RISK MATRIX

GENERAL INFORMATION							PRE-TREATMENT STATUS			TREATMENT (mitigation steps)		
ID	IDENTIFIED DATE	RISK SOURCE	RISK CLASIFICATION	TITLE	DESCRIPTION	EFFECT	LIKELYHOOD	OCCURANCE IMPACT	RISK RATING	RISK OWNER	TREATMENT	TREATMENT ACTION
1	13.05.2024.	INTERNAL	LEGAL	**EXISTING PARTNER(s) LEAVING THE PROJECT**	Possibility that a current partner may discontinue their involvement in the project before its completion because of change in managment, bankroptcy, inability to fulfill its task etc.	Effects on the project can be: delayes in project work, loss of expertise, reputational damage, project suspension, project termination.	POSSIBLE	MAJOR		PMB	MITIGATE	1. Regular project coordination meeting, monitoring process and progress of every partner in order to timely and proactively detect and prevent dissatisfaction or disengagement that could lead to departures.To map for each crucial project partner alternative expert and keep / establish relationship to have a redundancy if neccessary. Regular partner management (due dillingce) to avoid any surprises. 2. Searching new partner 3. Embedding new partner in the project
2	13.05.2024.	INTERNAL	LEGAL	**SEARCHING FOR A NEW PARTNER**	Challenge in identifying, finding, evaluating, and onboarding new partner into the project and its scope.	Potential effect can be termination of the project in case no suitable partner is found.	UNLIKELY	MAJOR		LDCK	MITIGATE	Monitoring of the market, participation in specialized maritime fairs in order to have a wider network in the specific area, clearly defined criteria for the new partner, engaginh stakeholders.
3	13.05.2024.	INTERNAL	LEGAL	**NEW PARTNER ENTERING THE PROJECT**	Eligibility of the proposed partner needs to be proved and accepted by Consortium and EC. Potential risks are including issues related to alignment, communication, coordination, and integration.	Delay in project development, comunication challenges, alignmet issues, quality and performance risks.	POSSIBLE	MODERATE		LDCK	MITIGATE	Coordinator will be in frequent communication and provide intensive support to a new partner during start phase, clear goal setting, continuos monitoring and feedback to the partner.
4	13.05.2024.	INTERNAL	LEGAL	**FUNDING ISSUE**	Event in which partner is utilising funding received from EC for any other non eligible costs.	If any partner is missusing the received funds, and EC finds out, partner exits the project and consortium needs to find new partner and include it in the project.	UNLIKELY	MAJOR		LDCK	AVOID	LDCK as coordinator will regulary ensure receiving funding spenditure reports from partners.
5	13.05.2024.	INTERNAL	LEGAL	**INTERPRETATION OF CONTRACTS AS PER BELGUM LAW**	During the implementation of the project there might be situation while consulting the contract wording we are not competely aware of its legal meaning due to differences of the Croatian and Belgium law.	Not knowledgable enough in the process of decision makiing.	POSSIBLE	MODERATE		LDCK	MITIGATE	Closly monitor partner's performance and being aware of their project needs.
6	13.05.2024.	INTERNAL	LEGAL	**TERMINATION OF THE PROJECT FOR ANY REASON**	Project can be terminated for different reasons specified in the risk matrix.	Partners can be in the situation of either request for additional funds or in the situation that partners should justify received budget.	POSSIBLE	MODERATE		PMB	MITIGATE	Aforhead any important decision for the project consortium consult Belgium lawyer.
7	13.05.2024.	INTERNAL	FINANCIAL	**BUDGET OVERRUN**	Approved budget is not sufficient for the planned project scope due to inaccurate cost estimation, scope changes, unforeseen expenses, inflation, resource constraints, or poor financial management practices.	Modification of the project, delay of the project or termination of the project.	POSSIBLE	MAJOR		LDCK	AVOID	Monitoring and control of the project expenditures, risk management. Conceptual design is developed as per budget from original inputs. If any budget implication occures it wuill be timely discussed with partners and solutions proposed (budget reallocation, modification of the project main particulars).
8	13.05.2024.	INTERNAL	PROCUREMENT	**PUBLIC PROCUREMENT POORLY PREPARED AND MANAGED**	If due diligence has not been applied to specific process: public procurement preparation from Project coordinator (LDCK).	Effect is budget overspend, overall project delay and no relevant entity applying for public procurement.	POSSIBLE	MAJOR		LDCK	AVOID	LDCK as coordinator wil appoint expert in public procurement to monitor whole public procurement process.
9	13.05.2024.	INTERNAL	SHIP PRODUCTION / TEST & TRIALS	**POTENTIAL DAMAGE AND TOTAL LOSS OF TH SHIP UNDER CONSTRUCTION**	Potential damages and total loss of the vessel during construction.	Potential effects are reputational damage, lawyer's costs, extention or termination of the project	POSSIBLE	MODERATE		PMB	MITIGATE	Timely apoint insurance expert to participate in the process of negotiating insurance policies for shipconstruction.
10	13.05.2024.	INTERNAL	SHIP PRODUCTION / TEST & TRIALS	**POTENTIAL DAMAGE AND TOTAL LOSS OF TH SHIP UNDER CONSTRUCTION**	Potential damages and total loss of the vessel during construction.	Potential effects are reputational damage, lawyer's costs, extention or termination of the project	POSSIBLE	MAJOR		PMB	MITIGATE	Timely apoint insurance expert to participate in the process of negotiating insurance policies for shipconstruction.
11	13.05.2024.	INTERNAL	PROJECT MANAGEMENT	**POOR PROJECT PERFORMANCE**	Non performance can result with loss of reputation /reputation risk.	This can lead the to loss of confidence between the partners, and between partners and EU. EU could decrease amount of founds for the project as well.	RARE	MAJOR			AVOID	Project team has been established with senior experts and with different background.
12	13.05.2024.	INTERNAL	PROJECT MANAGEMENT	**PROJECTS MAJOR FURNISHED EQUIPMENT (H2)**	If equipment is delivered without proper certificate than there is a risk for vessel build, schedule and costs.	Malformance and delays.	RARE	MODERATE		LDCK	AVOID	During procurement process to ensure that all equipment has certificates.
13	13.05.2024.	EXTERNAL	SHIP PRODUCTION / TEST & TRIALS	**SHIPYARD NOT PERFORMING**	At the end of the production, vessel is ot working as planned	Project delay, project suspension, project route replanning. Reputational risk.	POSSIBLE	MAJOR		LDCK	MITIGATE	Closly monitor shipyard's performance, appoint oversight engineers, participate in contractual setup to clearly define shipyard's obligations
14	13.05.2024.	INTERNAL	PROJECT MANAGEMENT	**EXTENSIVE PROJECT DELAY**	Due to resource allocation, scope changes, technical challenges or unforeseen circumstances project timelines, milestones, and deliverables are prolonged.	Effects on project success, including increased costs, decreased partner's satisfaction and reputational damage.	POSSIBLE	MODERATE		LDCK	MITIGATE	Clear communication with the partners with open, transparent communication channels and regular updates on project progress, challenges, and mitigation strategies to manage expectations and foster trust. Risk Management.
15	13.05.2024.	EXTERNAL	IT SECURITY	**DATA LOSS BECAUSE OF CYBERATTACK**	A cyberattack is any intentional effort to steal, expose, alter, disable, or destroy data, applications, or other assets through unauthorized access to a network, computer system or digital device.	Beside it can damage the individual enterprise of each partner, it would cause a downtime, data loss and could lead to the prolongation of the delivery deadlines and money loss.	UNLIKELY	MAJOR		LDCK	SHARE	All partners needs to ensure they have proper IT security within their own companies and follow the rules for IT safety especially regarding fishing. Furthermore, MCoE need to additionally ensure IT safety of the Share point where all documents are placed, as well as the backup server. Beside Share point and MCoE server, each partner should have their own backup. In case that one partner gets affected, PMB will agree which partner can overtake their tasks until their comeback.
16	13.05.2024.	INTERNAL	SHIPBUILDING ENGINEERING	**LATE COMPLETION OF CONCEPT DESIGN**	New fuel technology with insufficient knowledge could lead challenges in finding the competent design.	This can lead to loss of confidence between the partners, causing RISK no.1 and No.2, and also loss of trust from EU regarding possible future projects.	POSSIBLE	MAJOR		LDCK	MITIGATE	Involve shipowner and H2 powertrain lead earlier in the concept design. Ask ship owner not to change the design. Develop relationship and coordination between the designer, H2 engineers and ship owner in order for faster approval.
17	13.05.2024.	EXTERNAL	H2 TECHNOLOGY	**LATE APPROVAL OF THE CLASS**	Delays of class approvals because of lack of experience and knowledge with new H2 technology. Long process of drawing approval by owner/class.	This would result in spending more working hours than predicted and could influence on concept design.	UNLIKELY	MINOR		LDCK	ACCEPT	Involve shipowner and H2 powertrain lead earlier in the concept design. Develop relationship and review meetings during the basic design between the designer, H2 engineers, ship owner and class society.
18	13.05.2024.	INTERNAL	SHIPBUILDING ENGINEERING	**LATE COMPLETION OF DEATIL DESIGN**	Delays of class recommendations. Delay of data/drawing from the equipment maker. Delay of the shipyard technology inputs.	This would result in spending more working hours than predicted and would influence to the production deadlines.	RARE	MINOR		LDCK	MITIGATE	Ensure to work with proven equipment and material manufacturers and suppliers. A maker list can be created and LLTI list (Long Lead Time Item). Develop and organise model status reviews with class, ship owner. Create a backup team that can jump in the detail design in order to speed up the design.
19	13.05.2024.	EXTERNAL	SHIP PRODUCTION / TEST & TRIALS	**LACK OF INTERESTED SHIPYARDS**	Because of situation in the World and inflation rates, it can happen that there will be no interested shipyards for this new build.	This would lead to the situation that project would be stopped or even permanently canceled. It could have negative impact on the partners reputation.	UNLIKELY	MAJOR		PMB	AVOID	several weeks before concept design freeze, we should involve ship cost calculation experts to run a calculation cost in order that we check if we need to adjust concept design.
20	13.05.2024.	EXTERNAL	SHIP PRODUCTION / TEST & TRIALS	**SHIPYARD LIQUIDITY CHALLENGES**	Due to internal problems of the shipard, shipyard is not capable to fulfill its financial obligations.	Facing delays and financial increased costs.	POSSIBLE	MODERATE		PMB	AVOID	LDCK will support Jadrolinija to setup shipbuilding contract in the way to arrange monthyl time and material payments (shipyard's monthly realisation)
21	13.05.2024.	INTERNAL	SHIP PRODUCTION / TEST & TRIALS	**SHIPOWNER NOT ACCEPTING DELIVERY OF THE SHIP**	Ship is not corresponding with main contractual technical specification.	Overall project is facing delay.	POSSIBLE	MODERATE		PMB	MITIGATE	Close oversight of shipyards performance.
22	13.05.2024.	EXTERNAL	PROCUREMENT	**MATERIAL DELAY**	Long lead time from supplier or manufacturer.	This can influence on the production, affecting the sea trials and ultimately on the delivery date.	UNLIKELY	MODERATE		PMB	MITIGATE	Ensure to work with proven equipment and material manufacturers and suppliers. A maker list can be created as well as LLTI list. Department and project leader need to ensure to submit early enough Material Requisition to the shipyard. A list with external (outside of shipyard) scope of delivery to the shipyard needs to be created, same as the list of internal scope of delivery. Also a system to monitor status of the complete PO's nedds to be delivered.
23	13.05.2024.	INTERNAL	SHIP PRODUCTION / TEST & TRIALS	**H2 LEAK - SMALL LEAK IN EXTERIOR**	A small hydrogen leak could result from improper hardware installation, or damage of the piping, valves, or the tank itself.	If confined, a small leak may result in a hazardous atmosphere being produced. In the presence of an ignition source such as a spark or a flame, this incident may lead to fire. It would also present a hazard if personnel happened to be nearby.	UNLIKELY	SEVERE		PMB	MITIGATE	In all cases except for direct damage to the tank itself, there will be either an automatic or manual shutoff valve that will stop further release. Automatic shutoff will occur when an abnormal drop in system pressure, presence of hydrogen, or presence of flames is detected. With no confined areas in the vicinity of the tank, piping, and vaporizer, the chance of reaching a hazardous atmosphere with a small leak is negligible. The design of the ship minimizes the presence of ignition sources, mitigating the fire risk even if a hazardous atmosphere is reached. Also, design of the ship should secure that such areas are unoccupied by crew and completely off-limits to passengers.
24	13.05.2024.	INTERNAL	SHIP PRODUCTION / TEST & TRIALS	**H2 LEAK - LARGE LEAK IN EXTERIOR**	A large hydrogen leak could occur because of a major component failure or physical damage to the system.	The consequence of a leak could be formation of a hazardous atmosphere and/or damage to surrounding components. In the presence of an ignition source such as a spark or flame, this incident may lead to a large fire. Ignition of all of the contents of the fuel tank would produce a large flame that would rapidly rise hundreds of feet into the air away from persons on board. Containment of this sort of fire is not practical since it would likely last less than 10 seconds in the event of complete failure and spillage. It is possible that if there will be a high downdraft winds, or a torch that is not directed upwards, the flames could reach locations on the vessel that have other systems, crew, or passengers. It is much more likely, however, that the hydrogen would quickly dissipate upward and any fire could only be a danger to structures above the ferry, such as a bridge and mast. A severe fire could cause a complete structural failure of the tank and subsequent release of the fuel which would then ignite. The danger to passengers or crew on the vessel is probably low due to the buoyancy of the hydrogen.	UNLIKELY	SEVERE		PMB	MITIGATE	Appropriate selection of components considering the service conditions (marine environment), following the established codes, and using designs and suppliers with proven usage will mitigate against component failure. If the H2 tank is exposed to a fire, the superinsulation of the tank is likely to be sufficient to prevent significant boil-off, but If the insulation is compromised, the heating of the H2 will increase the pressure in the tank to the point where the boil-off valve opens and the contents are released in a controlled manner out of the vent mast to a safe location. Automatic shutoff will be triggered by an abnormal loss of pressure or hydrogen level and by hydrogen and flame detectors in the vicinity. The only way to prevent the sort of damage needed to cause a large leak would be to further reinforce the tank and other components. The design of the ship should secure that H2 tanks is a restricted personnel area, and protected from external impacts since it is far from the waterline. Enclosing this equipment is not desired because it would increase the risk of forming a hazardous environment.
25	13.05.2024.	INTERNAL	SHIP PRODUCTION / TEST & TRIALS	**H2 LEAK - INTERIOR LEAK IN FUEL CELL ROOM**	If the shutoff systems fails, hydrogen could in uncontrolled way somehow be released into an enclosed space such as the fuel cell room.	If the concentration of hydrogen would reach a point where enough ignition energy is present, this incident can lead to a large fire. This would depend on the speed of the leak and whether or not the ventilation system could prevent the concentration of hydrogen from reaching the lower flammability limit in the vicinity of an igniting spark. The lower flammability limit of hydrogen is 4% at room temperature, while the lower limit for self-sustaining combustion (in the absence of a sustained ignition source) is 8%. The ignition could be caused by hot surfaces or low level electrical discharges present in the vent fans, lighting, or in the electronics on the fuel cell racks themselves. If ignition happens early (at the 4% lower flammability limit), the resulting combustion may be little more than an instantaneous burst of flame, possibly followed by a torch of fire sourced at the leak, and would not cause much damage to systems outside of the flame, and not affect surrounding spaces. If the hydrogen concentration somehow reached a higher level, subsequent ignition would be more severe.	UNLIKELY	MODERATE		PMB	MITIGATE	We need to esure to install safety measures and that they are operating properly. In this case an uncontrolled leak will not lead to hydrogen reaching the lower flammability limit. The fuel cell room should have redundant hydrogen detection equipment that is designed to cut off the hydrogen fuel supply in the event of the detection of hydrogen leak, typically set to detect at 10% of the lower flammability limit of 4%. The fuel cell electronics should immediately and automatically be powered down. Also, fuel cell room must be designed with ventilation system that should be always in operation and would immediately remove any hydrogen that is detected in the room. If the ventilation system fails, hydrogen supply to the room should be cut off. Given the very high amount of ventilation provided in the fuel cell room, the leak would have to be quite large for the hydrogen concentration to reach the lower flammability limit. The damage to surrounding surfaces is mitigated by the facts that hydrogen flames have a low radiant emissivity due to the absence of carbon in the flame, and also water vapor in the air effectively absorbs infrared radiation coming from the product water in hydrogen flames.
26	13.05.2024.	INTERNAL	SHIP PRODUCTION / TEST & TRIALS	**FUEL CELLS - FAILURE**	If a fuel cell fail, it would cease consuming hydrogen.	If one individual fuel cell, or a rack of fuel cells stopped functioning, two things could happen: First, there could be a minor loss of power. We need to check how reduction in power (for example by 2.5%) influence in decrease of the speed and the ship might be few minutes late. Secondly, there would be an increase in back pressure in the hydrogen supply line due to reduced demand.	UNLIKELY	MINOR		PMB	MITIGATE	Online continuous monitoring of fuel cell status needs to be designed in order to detect problematic fuel cells prior to failure. In case of failure, shutoff system needs to be designed in order to prevent hydrogen from escaping into hazardous spaces in any significant quantity. If this shutoff is not functional and a significant amount of hydrogen escapes into a fuel cell room, the hydrogen detection system in that room will shut down all of the fuel cells in that room and ventilation system needs to be designed in order to vent the room. Furthermore, maybe each fuel cell rack can have a pressure regulating valve that automatically adjusts the flow into the fuel cells based on demand.
27	13.05.2024.	INTERNAL	SHIP PRODUCTION / TEST & TRIALS	**FUEL CELL - VENTILATION FAILURE**	Air is required for the fuel cells to operate, and a large amount of air needs to be supplied into the fuel cell room.	If the fuel cell room ventilation would fail and there would be a hydrogen leak, any hydrogen that would leak into the space would not be quickly dispersed to the exterior of the vessel. More importantly, fuel cell ventilation failure would cause oxygen in the space to be consumed very rapidly and would create an unsafe environment for personnel. The Occupational Safety and Health Administration defines the safe level of oxygen for breathing as 19.5% by volume. The natural oxygen content of air by volume is 20.9%. IF natural ventilation would occur the oxygen would be replaced by mostly atmospheric nitrogen and would still be below the safe low level of oxygen in a matter of seconds. The fuel cells would also be unable to develop full power as the oxygen was removed from the air. A simultaneous failure of ventilation, a hydrogen leak, and a failure of shutoff of electrical components due to hydrogen detection could lead to a fire, but such an event would be very unlikely outside of a major damaging event.	UNLIKELY	MINOR		PMB	MITIGATE	If ventilation to one fuel cell room is lost, the hydrogen supply valve to that room should be automatically shut. If there is a leak at the same time, this action limits the amount of hydrogen that could leak into the room to that only remaining in the piping, which keeps the maximum attainable hydrogen concentration below the lower flammability limit, and the fuel cells will stop consuming hydrogen and oxygen. In the unlikely event of ventilation failure and failure of the hydrogen supply shutdown, the oxygen in the space may be consumed until dangerously low levels are present. Personnel may decide to enter the fuel cell space to assess the situation, so it is important to ensure that oxygen levels are safe by using oxygen level detectors.
28	13.05.2024.	INTERNAL	SHIP PRODUCTION / TEST & TRIALS	**H2 TANKS - OVERFILL**	This could occur during bunkering operations at the dock. Some specific causes of overfill could be operator error, or failure of automatic high level shutoffs.	Overfill of the hydrogen tank would lead to venting the hydrogen into the atmosphere. If not vented properly and far away it can cause a fire.	UNLIKELY	MODERATE		PMB	MITIGATE	Overfill should be prevented by attentive bunkering operators and redundant level sensors in the tank to alert the operator when the tank has been filled. Furthermore, the hydrogen tanks ventilation system should be designed to vent the hydrogen far enough away from any hazardous zones.
29	13.05.2024.	EXTERNAL	SHIP PRODUCTION / TEST & TRIALS	**H2 SHIP INFRASTRUCTURE - ASSAULT ATTEMPT**	All systems that are vulnerable to gunfire are redundant, with the exception of the fuel tank. The fuel tank may also be the target because it is large.	This could lead to loss of vacuum of the containment tanks and a moderate leak of hydrogen.	UNLIKELY	MODERATE		PMB	MITIGATE	The structure of the tank should mitigate the likelihood that penetration can occur. It should be determined through consultation with H2 tank manufacturer what tests will be performed in order that a typical rifle cannot penetrate the layers of the tanks. Also a partial protective plates around the tanks can drastically reduce the possibility of a direct hit from gunfire.
30	13.05.2024.	INTERNAL	SHIP PRODUCTION / TEST & TRIALS	**BATTERIES FAILURE**	During any mode of operation battery can have failure.	Battery overcharge or failure could possibly lead to a fire in the battery compartment. If the fire would spread to the passenger cabin, it could cause serious injury to passengers and/or become a source of damage and ignition to hydrogen fuel systems. Additionally, the spread of smoke and fumes from battery combustion could pose injury risk to passengers and crew.	UNLIKELY	MAJOR		PMB	MITIGATE	The way to prevent battery overcharge is through battery type selection and thorough and robust system design. In the basic design phase, the system integrator will ensure that the battery management system is designed to prevent a charge that is too high during any mode of operation. The battery management system will monitor charge and discharge current, as well as resulting battery cell temperature. This provides feedback information to the battery management system to verify battery performance. Already during concept design attention should be paid to the path available for venting smoke and combustion products. Additionally, the choice of insulation and firefighting measures should be examined.
31	13.05.2024.	INTERNAL	SHIP PRODUCTION / TEST & TRIALS	**SHIP COLLISION**	Collision is always a possibility on a route.	The presence of a hydrogen system does not increase the severity of a collision but in case of hard collision that penetrates far enough in the ship damage to the fuel H2 system is possible. Any collision severe enough to possibly damage the fuel system would probably already be severe enough to cause the vessel to be lost.	UNLIKELY	MAJOR		PMB	ACCEPT	Collision prevention is a result of good navigation practices, attentive operators, and adequate design of the ship to applicable regulations that are designed to mitigate damage to the ship in the event of such a collision. Ship will be designed to class D acc. CRS, which includes structural design rules that consider the effects of collision damage.
32	13.05.2024.	INTERNAL	SHIP PRODUCTION / TEST & TRIALS	**H2 SPILL DURING BUNKERING**	Bunkering occurs when boat is not operating during night hours which involves the transfer of hydrogen fuel through pipes and hoses to refuel the vessel.	These operations will be performed by members of the crew and possibly other staff who work at the shore side facilities. Ideally, the only releases are of a moderate and controlled amount of vaporized hydrogen to the atmosphere. If the bunkering procedure is not followed, or hardware is unknowingly malfunctioning, then release of large quantities of vaporized hydrogen is possible, which would then pose a fire hazard either on the vessel, or at the shore side facilities. Relative to the hazards that exist for the vessel while underway, accidental damage to the equipment is not very likely because bunking occurs at a stationary, controlled facility. Operator error is far more likely to be the cause of spills.	UNLIKELY	MAJOR		PMB	ACCEPT	A well planned bunkering procedure with adequately trained crew is the best way to prevent major spills from occurring. To further mitigate the risk of error, a second person employed as a "spotter" or "fire watch" may be utilized who would be near an emergency shutoff switch that could be used in the event of a visual spot of a spill or fire. Adequate firefighting equipment should also be installed at the facility. Automatic shutoffs may also be used when high concentrations of hydrogen or fire are detected at the bunkering facility.

THREAT RISK RATING

LIKELYHOOD \ OCCURANCE IMPACT	INSIGNIFICANT	MINOR	MODERATE	MAJOR	SEVERE
ALMOST CERTAIN	Medium	High	High	Extreme	Extreme
LIKELY	Medium	Medium	High	High	Extreme
POSSIBLE	Low	Medium	Medium	High	High
UNLIKELY	Low	Low	Medium	Medium	High
RARE	Low	Low	Low	Medium	Medium

Explanation of Opportunity Risk Ratings and Tolerability

Category	Description	Treatment Priority	Description	Review
EXTREME	Extreme	Immediate	Extreme	Weekly-Monthly
HIGH	Intolerable	Urgent	Intolerable	Monthly
MEDIUM	Borderline tolerable	When time and resources pe	Borderline tolerable	Quarterly
LOW	Well within tolerances	No action required	Well within tolerances	Yearly