Nuclear Ships: History, Risks and Implications for the Spill Community

Abstract for Interspill 2025

Dr Conor Bolas, ITOPF, ConorBolas@itopf.org

Natalie Kirk, ITOPF, NatalieKirk@itopf.org

Introduction

The global drive for a carbon free future has put pressure on the shipping industry to find alternatives to traditional mineral oil fuels used for the propulsion of most modern ships. One option under consideration, alongside alternative fuels like methanol and ammonia, is nuclear propulsion. Although marine nuclear propulsion is not a new concept, recent technological advances have renewed interest in its potential. Nuclear propulsion presents an attractive option as it produces no greenhouse gases or other atmospheric pollutants, and vessels can operate for years or even decades without refuelling. However, there are significant drawbacks to this technology. Potential accidents could have severe environmental and socio-economic consequences.

If nuclear propulsion is to play a significant role in the future fuel mix, technological advancements will need to be parallelled by regulatory framework modernisation including liability and compensation to facilitate seamless transboundary maritime transportation and port access. Also required will be infrastructure development, comprehensive training of vessel crews and development of preparedness and response capability for shipping incidents involving radiation release.

Background and history of nuclear propulsion

Nuclear propulsion has been used for many decades in icebreakers and military vessels, but it has not yet been widely adopted in commercial shipping, primarily because of high costs and safety concerns. Currently, around 200 nuclear reactors are operational across 160 vessels, the majority of which are naval ships and submarines. Among these, seven are civilian nuclear-powered ships: six icebreakers and one icebreaking cargo vessel, all of which are owned by Russia.

New developments and challenges

A new generation of nuclear reactor, known as small modular reactors (SMRs), offer potential solutions to the cost and safety issues linked to traditional nuclear propulsion. These reactors are smaller, more affordable, and easier to manufacture. Additionally, certain designs, such as molten salt reactors, have inherent safety features that reduce the risk of overheating and meltdown. Several

initiatives are working towards commercializing SMR technologies for use onboard commercial ships, with some projects reportedly targeting prototype trials by 2035.

Nuclear shipping incidents

Widespread adoption of nuclear propulsion would introduce a new set of challenges for the spill response community. Incidents involving radioactive material present complexities that are vastly different from those associated with oil or alternative fuels. An entirely new way of thinking is required in every aspect of the response and different stakeholders are likely to be involved. The environmental impact of radioactive material has been well studied after several large well-known incidents worldwide, including those in the marine environment. Ships with nuclear propulsion will pose similar, but differing, threats to human health and the environment which will require detailed consideration.

In this study, using past nuclear incidents as a backdrop, authors investigate the potential implications of an incident involving a nuclear propelled vessel for the marine environment, affected communities and for the international spill community.