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Nuclear Industry Association response to the Environmental Audit Committee inquiry on Net Zero aviation and shipping

1. The Nuclear Industry Association (NIA) welcomes the chance to respond to the Environmental Audit Committees inquiry on Net Zero aviation and shipping.

2. The NIA is the trade association and representative body for the civil nuclear industry in the UK. We represent around 250 companies operating across all aspects of the nuclear fuel cycle. This includes the current and prospective operators of nuclear power stations, the international designers and vendors of nuclear power stations, and those engaged in decommissioning, waste management and nuclear liabilities management.

Summary

3. The majority of emissions from ships come from a fraction of the fleet. Around 7,300 ships will emit 47% all emissions in the shipping sector at design service speeds, and 17,100 ships will emit close to 80% of all emissions. Eliminating emissions from either of these sectors, meets the emission reduction targets for the industry as agreed under the Paris Agreement.

4. A proposal exists to eliminate emissions from the largest ships using compact and inherently safe molten salt reactors (m-MSRs), a type of Advanced Nuclear Technology. These would be electric ships, emitting nothing. This technology will be a reality soon, with a proof-of-concept reactor scheduled for 2025, and commercialisation and deployment expected from 2028/30.

5. Advanced modular reactors are purely zero-emission energy systems. They will emit no CO_2, no greenhouse gases, nor any other airborne pollution. Issues related to reprocessing of spent fuels, end-of-life waste management, recycling and reuse of components and fuels are in advanced stages of design and will provide effective and sustainable solutions to cheap, clean energy production and consumption.

6. Without a well-considered push for decarbonisation now, the UK will lose its chance to be a world-leader in this area and risk missing Net Zero by 2050. The UK will have access to a deployable advanced modular reactor technology inside this decade, but the Government needs to act quickly to keep up with the rest of the world.

7. Focusing investments and legislative efforts on the largest, most polluting sectors of the shipping industry will reduce emissions the most and create the greatest competitive advantage for the UK maritime sector.

What new technologies are there to reduce emissions from shipping vessels and how close to commercialisation are they?

8. There are two fundamental dichotomies in the question being asked, as the reduction in emissions from ships must be meaningful, and the cost of such solutions must be less than the cost of current fuels plus any penalties to be paid for pollution.

9. From the challenge posed by these dichotomies there are only two directions in which the shipping industry can move.

10. Meaningful emission reduction from shipping can either come from synthetic 'drop in' fuels used in combustion engines and will have to be produced by methods that actually reduce the lifecycle emissions of ships, or from advanced atomic technologies to both power electric ships and to produce those synthetic 'drop in' fuels.

11. For 'drop in' fuels, the choice is now between ammonia and methanol, both produced from hydrogen with nitrogen added for ammonia and carbon added for methanol. Neither are zero emission fuels, as substantial NOx is emitted from ammonia, and CO_2 is emitted from methanol.

12. Current hydrogen production in the UK comes from steam methane reforming which 'cracks' hydrogen from natural gas, the production and combustion of such fuels produce more CO_2 and greenhouse gas emissions than what is currently the case with heavy fuel oil (bunker fuel) for ships.

13. Despite being close to commercialisation, such fuels will not reduce emissions. This is the first dichotomy.

14. For emissions to be meaningfully reduced when producing and using these fuels, the feedstock hydrogen will have to be made from water using electrolysis. This is a carbon and greenhouse gas free technique. This 'clean' hydrogen can then be used to make both ammonia or methanol and meaningfully reduce emissions. Both fuels result in NOx and CO_2 emissions, but at a much lower rate on a lifecycle basis.

15. However, production of clean hydrogen is highly energy intensive and comes at a high cost of production when using wind and solar generated electricity, because the cost of both ammonia and methanol as marine fuels relies mostly on the cost of hydrogen.

16. With clean hydrogen as low as $3.50 per kilo, the marine fuel equivalent price is approximately $2,300 per ton, compared to just $550 per ton for very low sulphur fuel oil with Brent Crude Oil at $70 per barrel.

17. At $1.50 per kg of clean hydrogen, that price of ammonia and methanol is closer to $900 per ton equivalent. Even when adding substantial carbon taxes or pollution penalties, the price of the alternative is uneconomical and will not be adopted by the industry when at sea.

18. Add to this the power of oil producing nations to lower the cost of oil, and therefore bunker prices, and there is no scenario in which hydrogen derived drop in fuels which reduce emissions, will be adopted by the shipping industry.

19. The global shipping industry will always calculate the total cost of propulsion as the amortisation of machinery capital expenditure, the operational expenditure of fuels, lubes, and personnel, plus the cost of taxes and penalties that may be imposed. If that total is lower than the cost of running 'low emission fuel like ammonia and methanol, the lowest price will always win.

20. Clean hydrogen derived 'drop in' fuels can therefore reduce emissions but cannot be commercialised unless they are mandated by law so that the price difference between fossil fuels and 'dirty hydrogen' plus carbon taxes and pollution penalties are irrelevant. This is the second dichotomy.

21. The path to clean hydrogen which both meaningfully reduces emissions and at a price comparable top 'dirty' hydrogen from LNG, is to use dedicated production facilities powered by advanced modular reactor technologies and existing nuclear generated electricity combined with wind and solar generated power when available. Wind and solar cannot achieve the volumes required alone.

22. Nuclear power is a firm, low-carbon source of energy that, since Calder Hall came online in 1956, has saved over one billion tonnes of carbon dioxide from being emitted into the atmosphere. Despite its characteristics, and history on board submarines, nuclear has not been seriously considered and funded by the Government as a viable alternative to heavy fuel in the shipping industry.

23. Advanced modular reactors are purely zero-emission energy systems. They will emit no CO_2, no greenhouse gases, nor any other airborne pollution. Issues related to reprocessing of spent fuels, end-of-life waste management, recycling and reuse of components and fuels are in advanced stages of design and will provide effective and sustainable solutions to cheap, clean energy production and consumption.

24. There are several advanced modular reactor developments which would fit the bill and the first designs of floating production facilities are being drawn in the UK now.

25. The first advanced modular reactors are on track to be deployed in the West between 2025 and 2030, and several show early promise of highly competitive pricing, making the prospect of economically driven emission reductions where zero emissions come as standard a distinct possibility.

26. The global fleet is large and diverse, and we should not assume that one solution will fit all sizes and purposes.

27. The majority of emissions from ships come from a fraction of the fleet. For example, around 7,300 ships will emit 47% all emissions in the shipping sector at design service speeds, and 17,100 ships will emit close to 80% of all emissions. Eliminating emissions from either of these sectors, meets the emission reduction targets for the industry as agreed under the Paris Agreement.

28. Given the scale of the issue and significant gap in the global market, the UK has a unique chance to position ourselves as a world-leader in R&D and regulation in this sector, and the Environmental Audit Committee should encourage the Government to support and enable disruptive new technologies, such as nuclear- powered ships and nuclear-powered floating production of 'drop-in' fuels, as a priority.

29. Companies such as CORE POWER in the UK are proposing to eliminate emissions from the largest ships – the very ships contributing the most to the shipping sector's emissions – using compact and inherently safe molten salt reactors (m-MSRs), a type of Advanced Nuclear Technology. These would be electric ships, emitting nothing. This technology will be a reality soon, with a proof-of-concept reactor scheduled for 2025, and commercialisation and deployment expected from 2028/30.

30. The nuclear technology that CORE POWER is developing, can be deployed in two ways. Firstly, as part of a floating production system of green ammonia or methanol, and to power the largest vessels themselves, freeing them from the need to 'slow steam', or indeed, to ever take bunkers again.

31. This hits three key criteria of Government Net Zero policy:

    - **Compliance** – there are mandates to decarbonise both in the shipping sector and wider economy. Advanced modular reactors like the m-MSR can help hit key decarbonisation targets in shipping without compromising on efficiency. In fact, vessels fitted with m-MSR's can be used to power local infrastructure during port stays, such as gantry cranes and other equipment, in a process known as 'reverse cold-ironing', which has significant health benefits for these coastal communities.

- **Disruptive technologies** – innovation is vital to Net Zero and m-MSR powered ships are the future as they can positively disrupt the sector. Not only is nuclear a dispatchable source of powerful zero-carbon energy, but such ships can sail faster between ports while carrying more cargo, improving supply chain logistics, and will no longer require bunker stops, shipping journeys could be faster, safer, and more efficient.
- **Green hubs** – either by boosting UK maritime regions or the development of floating platforms that will be self-sufficient, nuclear technology will positively transform modern shipping methods and contribute significantly to the UK economy. These technologically advanced vessels will also require specialist recruitment and training for UK seafarers.

32. Deploying m-MSR power for large ships can help meet 69 of the 73 policy recommendations set out in the Department for Transport's *Maritime 2050: navigating the future* report, including maintaining and enhancing the attractiveness of the UK's regional maritime clusters and London as a global maritime professional services cluster, and boosting maritime SMEs and R&D capabilities in the sector.

33. We are at a point where decarbonising the shipping sector is no longer a 'nice to have' but a need. Due to the lack of visibility of this sector, shipping emissions have not been publicly considered a priority by the Government.

34. An important aspect of this is related to the work of IMO Intersessional Working Group on Reduction of GHG Emissions from Ships (ISWG-GHG). In particular current IMO regulations (e.g. EEDI, EEXI, SEEMP) consider direct emissions only (tank to wake), disregarding indirect emissions (well to tank), and, in respect to GHG, CO2 emissions alone, disregarding CH4, N20 and black carbon.

35. In order to ensure that shipping emissions are reduced, rather than displaced somewhere else, it is paramount that total lifecycle emissions ('well to wake') are considered, not only in respect to GHG but also in respect of pollutants affecting mortality, morbidity and damages to the environment (e.g. NOx, SOx, PM etc). In this respect the UK Government should support current EU proposal (ISWG-GHG 9/2) aiming at introducing lifecycle guidelines to estimate well-to-wake greenhouse gas (GHG) emissions of sustainable alternative fuels, while at the same time proposing amendments and ameliorations widening the scope to include all pollutants, and not just GHG emissions only.

36. CORE POWER has developed a methodology to account for the total life cycle emission of ships that could be seamlessly applied to current IMO regulations, without regulating what outside IMO jurisdiction. The methodology is based on recognized standards and studies of the externalities for onshore power generation. CORE POWER is willing to present and discuss the methodology to help frame a proposal to IMO ISWG-GHG in this respect.

37. Without a well-considered push for decarbonisation now, the UK will lose its chance to be a world-leader in this area and risk missing Net Zero by 2050. The UK will have access to a deployable advanced modular reactor technology inside this decade, but the Government needs to act quickly to keep up with the rest of the world.

38. Focusing investments and legislative efforts on the largest, most polluting sectors of the shipping industry will reduce emissions the most and create the greatest competitive advantage for the UK maritime sector.

39. Joining the dots between current advanced reactor technology investments, current efforts to decarbonise shipping and the regulatory low hanging fruit to enable modern, efficient, and environmentally friendly advanced atomic to become a workhorse for international shipping can create a new future for the UK as the leading maritime nation.

What further action is needed by the International Maritime Organization to drive emissions reductions? What can the UK Government do to drive international action on emissions?

How should the UK define its ownership of shipping emissions (i.e. arrivals, departures or both) in order to include them in legislative targets?

40. Since this EAC committee request for information was issued, the UK Government has in fact taken a major step forward in this area by launching, through the UK Maritime Coastguard Agency (which is the UK representative at the IMO), a call for consultation on the draft Merchant Shipping (Nuclear Ships) Regulations 2021.

41. Effectively, the UKMCA are looking to validate a proposal that would see SOLAS Chapter 8 (which includes resolution A.491.XII), pass into law in the UK.

42. SOLAS Ch 8 was ratified by all but 2 members of the IMO in 1981 and is the de-facto global standard for operating a nuclear-powered ship. However, SOLAS Ch 8 was devised in the 1970s with the technology of that time in mind. The rules set out need review and modernisation so that modern and efficient advanced modular reactor technologies can be considered for shipping. Bringing SOLAS Ch 8 into law, opens the door for the UK to promote a modernisation of those rules.

43. The Code should be updated to cover the new generation of advanced modular reactor technology that would be fitted on floating production units and vessels from the end of the decade onwards. This should be done in time to place the suggested amendments before the 2024-25 session of the IMO Maritime Safety Committee.

44. This action at IMO level, which the MCA must deliver so that bringing SOLAS Ch 8 into law will lay a path for modern technology, should be promoted in collaboration with other major powers such as the US, France and others including Japan and South Korea so that we can see the modernisation of a major part of the regulatory framework needed to eliminate emissions from shipping.

45. There is substantial support for advanced modular reactor technologies in the private commercial maritime sector spread across the UK, North America, Europe, and the Far East.

46. To cement a leadership position in the reduction and eventual elimination of seaborne emissions, the UK should consider a timeline for reduction to zero emissions, not just net zero emissions in UK waters.

47. This would spur substantial inward private sector investment in the UK and rapid deployment of zero emission energy technology not just in the maritime sector but beyond. What works at sea will work on land.

How effective will the global offsetting scheme for the UK and EU ETS be at stimulating technology improvement and/or behaviour change to reduce emissions from shipping?

48. Extending the UK and EU ETS to cover emissions from shipping, in our view, would help put the necessary pressure on the industry to decarbonise and for technologies such as the molten salt reactors being developed by CORE POWER to flourish and give the UK a clear advantage in terms of its Net Zero target, creating the right environment for disruptive technologies in shipping to be launched here.

49. Shipowners and operators consider ETS as carbon taxes and will approach the system in the same way they consider parking tickets. If the cost of wrongful parking and getting a ticket is less than the cost of compliance, they will always take the ticket. If polluting is and paying the penalty is cheaper than compliance, they will pollute.

50. Similarly, if the aim of carbon taxes and offsetting schemes is to level the playing field between fossil fuels and ‘drop in’ fuels, the power of oil producing nations to pump more oil and undercut

the price of synthetic fuels will inevitably endure for longer than the industry can afford to pay the price of ‘drop in’ fuels, regardless of how high carbon taxes are set. Invariably, the source of bona fide carbon offsets will diminish.

51. Advanced modular reactor technologies that can be deployed in the maritime sector are by nature zero emission energy systems which could also generate offsets and carbon credits.

52. Incentivising owners, operators, shippers, ports, bankers, insurers, and regulators to adopt these technologies that generate offsets for older, yet-to-be-replaced vessels, would create a virtuous circle of investment and development towards a true zero emission industry at the heart of global trade.

53. Simply put, shipping companies need to replace older ships over the next 20 years, and if the chance to start the replacement cycle with ships that off-set those that are still emitting and polluting actually gives an economic and competitive advantage if flagged and operated from the UK, the scene can be set for a resurgent UK maritime sector.

54. The UK Government should ensure that nuclear and advanced modular reactors are included as sources of offset generation, and where possible, plough a good portion of the revenues generated from offsetting schemes back into creating a world leading position for the UK in the maritime sector.