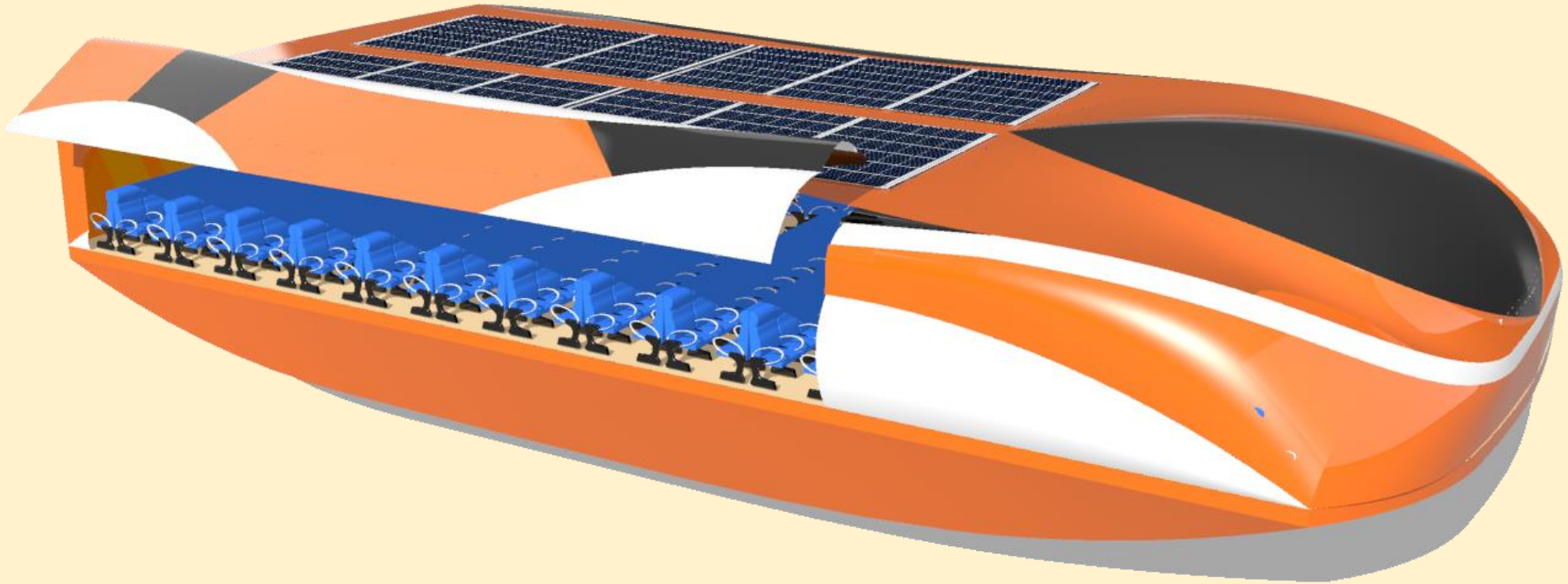
NWB01 Mechanism

- There is a hydrostatic piston unit provided at the side. the piston is connected to the operating lever via a link.
- Lifeboat can reach position when the passengers can enter into it.



Life-Boat NWB01

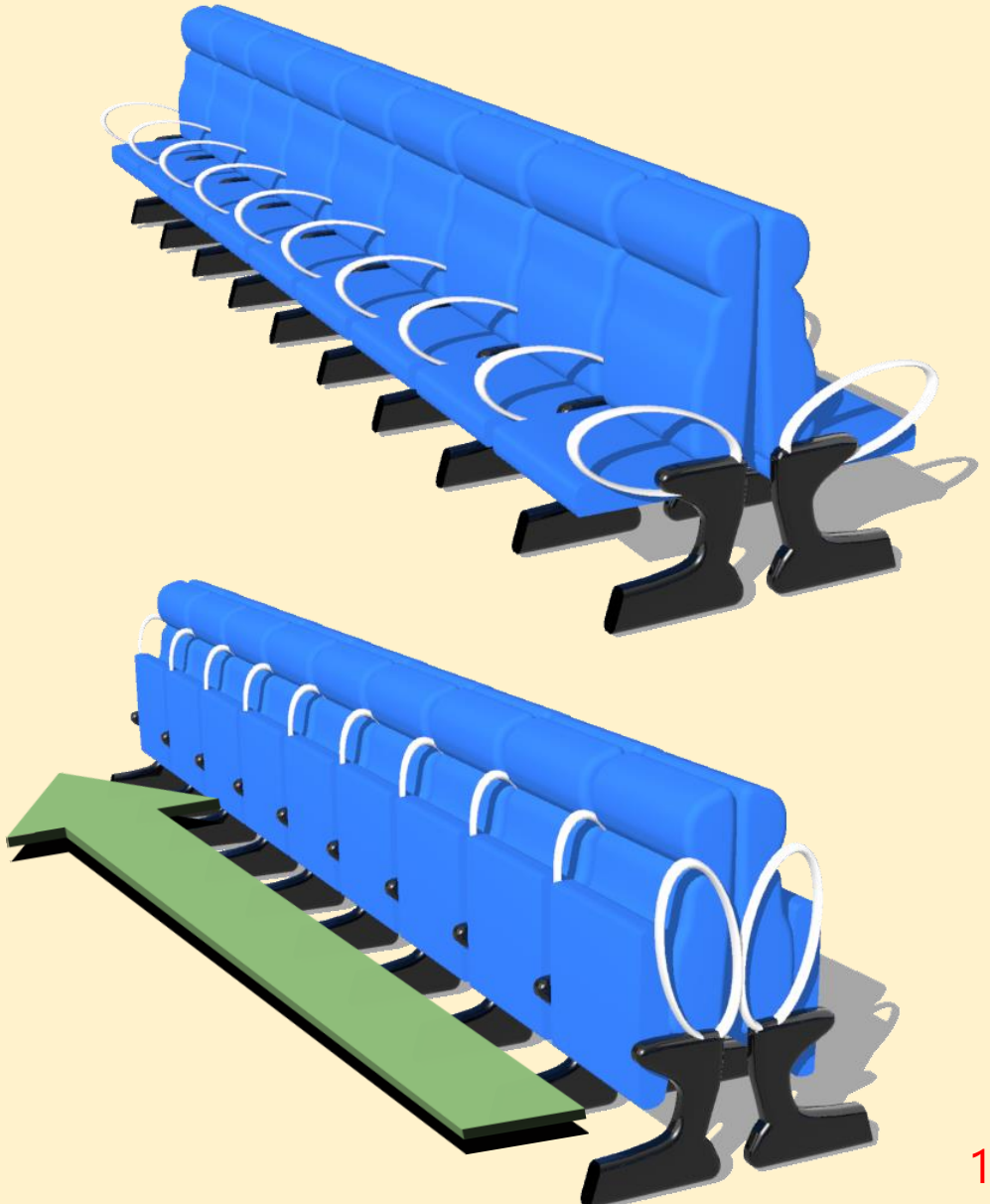
- Ramp door lifeboat will open widely on the one side
- Passengers can easily enter the lifeboat



Life-Boat NWB01

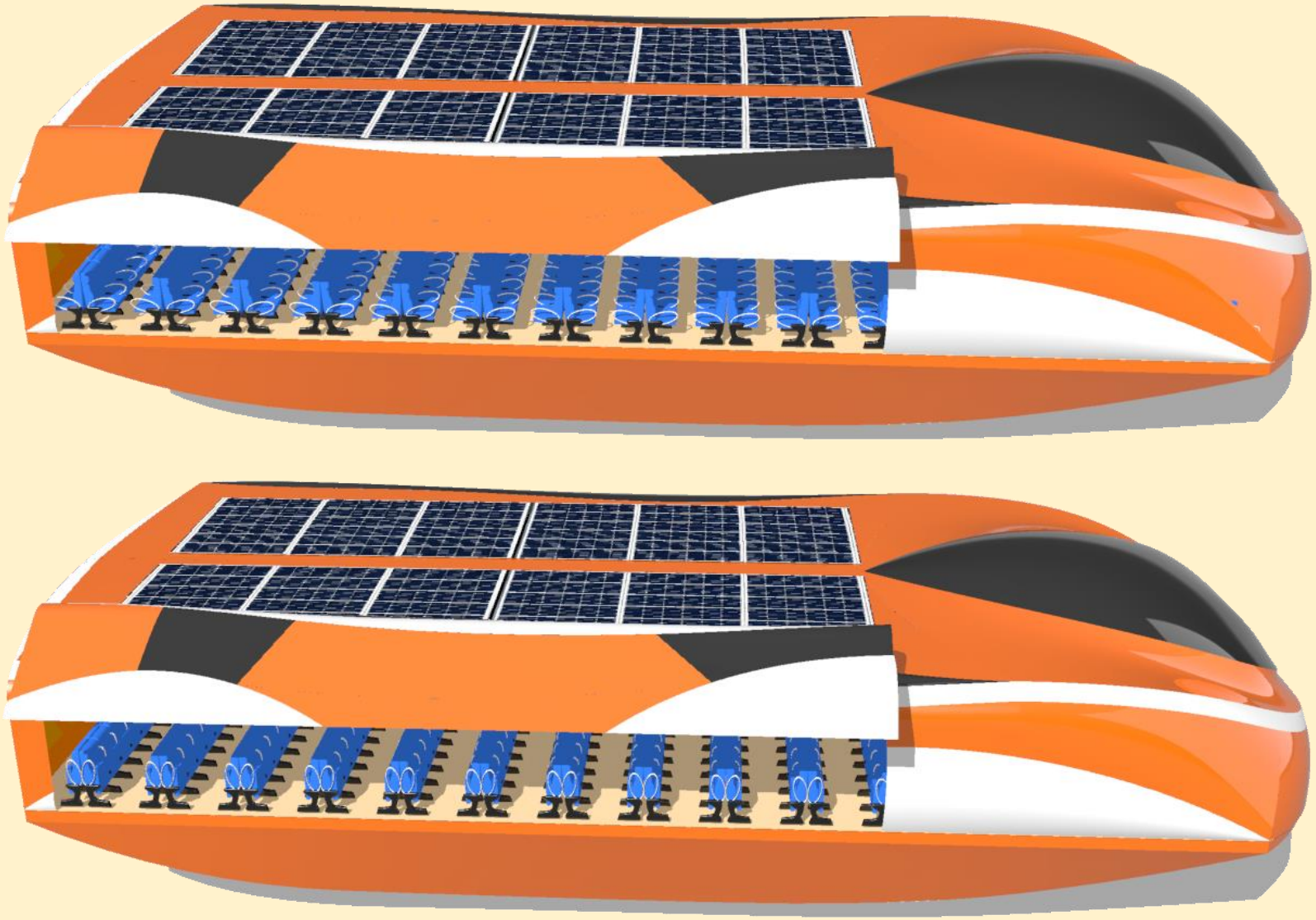
Design Seat

- Seat will be unfolded when person sit on it
- When seats are not used, they will be folded and there will make space for passenger to walk



Life-Boat NWB01

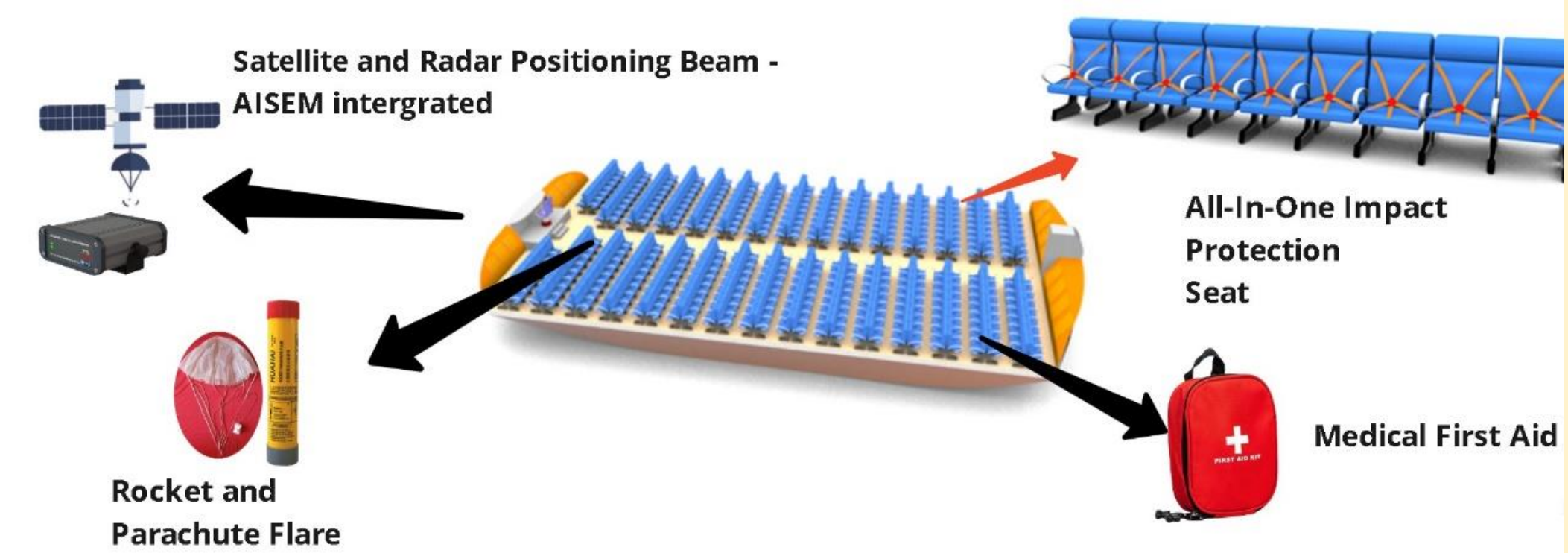
- The seat when folded and unfolded look like that at lifeboat
- There are 10 spaces that can be used for passengers to walk in



Life-Boat NWB01

- Mechanism can release the lifeboat with wire
- Lifeboat can voyage after fully deployed into sea

Life-Boat NWB01



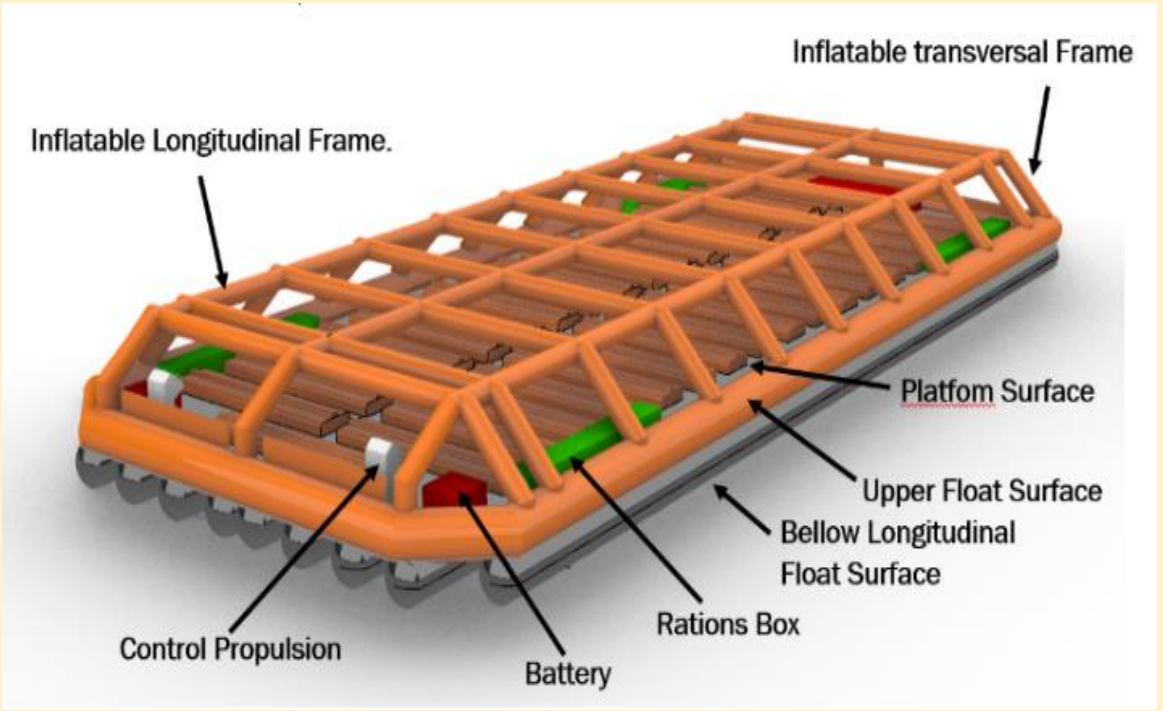
- The lifeboat as required by the IMO MSC LSA CODE, supposed to be equipped with SAR (Search and Rescue) equipment.
- The seats are equipped with seat belts with 5 branches so passengers will be safer from boat shocks.

Life-Raft NW-LR1

Shape and Dimension

"NW-LR1" life-raft consists of 5 main parts, that are

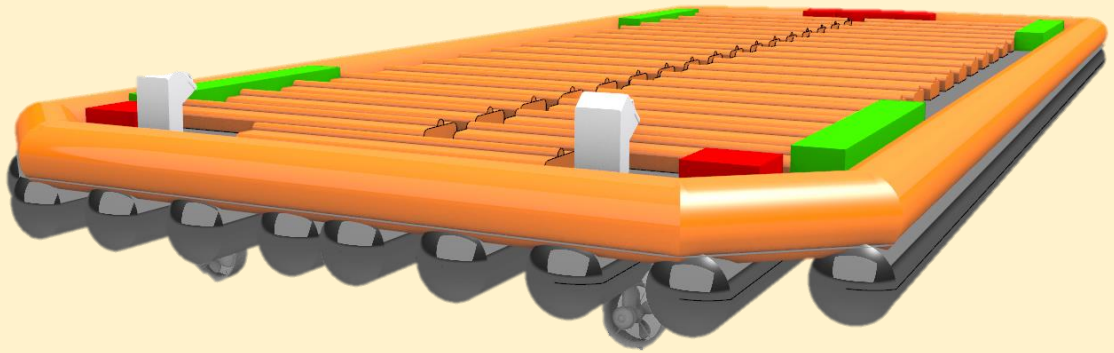
- Bellow Longitudinal Float Surface
- Upper Float Surface
- Platform Surface
- Inflatable transversal Frame, and
- Inflatable Longitudinal Frame

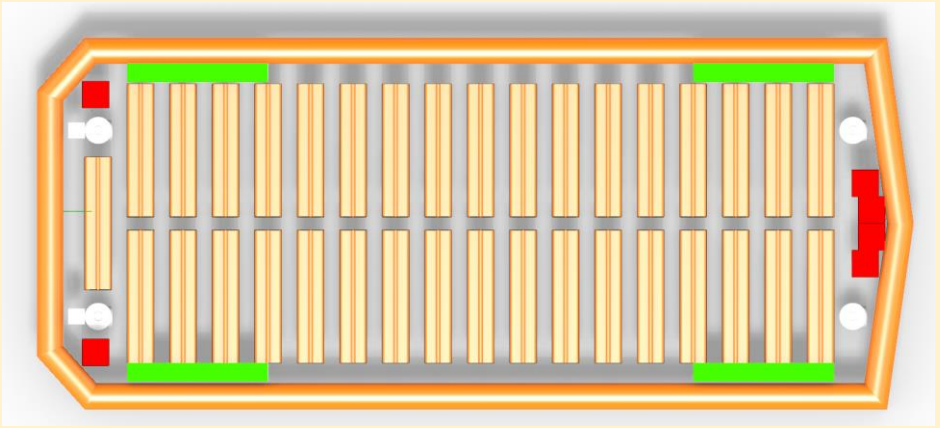


Life raft Dimension	
Length	33 m
Breath	14 m
Height	3.45 m
Cap.	700 Persons
Vol	740 m3
Weight	12.6 ton

Life-Raft NW-LR1

- life-raft will be connected with Inflatable Evacuation Chute, which is attached in ship's deck,



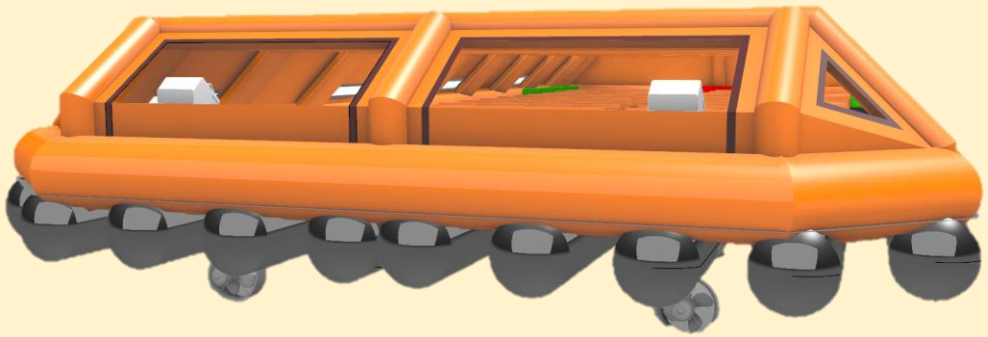


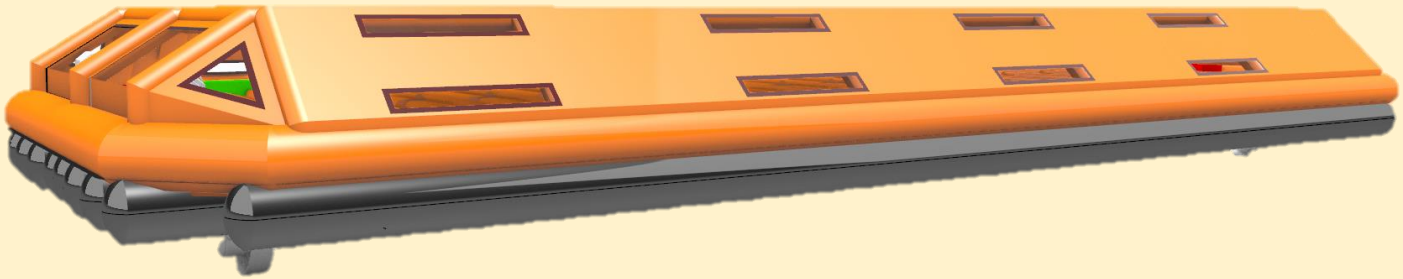
- In Survivability, based on IMO MSC LSA CODE about survival at Sea, the life-raft is designed with food's stock that 10000 KJ and 1.5 l fresh water for each person in 30 days.

Life-Raft NW-LR1

- In seaworthiness performance, the life-raft is used material PVC for its skin. The electric self-propulsion motors with battery is also attached at life-raft to support the stability and surge motion.

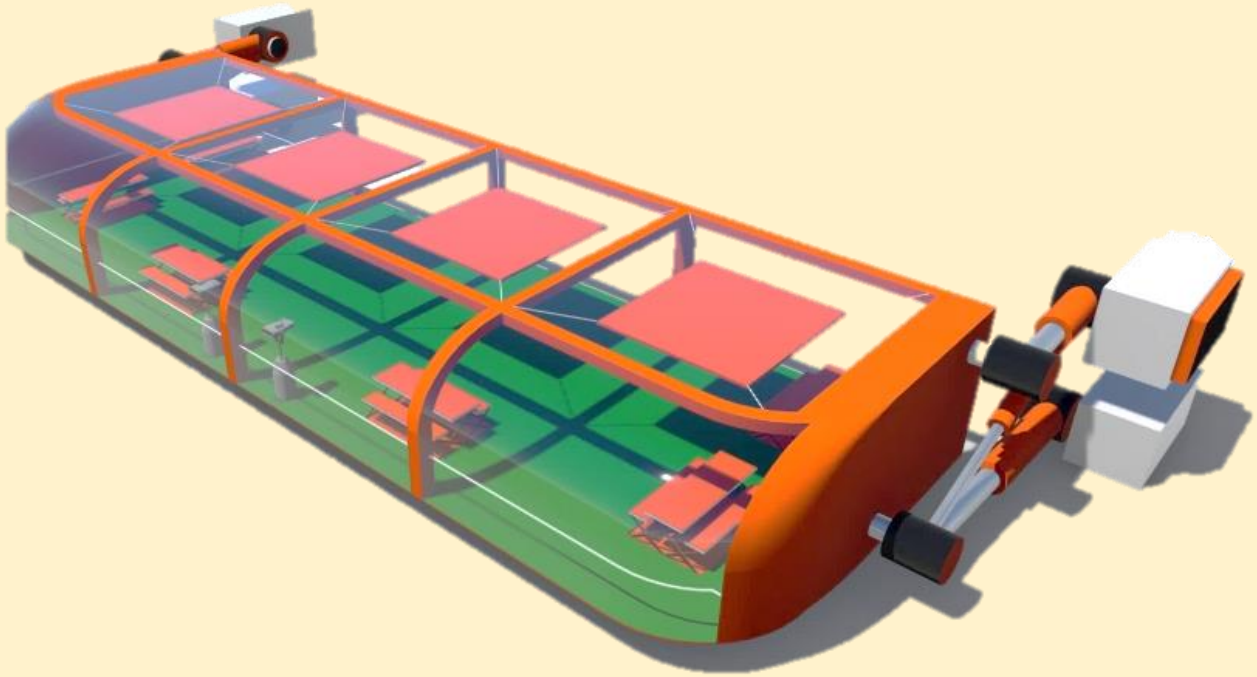
- The electric propulsion batteries are designed to be active for 8 hours.





SKY LIFT

SKY LIFT Dimension	
Length	24 m
Breath	8 m
Height	3.2 m
Cap.	530 Persons
Light Weight	60 ton



• The sky lift is a vertical platform that can accommodate transport passengers and escape from the higher deck level to the lower deck.

• To reduce vibrations and lift failure when doing a quick evacuation, this lift has **3 pairs of suspensions** on both sides and **strengthened support** .

SKY LIFT

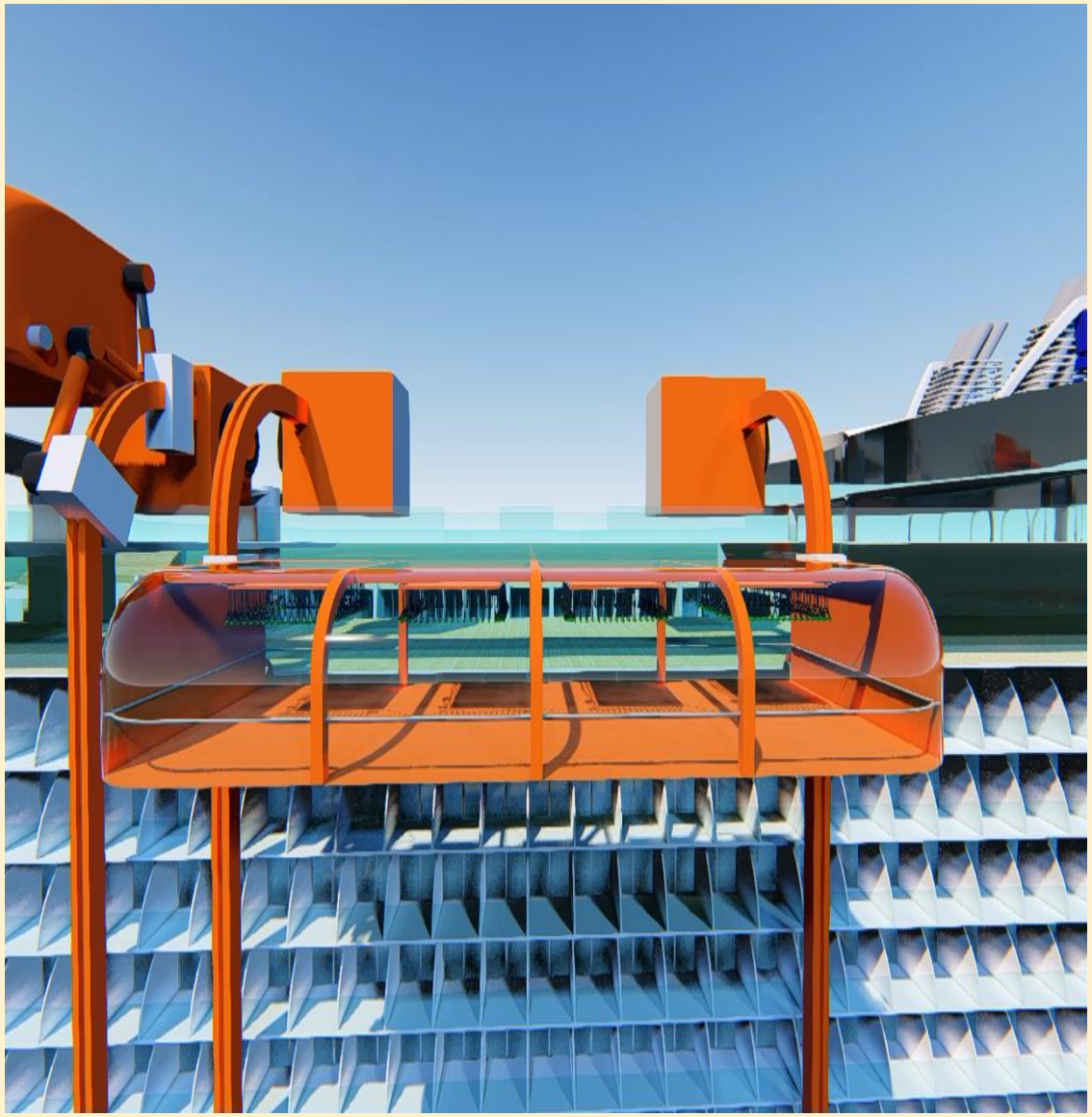
Normal Condition

- SKY-LIFT can be used as an entertainment place or restaurant because it has a large area.
- If an emergency comes, this function can be converted into an elevator.

SKY LIFT

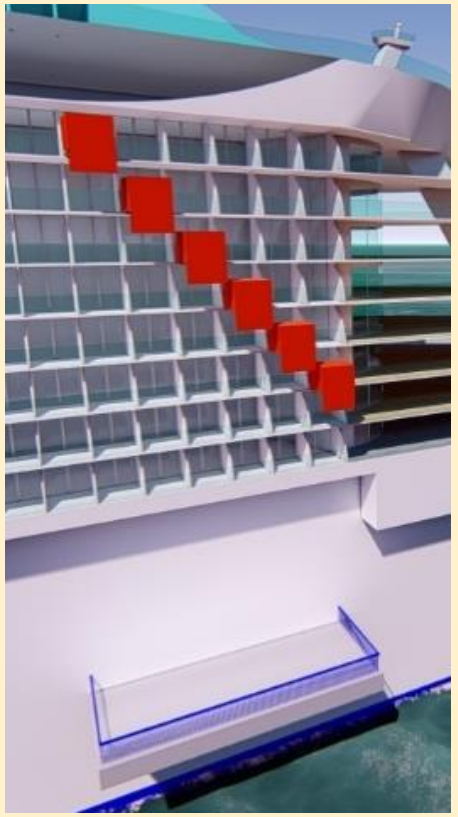
Evacuation Condition

- Chairs and tables in Sky Lift can be folded and replaced with handrails.
- This Sky Lift is given a rail construction that will be useful as a way up and down.



Inflatable Evacuation Chute

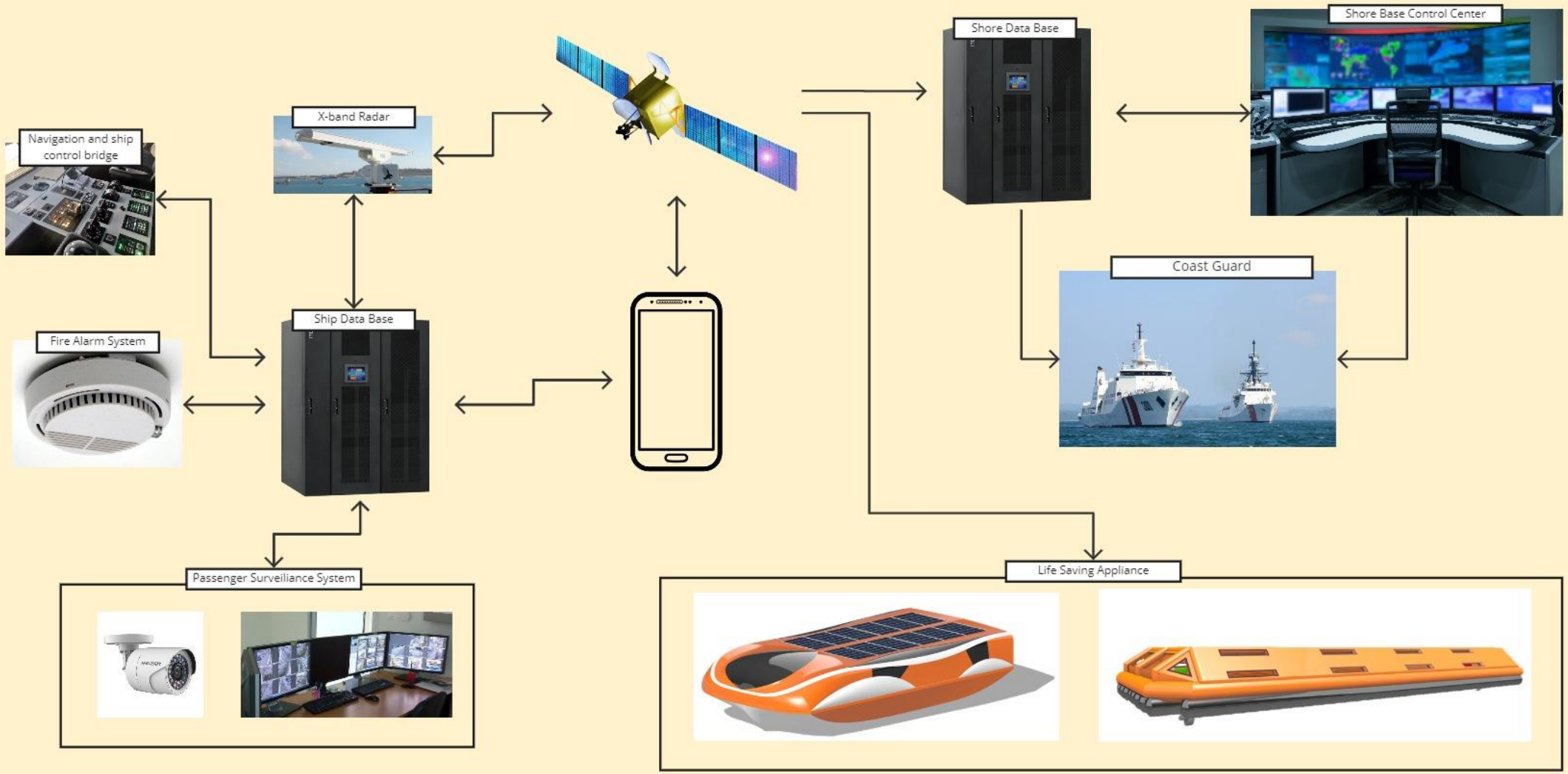
- The chute has an inlet diameter of 600mm with varying lengths depending on the placement.
- Chute will be placed per deck with a total of 4 pieces on the front and back.
- This method just by sliding through the chute, people can get down to the muster point quickly.
- This chute has a support system for landing passengers during evacuation by opening the landing ramp platform.
- To activate the chute is very easy, just drop the hose of the chute, the chute is ready to use.



AISEM

Autonomous Intelligent Safety and Evacuation Management

❑ **Framework overview and operation**



AISEM

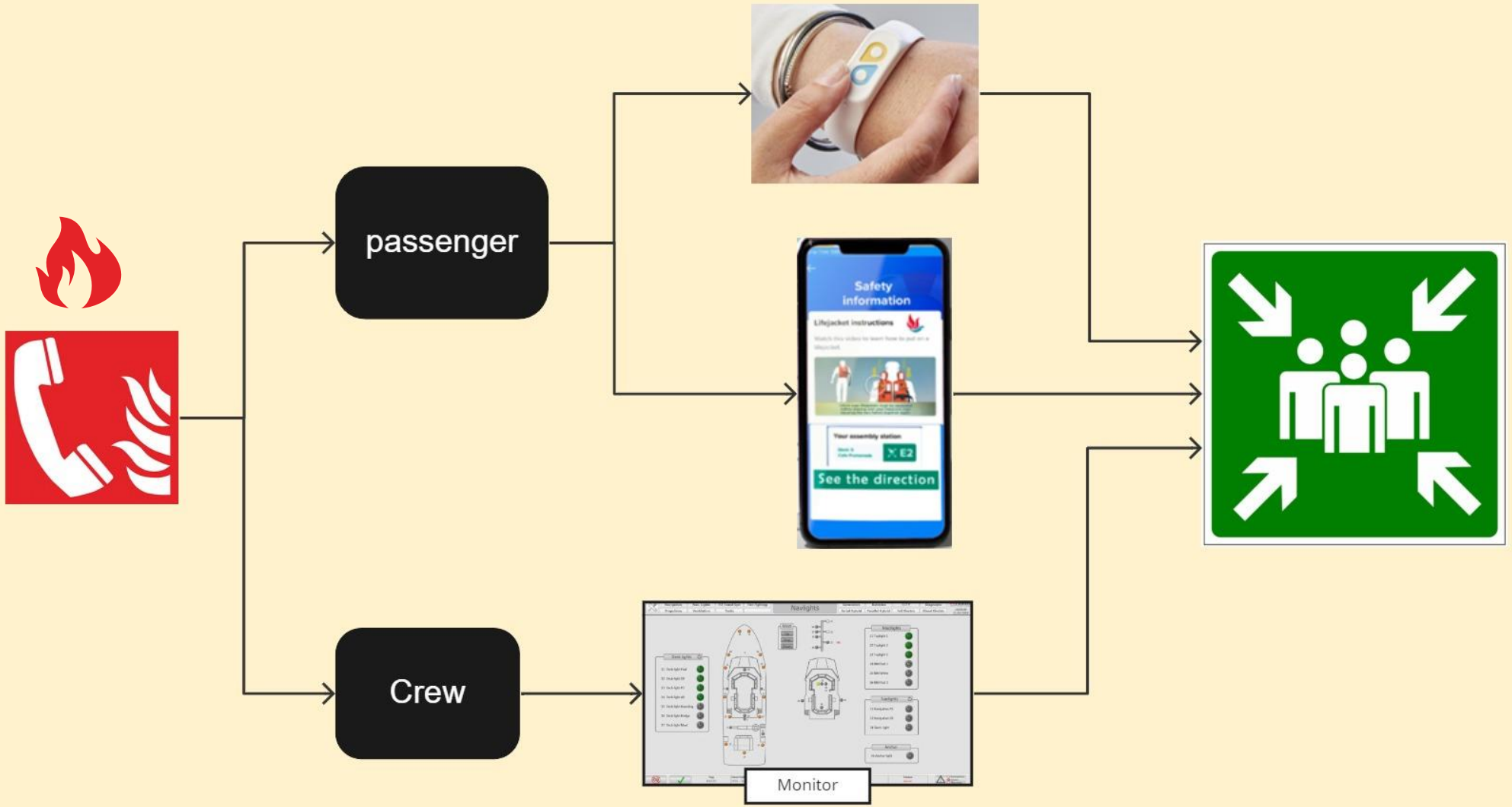
Autonomous Intelligent Safety and Evacuation Management

❑ **Smart Jacket**

- Help the crew and passenger in manage life-saving condition,
- reduce human sense of panic and uncontrolled evacuation,
- Give real-time coordination

AISEM

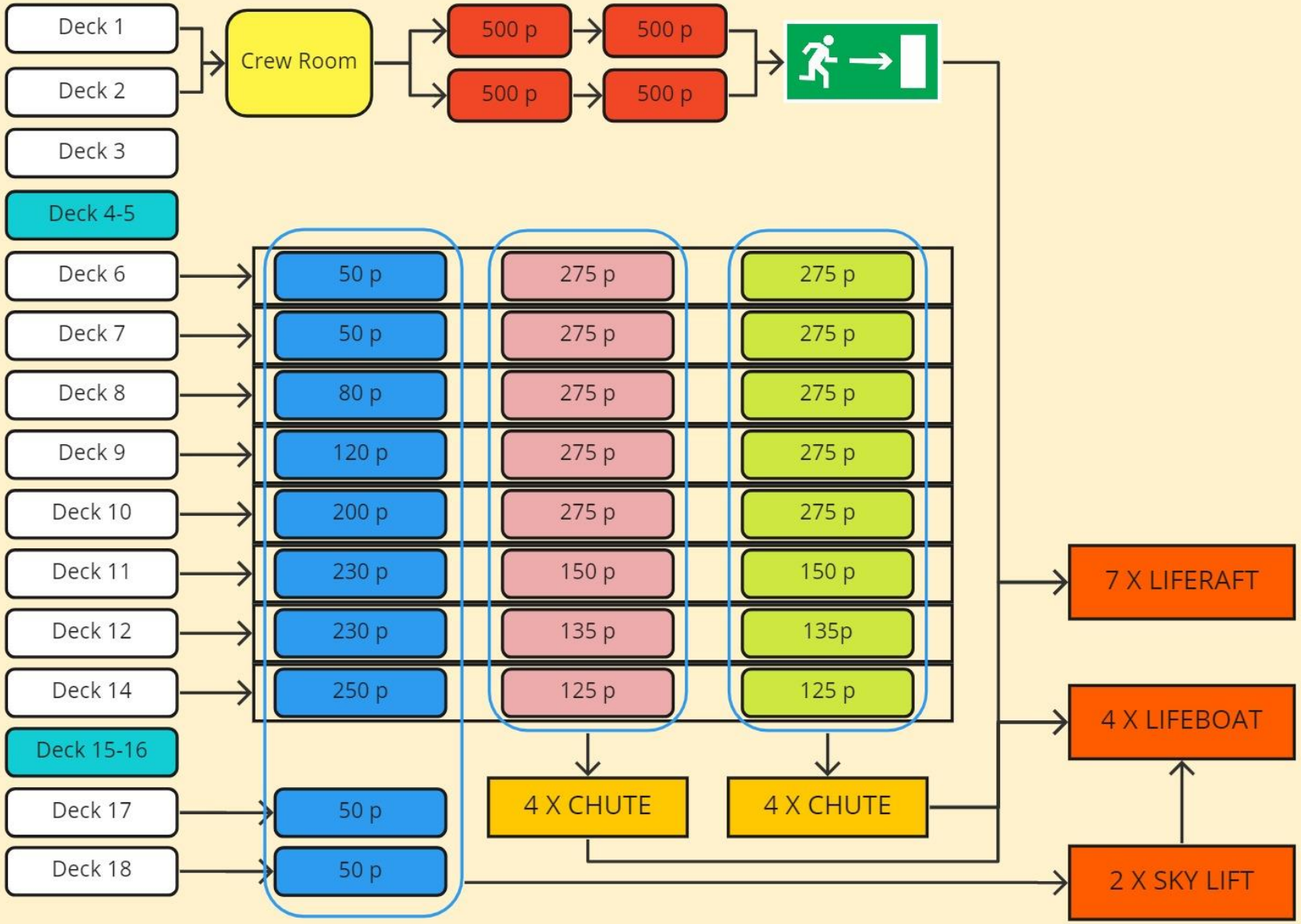
Safety bracelet and Evacuation Assistance in Passenger Apps



Evacuation Procedure Analysis

Evacuation Procedure

- Evacuation will be carried out if the danger siren has been activated
- Crew will give direction to passengers to go to the master points



Evacuation Procedure Analysis

- The faster scenario is **scenario 2 that** is using **new design** chute, sky lift and life raft for **18,185 minutes total evacuation time,**

- Scenario 2 is **12,68 Minutes faster** than the maximum evacuation time in SOLAS Chapter III Regulation 21.1.3, **30 minutes**.

Description	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
Max Walk Time	83,3	s	83,3	s	83,3	s	83,3	s
Max Chute/Stairs/Lift time	9000	s	208,3333	s	208,3333	s	1875	s
Max Lifeboat/Liferaft time	816,6667	s	799,5	s	1050	s	1050	s
Max Evacuation Time	9899,967	s	1091,133	s	1341,633	s	3008,3	s
Total Time	**165,00**	minutes	**18,18556**	minutes	**22,36056**	minutes	**50,13833**	minutes

Conclusion

Our proposed LSA design has advantages over the existing LSA, which we summarize as follows :

1. ***Safe & Reliable Evacuation*** → The combination of our rigid and high survival standard evacuation with intelligence-aided evacuation management.
2. ***Effective Control*** → provided by our ***Lifeboat NWB01 and AISEM***.
3. ***Time and Space Efficient*** → provided by our ***Life raft NW-LR01 and Evacuation Chute***.
4. ***Service Value Added*** → provided by our ***SKY-LIFT***.
5. ***Reduce Human-interact*** → provided by our ***AISEM***.

Suggestion

"Increase the intensity of collaboration between research institution and industry in the development of Life Saving Appliances, especially Cruise Ships "

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Institut
Teknologi
Sepuluh Nopember

Nawasena
ITS Team

THANK YOU FOR YOUR ATTENTION

TERIMA KASIH

Supported by

ITS Department of MARINE ENGINEERING

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MMD
Marine Manufacturing & Design
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HIMASISKAL

Appendix

APPENDIX A

REQUIREMENTS AND BACKGROUND OF LSA

General	Proper materials, not be damaged in stowage throughout the air temperature range -30°C to +65°C,
	be rot-proof, corrosion-resistant, and not be unduly affected by seawater, oil or fungal attack
	Colorized with international or vivid reddish orange, or a comparably highly visible colour on all parts where this will assist detection at sea, and retro-reflective material where it will assist in detection
	provided with electrical short circuit protection to prevent damage or injur
Personal Life saving appliances	**Lifebuoys**; Lifebuoy self-igniting lights; Lifebuoy self-activating smoke signals
	Lifejackets ; inflate automatically upon immersion, be provided with a device to permit inflation by a single manual motion and be capable of having each chamber inflated by mouth; have a luminous intensity of not less than 0.75 cd in all directions of the upper hemisphere.
	Immersion suits
	Anti-exposure suits; A person in fresh water wearing an anti-exposure suits complying with the requirements of this section shall be able to turn from a face-down to a face-up position in not more than 5 s and shall be stable face-up.
Survival Craft	**Life raft**; capable of withstanding exposure for 30 days afloat in all sea conditions.; Operation survival after dropped in 18 meter height minimum; enable it to be towed at a speed of 3 knots in calm water; be capable of withstanding a lateral impact against the ship's side at an impact velocity of not less than 3.5 m/s; equipped with two buoyant paddles, e first-aid outfit, four rocket parachute flares, six hand flares, efficient radar reflector,
	food store not less than 10,000 kJ (2,400 kcal) for each person, 1.5 l of fresh water for each person, and thermal protective aids; The stability of the liferaft when in the inverted position shall be such that it can be righted in a seaway and in calm water by one person
	Lifeboat; The lifeboat should be constructed to have ample stability in a seaway and sufficient freeboard when loaded with their full complement of persons and equipment, and are capable of being safely launched under all conditions of trim of up to 10° and list of up to 20° either way; The vertical distance (interior height) should be 1.7m minimum; Every passenger ship lifeboat shall be so arranged that it can be boarded by its full complement of persons in not more than 10 min from the time the instruction to board is given. All lifeboats shall be stable and have a positive GM value when loaded with 50% or the number of persons the lifeboat is permitted to accommodate in their normal positions to one side of the centreline; The engine shall be provided with either a manual starting system, or a power starting system with two independent rechargeable energy sources; All lifeboats shall be provided with a rudder and tiller; . Lifeboats which are not self-righting when capsized shall have suitable handholds on the underside of the hull to enable persons to cling to the lifeboat;. . Each free-fall lifeboat shall be so constructed as to ensure that the lifeboat is capable of rendering protection against harmful accelerations (3,5 m/s).
Launching and Embarkation Appliances	The passage of the **marine evacuation system** shall marine evacuation system shall provide for safe des provide for safe descent of persons of various ages, sizes cent of persons of various ages, sizes and physical capabilities wearing approved lifejackets from the embarkation station to the floating platform or survival craft
General emergency alarm system	**general emergency alarm system** shall be capable of sounding the general emergency alarm signal consisting of seven or more short blasts followed by one long blast on the ship's whistle or siren and additionally on an electrically operated bell or klaxon.

Appendix

APPENDIX B

PARENT CRUISE SHIP INFORMATION

Length	**340**	**M (LOA)**
Tonnage	180000	GT
Capacity	5000	Passengers
	2000	Crew
Operation	Global	

Appendix

APPENDIX C

Lifeboat

1. Light Weight Lifeboat

a. Frame

Frame	Area (m2)
st 1	2,918
st 2	3,307
st 3	3,38
st 4	3,43
st 5	3,469
st 6	3,497
st 7	3,517
st 8	3,53
st 9	3,536
st 10	3,538
st 11	3,539
st 12	3,54
st 12	3,54
st 13	3,541
st 14	3,542
st 15	3,542
st 16	3,543
st 17	3,543

Frame	Area (m2)
st 18	3,543
st 19	3,543
st 20	3,54
st 21	3,535
st 22	3,528
st 23	3,517
st 24	3,503
st 25	3,485
st 26	3,463
st 27	3,439
st 28	3,416
st 29	3,395
st 30	3,37
st 31	3,34
st 32	2,908
st 33	1,99
Total	115,967

Density of fiberglass	1230 kg/m3
thickness frame	0,05 m
Weight Construction	7131,9705 kg
	7,1319705 ton

b. Plat Needed

Plat 1	176,305	352,61
Plat 2	49,409	98,818
Plat 3	10,645	21,29
Plat 4	10,213	20,426
Plat 5	35,711	71,422
	Total	564,566 m2

Density of fiberglass	1230 kg/m3
thickness frame	0,045 m
Weight Construction	31248,728 kg
	31,248728 ton

c. Light Weight

Plat + Frame	=	38,380699 ton

c. Electricity needs

equipment name	number	weight (kg/Unit)	Total(kg)
Panel Surya	68	12	816
Baterai	14	175	2450
Inverter	1	60	60
MPPT solar charger	5	40	200
Panel Bus	3	80	240
Main Switch Board	1	150	150
Jumlah			3916

equipment name	Total (Ton)
electrical equipment (Set)	3,916
Navigation and communication (Set)	1
Total	4,916

Appendix

APPENDIX C

Lifeboat

1. Light Weight Lifeboat

d. Seats

533	x	20	kg	=	10660 kg
					10,66 ton

e. Machinery Installation

1. Hull Resistance

Speed (knot)	Fung Resist. (kN)	Power (kW)	eff
10	54,2	557,46	50%

2. Main Engine

Merk/Tipe	Volvo Penta D6-IPS600		
Power	311	kW	622
Weight	920	kg	
Total	2	unit	
Total Engine	1,84	ton	

3. Aux, Engine

Merk/Tipe	Baterai	
Weight	12,5	kg
Total	11	unit
Total Battery	0,1375	ton

d Total Weight Aux. Engine

W mt =	1,9775	ton
Spare weight		
Wres =	0,098875	ton

LWT = WST + WE&O + WM

LWT = 62,8783604 ton

Appendix

APPENDIX C

Lifeboat

2. Payload

Information	Total
Kru	1
Passenger	532
Total	533
Weight per person	100
Total (kg)	53300
Total (ton)	53,3

Appendix

APPENDIX C

Lifeboat

3. Consumable Tank

Fuel Requirements

Weight Fuel Oil Main Engine

WFO = BHPME .SFOC .Endurance . 10-6 (Ton)

Where BHPME = BHP Of Main Engine (kW)

SFOC = Specific Fuel Oil Consuption

Endurance = 3 Days (Maximum endurance)

So,	BHPME =	311	kW	
	FOC =	87830	g/h	
	WFO =	12,65	Ton	at 2 engine

Fresh Water Needs

Total Person	=	600	persons
Needs a drink	=	2	ltr/persons/days
Endurance	=	3	days
Total Freshwater Needs	=	3600	liter
	=	3,6	m3
Weight Freshwater	=	3,6	ton

Appendix

APPENDIX C

Lifeboat

4. Total Displacement

Payload	53,3 Ton
LWT	62,88 Ton
DWT	16,24758607 Ton
Total Weight	132,426 ton

5. Electric

Perhitungan Kelistrikan

No.	Equipment	Jumlah	Power Total (watt)	
1	Light Room	30	300	
3	Nav. Light	2	60	
4	Radar	1	100	
5	GPS	1	25	
6	Reverse Osmosis	3	120	
			605	watt
			0,605	kW
Operasi	24 jam		14,52	Kwh
Volt	12 V			
AH Requiemnent			1210 AH	

Batterai
Mastervolt Liion 90 Ah
Jumlah Batterai 13,44444
14

Berat
@ 12,5 kg = 175 kg
0,175 ton

1260 Ah

MLI-E 12/1200

Appendix

5. Stability Lifeboat

   Loadcase - Loadcase 1

   Damage Case - Intact

   Free to Trim

   Specific gravity = 1,025; (Density = 1,025 tonne/m^3)

   Fluid analysis method: Use corrected VCG

APPENDIX C

Lifeboat

Item Name	Quantity	Unit Mass tonne	Total Mass tonne	Unit Volume m^3	Total Volume m^3	Long. Arm m	Trans. Arm m	Vert. Arm m	Total FSM tonne. m	FSM Type
Construction	1	38,100	38,100			9,538	0,000	1,300	0,000	User Specified
Persons	533	0,080	42,640			9,500	0,000	2,200	0,000	User Specified
F.O	100%	15,381	15,381	16,288	16,288	7,532	0,000	0,601	0,000	Maximum
Engine	2	1,000	2,000			5,000	0,000	0,800	0,000	User Specified
F.W	100%	4,391	4,391	4,391	4,391	11,399	0,000	0,541	0,000	Maximum
Electric	1	5,000	5,000			17,000	0,000	2,000	0,000	User Specified
Safety Equipment	1	1,000	1,000			2,000	0,000	2,000	0,000	User Specified
Seats	533	0,020	10,660			9,500	0,000	2,200	0,000	User Specified
Total Loadcase			119,172	20,679	20,679	9,504	0,000	1,611	0,000	
FS correction								0,000		
VCG fluid								1,611		

Appendix

Loadcase - Loadcase 2

Damage Case - Intact

Free to Trim

Specific gravity = 1,025; (Density = 1,025 tonne/m^3)

Fluid analysis method: Use corrected VCG

APPENDIX C

Lifeboat

Item Name	Quantity	Unit Mass tonne	Total Mass tonne	Unit Volume m^3	Total Volume m^3	Long. Arm m	Trans. Arm m	Vert. Arm m	Total FSM tonne. m	FSM Type
Construction	1	38,100	38,100			9,538	0,000	1,300	0,000	User Specified
Persons	0%	15,381	0,000	16,288	0,000	7,500	0,000	0,000	0,000	Maximum
F.O	0%	4,391	0,000	4,391	0,000	11,207	0,000	0,000	0,000	Maximum
Engine	533	0,080	42,640			9,500	0,000	2,200	0,000	User Specified
F.W	2	1,000	2,000			5,000	0,000	0,800	0,000	User Specified
Electric	1	5,000	5,000			17,000	0,000	2,000	0,000	User Specified
Safety Equipment	1	1,000	1,000			0,000	0,000	0,000	0,000	User Specified
Seats	533	0,020	10,660			9,500	0,000	2,200	0,000	User Specified
Total Loadcase			99,400	20,679	0,000	9,706	0,000	1,795	0,000	
FS correction								0,000		
VCG fluid								1,795		

Appendix

Loadcase - Loadcase 3

Damage Case - Intact

Free to Trim

Specific gravity = 1,025; (Density = 1,025 tonne/m^3)

Fluid analysis method: Use corrected VCG

APPENDIX C

Lifeboat

Item Name	Quantity	Unit Mass tonne	Total Mass tonne	Unit Volume m^3	Total Volume m^3	Long. Arm m	Trans. Arm m	Vert. Arm m	Total FSM tonne. m	FSM Type
Konstruksi	1	38,100	38,100			9,538	0,000	1,300	0,000	User Specified
FO	0%	15,381	0,000	16,288	0,000	7,500	0,000	0,000	0,000	Maximum
FW	0%	4,391	0,000	4,391	0,000	11,207	0,000	0,000	0,000	Maximum
Orang	0	0,080	0,000			9,500	0,000	2,200	0,000	User Specified
Mesin	2	1,000	2,000			5,000	0,000	0,800	0,000	User Specified
listrik	1	5,000	5,000			17,000	0,000	2,000	0,000	User Specified
Peralatan keselamatan	1	1,000	1,000			0,000	0,000	0,000	0,000	User Specified
Kursi	533	0,020	10,660			9,500	0,000	2,200	0,000	User Specified
Total Loadcase			56,760	20,679	0,000	9,860	0,000	1,490	0,000	
FS correction								0,000		
VCG fluid								1,490		

Appendix

APPENDIX D

Life raft

1. Life-Raft Material Weight

Total Weight of material Life-raft			
Density of Air	=	1.225	kg/m^3
Volume Life-raft	=	740.00	m3
Material Weight	=	Density x Volume	kg
	=	1.225 x 740	kg
	=	906.50	kg
	=	0.91	ton

2. Life-Raft Volume

Volume Liferaft		
Part	**Total**	**Total Volume (m3)**
Bellow Float Sufrace	10	259.05
Upper Float Surface	1	68.00
Platform	1	372.00
Inflatable transversal Frar	11	34.87
Inflatable Longitudinal	3	6.08
Total		740.00

3. Life-Raft Weight

Total Weight of Life-raft			
Equipment	Unit	Unit - Weight (ton)	Total (Ton)
Emergency Food Rations 10000 Kj - 0.5 gram	2100	0.0000005	0.00105
Propulsion 100 HP / 75 kW - 17	4	2	8.00
Battery 12V 2000AH	50	0.05	2.50
Propulsion Control	2	0.05	0.10
Material	1	0.91	0.91
Total			11.51
Space for another Equipment (Epirb, Whistle, Anchor, ect) 10%			12.66

3. Life-Raft Power Estimation

Power Calculation		
Power Motor	75	kW
Number of motor	4	
Total Power	300	kW
Design Operational Time Motor	8	Hours
Total Energy	2400	kWh
	2400000	Wh
Capacity Battery Demand	100000	AH
Capacity Battery	2000	AH
Number of Battery	50	

Appendix

APPENDIX E

Evacuation Analysis

One side Evacuation Analysis (Starboard side example) Scenario 1										
Number of deck	2x *SKY LIFT*		4 x *chute*		4 x *chute*		Stairs		Stairs	
	person	time (s)	person	time (s)	person	time (s)	person	time (s)	person	time (s)
Deck 1							500	1875	500	1875
Deck 2							500	1875	500	1875
Deck 3										
Deck 4-5										
Deck 6							300	9000	300	9000
Deck 7							300	12000	300	12000
Deck 8							300	15000	300	15000
Deck 9							300	18000	300	18000
Deck 10							300	21000	300	21000
Deck 11							250	17500	250	17500
Deck 12							250	17500	250	17500
Deck 14							250	17500	250	17500
Deck 15-16										
Deck 17							25	1750	25	1750
Deck 18							25	1750	25	

Appendix

APPENDIX E

Evacuation Analysis

One side Evacuation Analysis (Starboard side example) Scenario 2										
Number of deck	2x *SKY LIFT*		4 x *chute*		4 x *chute*		Stairs		Stairs	
	person	time (s)	person	time (s)	person	time (s)	person	time (s)	person	time (s)
Deck 1							500	1875	500	1875
Deck 2							500	1875	500	1875
Deck 3										
Deck 4-5										
Deck 6	50	41,6667	275	206,25	275	206,25				
Deck 7	50	41,6667	275	206,25	275	206,25				
Deck 8	50	41,6667	275	206,25	275	206,25				
Deck 9	80	66,6667	275	206,25	275	206,25				
Deck 10	120	100	275	206,25	275	206,25				
Deck 11	200	166,667	150	112,5	150	112,5				
Deck 12	230	191,7	135	101,25	135	101,25				
Deck 14	250	208,3	125	93,75	125	93,75				
Deck 15-16										
Deck 17	50	41,7								
Deck 18	50	41,7								

Appendix

APPENDIX E

Evacuation Analysis

One side Evacuation Analysis (Starboard side example) Scenario 3										
Number of deck	2x *SKY LIFT*		4 x *chute*		4 x *chute*		Stairs		Stairs	
	person	time (s)	person	time (s)	person	time (s)	person	time (s)	person	time (s)
Deck 1							500	1875	500	1875
Deck 2							500	1875	500	1875
Deck 3										
Deck 4-5										
Deck 6	50	41,6667	275	206,25	275	206,25				
Deck 7	50	41,6667	275	206,25	275	206,25				
Deck 8	50	41,6667	275	206,25	275	206,25				
Deck 9	80	66,6667	275	206,25	275	206,25				
Deck 10	120	100	275	206,25	275	206,25				
Deck 11	200	166,667	150	112,5	150	112,5				
Deck 12	230	191,7	135	101,25	135	101,25				
Deck 14	250	208,3	125	93,75	125	93,75				
Deck 15-16										
Deck 17	50	41,7								
Deck 18	50	41,7								

Appendix

APPENDIX E

Evacuation Analysis

One side Evacuation Way (Starboard side example) Scenario 4										
Number of deck	lift		chute		chute		tangga		tangga	
	person	time (s)	person	time (s)	person	time (s)	person	time (s)	person	time (s)
Deck 1							500	1875	500	1875
Deck 2							500	1875	500	1875
Deck 3										
Deck 4-5										
Deck 6		0	265	795	265	795	35	1050	35	1050
Deck 7	50	41,6667	260	780	260	780	15	600	15	600
Deck 8	50	41,6667	250	750	250	750	15	750	15	750
Deck 9	80	66,6667	245	980	245	980	15	900	15	900
Deck 10	120	100	225	1125	225	1125	15	1050	15	1050
Deck 11	200	166,667	140	840	140	840				
Deck 12	230	191,7	135	945	135	945				
Deck 14	250	208,3	125	1000	125	1000				
Deck 15-16										
Deck 17	50	41,7								
Deck 18	50	41,7								

Appendix

APPENDIX E

Evacuation Analysis

From the time calculation, we conclude that the faster scenario is scenario 2 that is using chute, sky lift and life raft for **18,185 minutes total evacuation time**, which is **12,68 Second Lower** than the maximum evacuation time in SOLAS Chapter III Regulation 21.1.4, **30 minutes**

Survival Craft Embarkation + Deployment Time	Conventional lifeboat		New liferaft		New lifeboat	
	person	time (s)	person	time (s)	person	time (s)
	150	816,667	700	1050	533	799,5

Description	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
Max Walk Time	83,3	s	83,3	s	83,3	s	83,3	s
Max Chute/Stairs/Lift time	9000	s	208,3333	s	208,3333	s	1875	s
Max Lifeboat/Liferaft time	816,6667	s	799,5	s	1050	s	1050	s
Max Evacuation Time	9899,967	s	1091,133	s	1341,633	s	3008,3	s
Total Time	**165,00**	minutes	**18,18556**	minutes	**22,36056**	minutes	**50,13833**	minutes

Scenario 1	Conventional (Existing)	Room > Stairs > Existing Lifeboat
Scenario 2	New Design 1	Room > Chute & Skylift > New Design Lifeboat
Scenario 3	New Design 1	Room > Chute & Skylift > New Design Liferaft
Scenario 4	All Possible	Room > Chute & Skylift & stairs > New Design Liferaft