ERASMUS UNIVERSITEIT ROTTERDAM

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# Set Sail for Utopia

## How the Dutch Public and Political Opinion Influenced the Development of Dutch Nuclear Merchant Shipping, 1950-1990

by

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# Keywords

Nuclear merchant ships, nuclear merchant marine, history of nuclear technology, Dutch public opinion, Dutch history, Dutch political opinion, sentiment analysis, newspaper research, 1950-1990.


# Abstract


This thesis shows the development of the Dutch public and political opinion on nuclear merchant shipping from 1950 to 1990. It is hypothesised that the public opinion not only changed over the years, but it negatively influenced the plans to build new nuclear merchant ships. Indeed, sentiment analysis shows a change in public opinion towards nuclear merchant shipping: first it was positive, then, in 1980, it changed for the worst. Two factors stand out when analysing the years surrounding 1980.

First, the rhetoric changes, in that nuclear merchant ships are suddenly compared indiscriminately with nuclear weapons. The Dutch public always thought that nuclear weapons were a bad thing. This bad reputation spilled-over to nuclear merchant ships, rendering them unpopular as well. Second, nuclear merchant ships got confused with other types of nuclear applications, such as nuclear naval ships, nuclear weapons, and even nuclear waste. As resistance towards those applications grew, so too grew the resistance towards nuclear merchant ships. The political opinion showed a similar development, albeit some years earlier.

Both the negative public and political opinion disincentivised shipbuilders and shipowners from investing into nuclear merchant ships. On the one hand. the political willpower to engage in multilateral agreements lacked. The agreements were necessary to give nuclear merchant ships international berth rights. On the other hand, a negative public opinion resulted in protests against nuclear ships. Any projected profitability of nuclear merchant ships would diminish due to delays because of protests. This, of course, made nuclear merchant ships into an unattractive investment.

*"Our generation lives between Hell and Utopia.*
*For the very force that can destroy the human race,*
*can create wonders without end on earth.*
*It is small wonder that men's minds today shuttle between fears of doom*
*and dreams of unprecedented bounty.*
*Here is the Utopian Promise of the Peacetime Atom."*
**David O. Woodbury, 1916**

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# Chapter one:
# A tale of ships, the future, and nuclear scientists

A crowd of mumbling spectators stood in a cathedral-like drydock, in awe of what stood before them: the first nuclear-powered merchant ship. It was July 21st, 1959, and they watched the christening of the *NS Savannah*. It would take another two-and-a-half years before the nuclear reactor was completed but that would not stand in the way of a celebratory ceremony. Indeed, the crowd was celebrating the new atomic age, which was heralded 45 years earlier by the popular novelist H. G. Wells as a time where almost every part of life was sustained by nuclear power.[1] The *NS Savannah* marked, for the crowd, the beginning of a time where nuclear power was used in other applications than nuclear weapons. She would drastically revolutionise merchant shipping, just as her namesake: the first steam ship that crossed the Atlantic ocean, the *SS Savannah*. Yet, with hindsight, we know that the implementation of nuclear power in everyday life stayed limited, if not away at all in the case of nuclear merchant shipping. The *NS Savannah* would be one of only four nuclear merchant ships that actually sailed. Three of which were decommissioned as nuclear ships shortly after their christening, and the only one that is still in use only sails between the same two harbours. The track-record of nuclear merchant ships can hardly be called a success. Still, present-day nuclear scientists maintain that nuclear merchant ships are an attractive alternative to fossil fuel-powered merchant ships.

## 1.1– History does not repeat itself but it surely rhymes

To apply nuclear power to propel merchant ships has been proposed and justified in recent academic literature. The plea for nuclear merchant ships is supported with reasons for why nuclear merchant marine is nowadays a possible and probably even a necessary option. First, conventional ships make up for a large part of the production of greenhouse gasses, which are becoming problematic as Nobel Prize winner Al Gore, among many others, so avidly voiced.[2] Nuclear merchant ships, on the other hand, produce no greenhouse gasses. Second, letting ships run on fossil fuels enhances the political and economic dependency on primarily Middle-Eastern countries. Again, this is not the case with nuclear merchant ships. Third, nuclear merchant ships are thought the solution to logistical problems, such as transporting perishable goods with merchant marine. Nuclear merchant ships run faster, cheaper and more

[1] H.G. Wells, *The World Set Free: A Story of Mankind* (New York: E.P. Dutton & company, 1914).
[2] A. Gore, *An Inconvenient Truth* (Universal Pictures, 2007).

cleanly. According to the literature, nuclear merchant shipping combats all the problems that conventional shipping brings. A historical context, however, is absent. This entire discussion already occurred, be it seventy years earlier.

Since the 1950s, many nuclear scientists tried to find new and efficient ways to apply nuclear technology to existing products. Nuclear merchant ships were one of the more obvious implementations of nuclear power. So, to combat environmental challenges, to increase political and economic independence from the Middle-East, to provide an answer to the depleting oil-reserves, and to achieve more profits, nuclear merchant ships were a particularly popular option.

Present-day nuclear scientists agree with their colleagues from a different era, but fall into the same trap as well. They act as if nuclear development takes place in a political and public vacuum. As if the public and political opinion, which is the majority's view on a subject, has no possible influence on the implementation of an innovative technology. Their research stretches to neither politics' nor the public's influence on the matter. This thesis introduces the notion that the public and political perception on the use of nuclear merchant shipping has influenced the implementation of nuclear merchant ships, or better yet, the lack thereof.

This thesis does so, not by conducting global research, but by using the Netherlands between 1950 and 1990 as a case study to show the correlation – if there is one – between the public's and politics' perception on nuclear-powered merchant marine and the lack of broad implementation of this technology. The focus of this thesis is to analyse the extent to which the Dutch public and political perception influenced the development of Dutch nuclear merchant ships in the period from 1950 to 1990.

It is hypothesised that the public and political opinion changed during this time period. In the 1950s, nuclear merchant ships were met with enthusiasm and general curiosity. Especially in the early-1960s, the Dutch public saw nuclear merchant ships as something positive. Figure 1.1 shows people queueing for the *NS Savannah* when she berthed in Rotterdam in the early 1960s. The same happened when the second nuclear merchant ship, the *NS Otto Hahn*, berthed some years later. Politicians welcomed these ships with speeches and plans were made to build even more nuclear ships, illustrating also a positive political view on nuclear merchant ships.

Fast-forward to 1988, when the last nuclear merchant ship was floated-out. That ship was met with protests wherever it went. Locals, supported by some politicians, blocked ports

Figure 1.1 – *Visitors queueing up to board the NS Savannah in Rotterdam*.

and tried to stop this nuclear ship to berth their harbour. This contrasts heavily with the positive view on nuclear merchant ships of the 1950s. Ergo, the public and/or political opinion on nuclear merchant ships changed for the worst between 1950 and 1990.

Surely, to truly understand the viability of nuclear merchant shipping, as nuclear scientists try to do, this change in public and political opinion needs to be analysed because no matter how well ships work or how profitable they are, if there is no public or political support, the owners and exploiters of the nuclear merchant ships will face nothing but resistance. Every time the ship will try to berth a harbour will be met with blockades and protests. In that case, the profitability does not matter, as delays will pale the profits with losses. So, how did the public and political opinion develop longitudinally and how did this affect the use of nuclear merchant ships?

Present-day nuclear scientists try to understand the lack of current nuclear merchant ships by studying the failure that were the operational nuclear merchant ships. So too does this thesis start there. In chapter two, the following question is dealt with: which projected benefits of nuclear merchant shipping led to the development of the four nuclear merchant ships and what problems led to their discontinuation according to existing relevant academic literature? Basically, this chapter provides much needed context to the research question. Indeed, to measure the influence of, in this case, the public and political opinion on nuclear merchant shipping, one needs to know the other influences as well. Not only does this chapter provide such possible influences but it also contains analyses of present-day researchers on which factor influenced most.

In order to understand the actual development of the public opinion – the political opinion will be covered in later chapters – a baseline measurement needs to be set. Chapter

three analyses the public opinion to nuclear merchant shipping in the late-1950s and early-1960; which is a period where public opinion is expected to be positive towards nuclear merchant shipping. The arguments used to explain why nuclear merchant shipping is a positive contribution to society are also important for the baseline measurement. Concretely, the question that chapter three answers is: on which factors was the Dutch public opinion on nuclear merchant shipping based in the late 1950s and early 1960s?

Chapter four shows the development of the public opinion on nuclear merchant shipping, starting from the baseline measurement set in chapter three. The main focus points are, first, to established when the public opinion deviated from the baseline measurement set in chapter three; and second, what elements contributed to this change. A comparison with the arguments provided by chapter three is made. Contrived to a question, the goal of chapter four is: when did the Dutch public opinion on nuclear merchant shipping change and what elements contributed to this change?

Only one unchartered factor that could influence nuclear merchant shipping remains: the political opinion. Chapter five focusses on this factor because, especially in a democracy, political opinion and public opinion are hypothesised to be similar. If that is the case, then surely political opinion is important for the success of nuclear merchant ships. The public can delay, block or boycott nuclear merchant ships, but the government can outright ban them. So, similar to the questions of chapter four: in what way did the political opinion develop over time and why?

But first, as the term is used plentiful already, it is important to understand what nuclear power and its applications actually mean.

## 1.2 – A small introduction to nuclear power

Definition-wise, nuclear power can mean two things, nuclear fusion and nuclear fission. Nuclear fusion happens when two or more atomic nuclei fuse into one or more new atomic nuclei.[3] *Id est*, it is the fusion of the cores of smaller atoms, such as helium or hydrogen, which then forms new atoms such as uranium and plutonium. The technology of fusion relies on the chain reaction set of previous fusion-reactions to produce energy. Indeed, the residual product of nuclear fusion, namely uranium and plutonium isotopes, releases an extensive amount of energy that sparks a new fusion process, creating the desired chain reaction. Yet, the chain reaction necessary for fusion technology is difficult to harness. So difficult, in fact,

[3] J.K. Shultis and R.E. Faw, *Fundamentals of Nuclear Science and Engineering* (New York: Marcel Dekker, 2002), 151.

that large scale nuclear fusion power is not successfully exploited outside thermonuclear weapons, and even in the case of thermonuclear weapons, only a few countries are able to develop and manufacture such weapons.

Nuclear fission, which is the most common form of nuclear power, is the process of radioactive decay in which the atom splits into smaller parts, and by doing so, releasing massive amounts of energy.[4] Normally, an atom does not split by itself. So in order to split an atom, its core – or nucleus – needs to be destabilised, which is achieved by injecting neutrons or protons by force. Adding a neutron or proton into an atom's core, however, requires considerable energy. Therefore, isotopes such as uranium-235 and plutonium-239 are used because they absorb neutrons more easily, thus requiring less energy when adding neutrons and protons to its core, making the whole process relatively easier.[5] When the core is destabilised, the atom itself breaks down, releasing not only a copious amount of energy, but

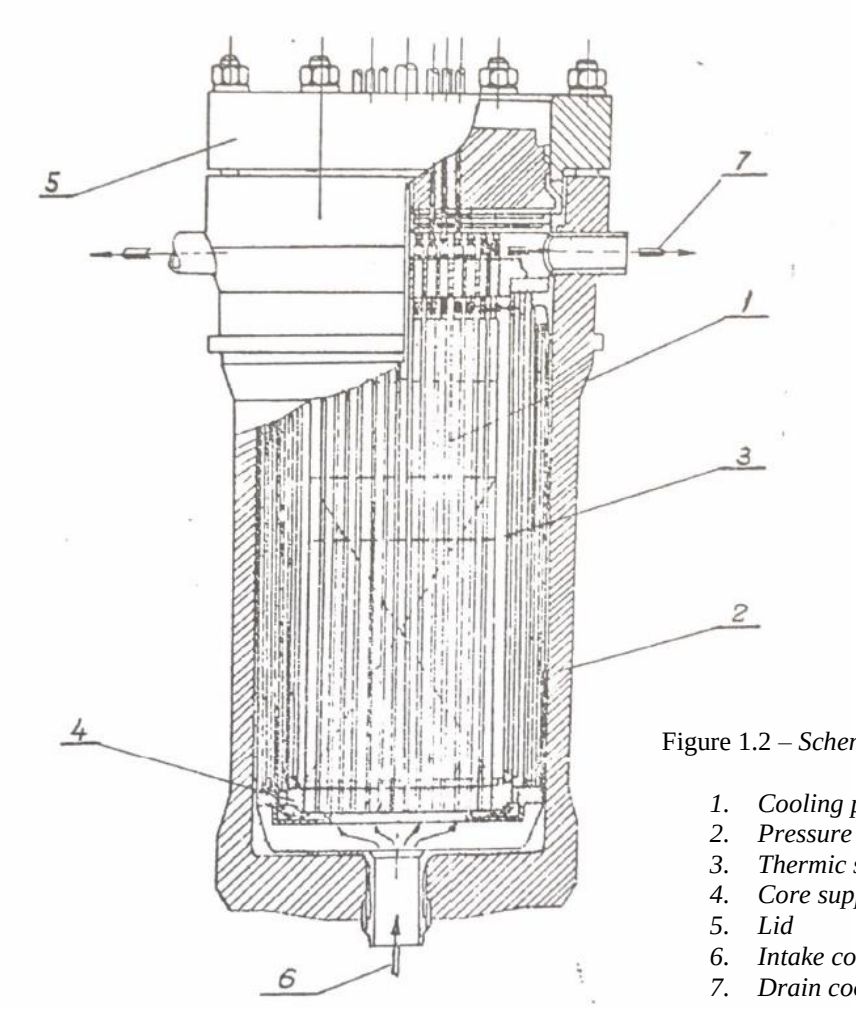


Figure 1.2 – *Schematic drawing of the reactor core.*

1. *Cooling pipes*
2. *Pressure vessel*
3. *Thermic shielding*
4. *Core support*
5. *Lid*
6. *Intake cooling solution*
7. *Drain cooling solution*

[4] M. Lefort, *Nuclear Chemistry* (D.Van Nostrand Company Inc., 1968), 202.
[5] J. Byrne, *Neutrons, Nuclei, and Matter: An Exploration of the Physics of Slow Neutrons*, Dover ed (Mineola, N.Y: Dover Publications, 2011), 259.

electromagnetic radiation as well.[6] The electromagnetic radiation contains gamma rays, which are biologically hazardous and hard to block given their persistent property. Other radiation is also released but this is easier to contain compared to gamma rays. Alpha rays, for example, are potentially more hazardous than gamma rays, but cannot penetrate the skin.

Even though nuclear fission is more broadly used, it is almost exclusively used under supervision of governments. Whether it is a nuclear power plant, a nuclear submarine or a nuclear weapon, a government likely owns it or regulates it heavily. This is because of the risk of turning uranium-235 or plutonium-239 into a nuclear weapon, adding to the nuclear proliferation – *Id est*, a nuclear arms race. Proliferation is generally feared by governments and is circumvented when possible.[7] The use of low-enriched uranium is a solution to this problem. Low-enriched uranium is the term for processed uranium-ore which contains only 20 percent of uranium-235 isotopes, as opposed to a 60 percent concentration – which is called yellow cake – that is normally used for the development of nuclear weapons. Thus, low-enriched uranium enables the use of nuclear fission in the private sector while keeping the risks of proliferation slim.

Nuclear merchant ships use fission power with low-enriched uranium instead of fossil fuel for their propulsion. Conventional ships burn fossil fuel and use the resulting energy –in the form of heat– to create and pressurise steam, which is then fed to turbines that move its underwater propellers. Nuclear propulsion works in a similar way, in that the energy released by the fission reaction is used to create steam. First, hot water is fed into the generator and pumped through tubing that go past the reactor (figure 1.2). The reactor's radiant heat then creates superheated water of nearly 300 degrees Celsius, which heats the water in the secondary loop through the outlet. Superheating means that the water is pressurised whilst being heated so that it stays liquid even though it has exceeded boiling point. A valve in the secondary loop regulates the amount of water that enters the gearbox which transfers the energy in the form of heat into mechanical energy used for driving the propellers. Further in the secondary loop, the water is cooled with plain sea water, so that it is more manageable. Pumps then feed that cooled water through a heater to superheat the water again, which is then led into the primary loop to start the process all over again. This type of reactor is fittingly called a Pressurised Water Reactor, or PWR for short (figure 1.3).

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[6] '14.20 Gamma Decay', accessed 13 December 2017, https://www.eng.famu.fsu.edu/~dommelen/quantum/style_a/ntgd.html.

[7] A. Glaser, 'About the Enrichment Limit for Research Reactor Conversion: Why 20%?', in *International Meeting on Reduced Enrichment for Research and Test Reactors (Hereinafter Referred to as RERTR Conference), Boston*, 2005, 3–4.

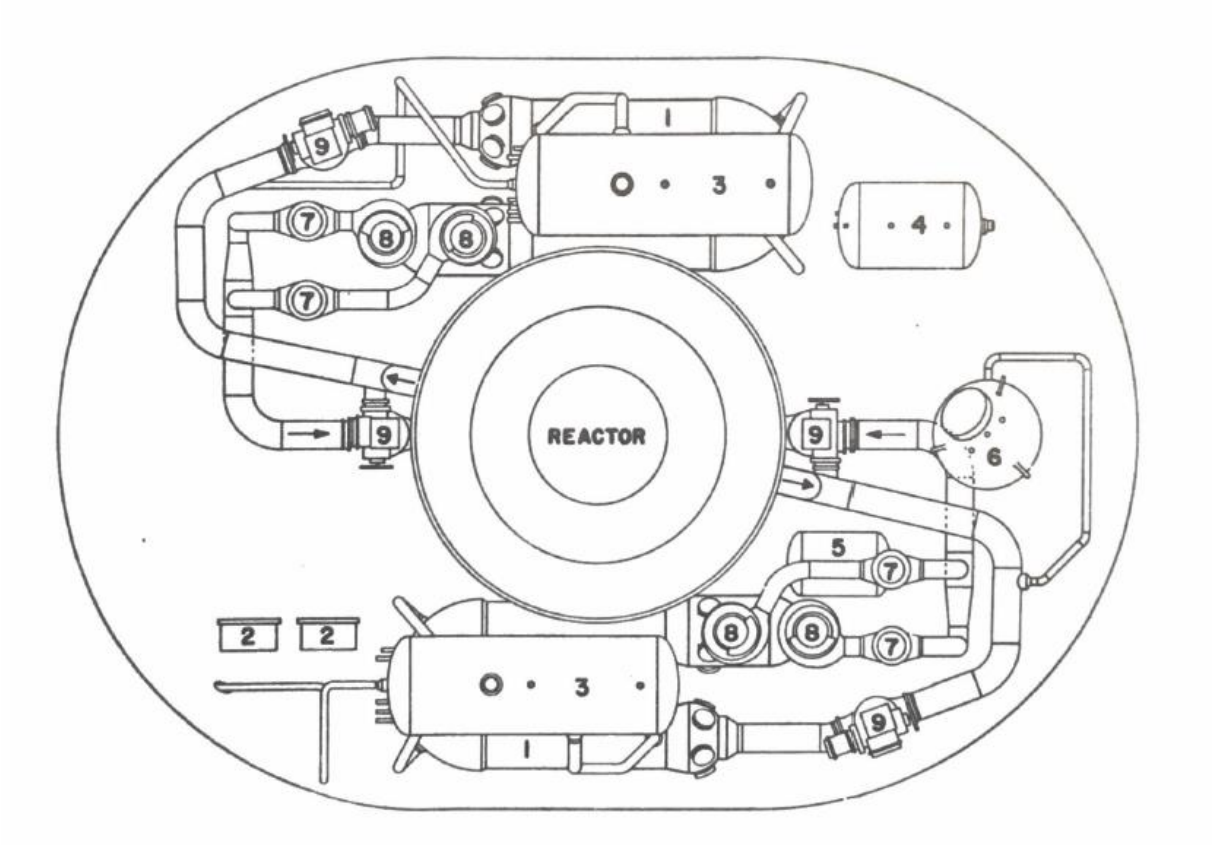


Figure 1.3 – *Schematic drawing of the primary loop of a PWR.*

1. *Heat exchanger*
2. *Coolers*
3. *Steam tank*
4. *Condenser*
5. *Safety tank*
6. *Pressure generator*
7. *Valve*
8. *Pump*
9. *Gate valve*

Naturally, using fission power to heat water brings its challenges. First, the energy released by a fission reaction is so vast that it needs active cooling to prevent it melting through the ship's hull.[8] On the other hand, such massive energy heats water more efficiently, which results in potential faster sailing speeds and/or the possibility of powering enormous ships. The second challenge is that fission power releases harmful gamma rays, unlike conventional propulsion.[9] Ergo, the engine needs to be shielded against radiation. Also, when modifications or repairs need to be done, only specially trained engineers can do so. This means a relatively more expensive workforce. These challenges are inherent for all types of nuclear reactors.

Another type of reactor is called Boiling Water Reactor (BWR), which, as the name suggest, allows the water in the reactor to boil. This allows the reactor to be significantly less pressurised. A BWR, though, is larger than a PWR, as steam needs to build up in the core

[8] L.O. Freire and D.A. Andrade, 'Historic Survey on Nuclear Merchant Ships', *Nuclear Engineering and Design* 293 (November 2015): 179, https://doi.org/10.1016/j.nucengdes.2015.07.031; J.G.C.C. Jacobs, 'The Integration of a Helium Cooled Reactor in a 800 Teu Container Feeder', n.d., 15.

[9] W.H. Berman and L.M. Hydeman, 'International Control of the Safety of Nuclear-Powered Merchant Ships', *Michigan Law Review* 59, no. 2 (1960): 233–258; J. Carlton, R. Smart, and V. Jenkins, 'The Nuclear Propulsion of Merchant Ships: Aspects of Risk and Regulation', 2010, 237.

and, indeed, steam needs more space than liquid water. The downside of using steam lies in the difficulty of regulating the temperature. Running steam too hot equates to more pressure, which is then difficult to depressurise, as the steam is radioactive and cannot be released without hazardous results. Also, turning down the power of the heating elements is difficult, as a nuclear reaction releases plenty energy or none at all, unlike conventional heating, where one solely needs to turn down the amount of fuel injected.

BWR-installations can either have a direct or an indirect loop. A direct loop has the steam directly going to the gearbox to drive the propellers. To minimise the risk of containment, the gearbox and turbines need shielding too. Even with extra shielding, a direct loop is cheaper. It is also more risky. The indirect loop works similar to that of the PWR but works with steam instead of superheated water. Almost all BWR-plans are from the Norwegian *Institutt for Aromenergi* (IFA) but were ultimately never realised.

The last types of reactor are the Organically Cooled Reactor (OCR) and the High Temperature Gas-cooled Reactor (HTGR). In the case of the OCR, potent organic heat transfer agents are used. Such heat transfer agents have a high boiling temperature and thus require less cooling and are safer. Also, their corrosive properties are neglectable, unlike water. There are, however, some downsides to using an OCR. The radioactivity exerted from the reactor changes the chemical properties of the heat transfer agents. Simply put, they form polymers, better known as plastic, which clogs the system.[10]

The HTGR counters these negative properties by using gas to transfer the heat. This gas, though, needs to be pumped around with higher speeds, as the gas is even less potent to transfer heat than the organic heat transfer agents and loses energy at a high rate. Also, the gas need more heat because the gas turbines only work at 650 degrees Celsius or higher. To achieve such temperatures, high-enriched uranium fuels the reactor. This technique is commonly used in naval nuclear ships but makes civilian use of a HTGR improbable because of the proliferation-issues of privatised yellow cake.

The four completed nuclear merchant ships were all powered by a PWR or a BWR. These types of reactors were simply all-round best for commercial use. It was the best chance for realising the dream that was nuclear merchant shipping.

[10] A.C. van Dongen, *Aspecten Rond Het Ontwerp En de Bouw van Een Nucleaire Onderzeetanker* (Eindhoven: Technische Hogeschool Eindhoven, 1972), 80–94.

# Chapter two:
# The dream incarnated

Present-day nuclear scientists refer to the four nuclear merchant ships ever built to explain why the world has never seen more of those kinds of ships. They discuss the advantages and disadvantages of each ship so that they may predict future usefulness and practicality of this technology. Table 2.1 gives a chronological overview of the four nuclear merchant ships, starting with the *NS Savannah*, followed by the *NS Otto Hahn*, the *NS Mutsu*, and lastly the *NS Sevmorput*.

Table 2.1 – *Name, nationality, period of operation, and objective per nuclear merchant ship.*

| Ship name and flag state | Period of operation | Objective |
|---|---|---|
| *NS Savannah*<br>USA | 1962-1972 | Demonstrating design, operation, and manning, as well as generating goodwill. |
| *NS Otto Hahn*<br>West-Germany | 1968-1979 | Research ship with the primary purpose of gaining experience on future nuclear transport ships. |
| *NS Mutsu*<br>Japan | 1974<br>1991-1992 | Commercial prototype for transporting cargo. |
| *NS Sevmorput*<br>Soviet Union/Russia | 1988-present | Container ship, later primarily transport and icebreaking in remote Artic regions. |

*Source: W.H. Donnelly, Nuclear Power and Merchant Shipping (US Atomic Energy Commission, Division of Technical Information, 1965); H. Schøyen and K. Steger-Jensen, 'Nuclear Propulsion in Ocean Merchant Shipping: The Role of Historical Experiments to Gain Insight into Possible Future Applications', Journal of Cleaner Production 169 (December 2017): 153.*

The first nuclear merchant ship, the *NS Savannah*, was christened on July 21st, 1962, but the nuclear reactor was not completed yet, which delayed the maiden voyage until August 20th, 1962.[11] The *NS Savannah* had two objectives: generate goodwill towards nuclear power and test the feasibility of a low enrichment uranium core in a naval reactor. This particular reactor had an output of 20,300 horsepower, which is more than engines of similar-sized conventional ships produce. Measuring just shy of 182 metres long and 24 metres wide, she was regular in size compared to other cargo ships. Still, given her idiosyncratic propulsion, the *NS Savannah* was striking enough to attract significant attention and visitors everywhere she would berth. She sailed a total of 77 million nautical miles, which equates to lapping

[11] R.S. Lange, *Theme Study - Large Vessel NS Savannah* (Washington DC: U.S. Department of the Interior, History Division, NPS, 1990), 32.

Earth 3600 times, to welcome a total of 1,400,000 visitors on board. [12] After the *NS Savannah* achieved her objectives, she was decommissioned on January 10, 1972.

Whilst the *NS Savannah* was still operational, on October 1st, 1968, the second nuclear merchant ship was completed in West-Germany: the *NS Otto Hahn*. The *NS Otto Hahn* was smaller than the *NS Savannah*, as she measured 172 metres long and 23 metres wide. With 11,000 horsepower, the engine of the *NS Otto Hahn* was considerably less powerful also. The *NS Otto Hahn*'s objective was not so much generating goodwill, like the *NS Savannah*, but solely to analyse the feasibility of nuclear merchant shipping in the future. When the *NS Otto Hahn* gathered enough data in 1979, her reactor was decommissioned and her life as a nuclear merchant ship came to an end.[13]

Like the *NS Savannah* and the *NS Otto Hahn*, the third nuclear merchant ship ever produced, the Japanese-made *NS Mutsu*, was an experimental nuclear merchant ship.[14] The *NS Mutsu* was even smaller than the *NS Otto Hahn*, as she measured 130 metres long and 19 metres wide. Apart from the measurements, the maximum propulsion power of 10,000 horsepower was less too. Unlike the other two nuclear merchant ships, the *NS Mutsu* critically failed on her maiden voyage in 1974. The reactor core leaked radiation and to avoid more damage and radiation, the fuel was removed the same year. Ultimately, in 1991, the *NS Mutsu*'s nuclear power engine was completely overhauled. This ensured that the *NS Mutsu* could gather some data after all, which she did in the following year, and eighteen years after her maiden voyage. After travelling a mere 15,000 nautical miles, the *NS Mutsu* was decommissioned as a nuclear ship and turned into a scientific reconnaissance ship.[15]

Unlike the three experimental nuclear merchant ships, the Russian-built *NS Sevmorput* has been commercially used since her completion in 1988, albeit under the state-owned companies like Murmansk Shipping Company and since 2008 Atomflot.[16] The nuclear reactor

[12] R. Adams, 'Why Did The NS Savannah Fail? Can She Really Be Called a Failure? - Atomic Insights', accessed 23 November 2017, https://atomicinsights.com/cover-story-why-did-savannah-fail/.
[13] H. Schøyen and K. Steger-Jensen, 'Nuclear Propulsion in Ocean Merchant Shipping: The Role of Historical Experiments to Gain Insight into Possible Future Applications', *Journal of Cleaner Production* 169 (December 2017): 152–60, https://doi.org/10.1016/j.jclepro.2017.05.163.
[14] Jacobs, 'The Integration of a Helium Cooled Reactor in a 800 Teu Container Feeder', 16.
[15] M. Adachi et al., 'The Decommissioning Plan of the Nuclear Ship MUTSU', 1995, 49, http://inis.iaea.org/Search/search.aspx?orig_q=RN:27029493.
[16] 'Nuclear Powered Fleet: Nuclear Powered Vessels Nuclear Powered Vessels Characteristics, Maintenance, Nuclear Power Unit: The "SEVMORPUT" Nuclear Powered Lighter-Aboard Ship', accessed 23 November 2017, https://web.archive.org/web/20040811150333/http://atomic.msco.ru/cgi-bin/common.cgi?lang=eng&skin=menu2&fn=lihter; Schøyen and Steger-Jensen, 'Nuclear Propulsion in Ocean Merchant Shipping', 156.


Figure 2.1 – *The Murmansk-Dudinka route across the Barents Sea.*

has operated for the last thirty years without major incidents. However, the *NS Sevmorput* laid idle for ten years in the 2000s, due to logistical problems in refuelling. When finally refuelled, the *NS Sevmorput* recontinued steaming the ice-invested Murmansk-Dudinka route (figure 2.1) and continues to do so until this day. In terms of propulsion, the *NS Sevmorput* is quite similar to the other nuclear merchant ships, were is not that the *NS Sevmorput* is designed as an icebreaker. This means her hull is reinforced so that ice up to one meter thick can be breached.[17] Also, the *NS Sevmorput* is a lighter aboard ship (LASH). Due to its onboard crane, a LASH has the ability to load and unload barges – also called lighters – on its own. Said barges can then transport the cargo further inland into shallow waters, as they are smaller and fare less deep than the LASH. The fact that the *NS Sevmorput* is designed to transport lighters adds to the size. With a length of over 260 metres and a width of 32 metres, the *NS Sevmorput* is significantly larger than the other nuclear merchant ships. Consequently, the *NS Sevmorput* is more powerful too with her 27,600 horsepower.

Indeed, that four merchant ships were powered by nuclear fission illustrates to some extent the possibility for nuclear powered merchant ships. However, if it was truly viable, why were there only four nuclear merchant ships ever made? Contemporary explanations are given from an economic, a technical, a juridical and an ideological perceptive.

## 2.1 – Economic perspective

One of the most dominant approaches in recent academic literature to why nuclear merchant ships are desired comes from an economic perspective. There are several arguments made. First is the benefit of speed. Nuclear merchant ships can steam at high speeds over long

[17] 'Nuclear Powered Fleet: Nuclear Powered Vessels Nuclear Powered Vessels Characteristics, Maintenance, Nuclear Power Unit: The "SEVMORPUT" Nuclear Powered Lighter-Aboard Ship'.

distances.[18] Like shipping in general, faster travel speeds equates to more commodities shipped. Indeed, a merchant ship spends most of its time on open sea and reducing that time spent most effectively reduces travel times. Simply increasing the engine speeds on conventional ships offers no solution. Oil-powered ships are limited to do so because it would result in a diminishing return on their fuel-use: the money they would earn extra with shortened travel times would be cancelled out by extra fuel costs. The speed of nuclear-powered ships, on the other hand, has no effect on its fuel-use.[19]

Higher speeds also enable the transport of logistically challenging commodities. Perishable goods, for example, can generally be shipped via airplane only. They can, however, be shipped by cargo ship if a higher average speed is achieved, as would be the case with nuclear merchant shipping. Considering that seaborn shipping is considerably cheaper than airborne shipping, it would open new markets and thus create a boost to global trade.[20]

Second is the benefit of size. Not only is the propulsion-mechanism of nuclear merchant ships more efficient than their conventional oil-driven counterparts, it is significantly smaller too; even with the added shielding. Less needed space for the engine means more room for actual cargo. Given the more efficient nature of using nuclear fuel over fossil fuel, a nuclear merchant ships only needs to haul between 20 to 30 grams of fuel to travel thousands of nautical miles, as opposed to tonnes of fossil fuel. Of course, the space for those tonnes of fuel can then also be used for cargo. Because both the engine and fuel storage are significantly smaller, nuclear merchant ships are hypothesised to net higher earnings than a conventionally powered ship.[21]

That is also the crux. To prove the abovementioned hypothesis – that nuclear merchant ships net higher earnings – academics use the cases of the *NS Otto Hahn* and, to a lesser degree, the *NS Savannah*. Both cases show the same outliers in costs: the developmental, docking, and overall operational costs were considerably higher than their conventionally-powered counterparts.[22] The up-front costs to produce the *NS Otto Hahn* came out as much as seven times higher as a conventionally-powered ship with the same amount of horsepower.[23]

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[18] J.R. Bauman, 'Analysis of Past, Present and Future Applications of Nuclear Power for Propulsion of Marine Vehicles.' (Massachusetts Institute of Technology, 1972), 12.
[19] Jacobs, 'The Integration of a Helium Cooled Reactor in a 800 Teu Container Feeder', 16–17.
[20] Jacobs, 16–17.
[21] Bauman, 'Analysis of Past, Present and Future Applications of Nuclear Power for Propulsion of Marine Vehicles.', 12–13.
[22] Lange, *Theme Study - Large Vessel NS Savannah*, 32.
[23] Schøyen and Steger-Jensen, 'Nuclear Propulsion in Ocean Merchant Shipping', 154; Bauman, 'Analysis of Past, Present and Future Applications of Nuclear Power for Propulsion of Marine Vehicles.', 13; W.H. Donnelly, *Nuclear Power and Merchant Shipping* (US Atomic Energy Commission, Division of Technical Information, 1965), 17.

Moreover, the *NS Otto Hahn* laid bare that operational costs were higher, as most of the harbours were not fitted for the *NS Otto Hahn*, which led to costly adjustments. For example, maintenance of the *NS Otto Hahn* was too specialised for a harbour to facilitate, so the *NS Otto Hahn* was forced to facilitate this single-handedly. The projected operational costs of all nuclear merchant ships increased as a result, as every future nuclear ship had to bring its own maintenance crew. Both the *NS Savannah* and the *NS Otto Hahn* had highly educated nuclear engineers working in the engine room, who earned much more than engineers working on conventional ships. The deck officers of the *NS Savannah* even had a dispute with the owners because the nuclear engineers earned more than the deck officers.[24]

Also, the *NS Savannah* had higher operational costs because nuclear fission was new in the 1950s. For example, there was no statistical data on the safety. Insurance companies simply did not know how to estimate the risk.[25] The liability limit –which is the maximum amount the insurance company pays in case of an accident– was set on a hundred million American dollars, which was decided during the 1961 Convention On The Liability Of Operators Of Nuclear Ships in Brussels, attended by all countries that employed nuclear fission technology.[26] In today's American dollars, it would amount to one billion. This cost is significantly higher than the insurance for a conventional ship, which covers for 80 percent of the ship's current value in liability. In today's value of money, that would be around 290 million dollars for the *NS Savannah*; less than one-third the costs. Still, even with such an extensive insurance, nuclear countries had not ratified[27] this agreement yet, which meant, in the case of the *NS Savannah*, that the United States government would assume liability in case of a nuclear disaster.[28] Whether a company would invest in building a merchant ships that has such expensive premiums remains the question.

In establishing the viability of nuclear merchant ships, nuclear scientists used empirical data for the costs but hypothesised the benefits of lesser fuel costs and so forth. This renders the comparison false. Neither the *NS Otto Hahn* nor the *NS* Savannah ever transported significant amounts of commodities because the ship primarily housed labs, offices, and cabins for passengers. Both ships would, thus, never generate income comparable to conventional merchant ships. It is impossible to calculate the hypothesised profits with only

[24] Donnelly, *Nuclear Power and Merchant Shipping*, 28–30.
[25] Donnelly, 30–31.
[26] B.S. Haas, *Strategies for the Success of Nuclear Powered Commercial Shipping*, 2014, 8.
[27] Ratifying an agreement: include the affirmation of the agreement in the country's law.
[28] Berman and Hydeman, 'International Control of the Safety of Nuclear-Powered Merchant Ships', 245.

the expenses, for to calculate profits, one needs to account for both income and expenses; and the expenses remain a mystery for now.

Conventional merchant ships, unlike nuclear ones, can be built rather inexpensively, since their design and building techniques are already proven. Moreover, they can dock cheaply, since most harbours are fitted to handle conventional merchant ships and can easily deal with technical problems because of the on-site know-how. The discrepancy between nuclear and conventional merchant ships can thus be assigned to the difference in scale. Upscaling the use of nuclear merchant ships would most likely result in a drastic drop in developmental and operational costs, for it becomes a standard, just like oil-powered ships are the standard as of today. For example, the *NS Sevmorput* waited a decade for new fuel; a costly logistical challenge. Conventional ships enjoy standardised refuelling protocols, which makes refuelling relatively easy, cheap and, above all, fast.

To conclude, present-day nuclear scientists explain the economic advantages of exploiting a nuclear merchant ship. First, it can sail faster than current oil-driven ships. Second, it only has to refuel once per decade, which means nearly unlimited travel-flexibility. And last, given the average oil price, nuclear merchant shipping is considered cheaper than conventional merchant shipping in the long run. However, studying the *NS Savannah* and the *NS Otto Hahn* disproves these statements. The financial reconstructions that were made in academic literature are just approximations on the total costs of each nuclear merchant ship. Rough extrapolations on the economic viability are tried, but the sample size for such extrapolations, however, is too small to extrapolate reliably; only the costs are taken into account and the benefits are quantitatively ignored.

## 2.2 – Technical approach

The four nuclear merchant ships were built to test the technical feasibility of the use of a low-enriched uranium core and overall performance, especially in the cases of the *NS Savannah*, the *NS Otto Hahn*, and the *NS Mutsu*.[29] Both the *NS Savannah* and the *NS Otto Hahn* had minor problems throughout their nuclear career; none of which were severe enough to be the reason for their decommissioning. In fact, to sail such distances as both ships had, proves the technology's viability. Merchant ships aside, nuclear fission was also implemented in other ships, primarily naval ones, which further proves the technology.

[29] Donnelly, *Nuclear Power and Merchant Shipping*, 2.

The *NS Mutsu*, however, was decommissioned due to technical issues. The reactor's shielding, which needed to prevent radioactive leaks, started leaking radiation mere miles outside the harbour. Research shows that the shield's vulnerability was due to two different companies working on the development and manufacturing of the shielding and that neither of these companies had a complete overview of the project.[30] Also, the type of shielding was new altogether and not based on the shielding of the *NS Savannah* nor the *NS Otto Hahn*. The novelty of the reactor shield combined with logistical problems due to imperfect collaboration of the two companies resulted in the *NS Mutsu's* failure. Nuclear scientists maintain that trust issues due to the *NS Mutsu*-debacle is a reason for why more nuclear initiatives lacked in the West.

The accident with the *NS Mutsu* proved the point of the 1961 Brussels Convention. Nuclear merchant ships are potentially hazardous and the costs and damages caused by a nuclear disaster is unpredictable still. As a result, politicians stayed weary toward nuclear merchant ships. For that reason, as established earlier, the insurance costs for nuclear merchant ships are severely higher than that of a conventional ship. Thus, present-day nuclear scientists argue that the problem of nuclear merchant shipping is also a juridical one.

## 2.3 – Juridical approach

At the time of the *NS Savannah*'s and the *NS Otto Hahn*'s development, lawyers William Berman and Lee Hydeman were sceptic to seeing a nuclear merchant ship being used.[31] They thought nuclear marine shipping juridically too complex, due to its international nature. Nuclear cargo ships would be used for international trade and were, thus, not only a domestic affair; unlike most other uses of nuclear fission, like nuclear power plants.[32] Not only needed the owner of the nuclear cargo ship account for the constant radiation – which is inherent to nuclear fission – to which the crew would be constantly exposed, but in case of a calamity, the company needed to prove that it would be capable of handling the situation correctly and quickly, anywhere in the world. Concretely, this meant an expensive insurance on the one hand, since all potential damages needed to be accounted for, and making and honouring international agreements on the other. Standard agreements on ship safety did not suffice because they were based on standard structural techniques used in building the ship and general properties of the ship, whereas nuclear cargo ships would significantly differ from

[30] Adachi et al., 'The Decommissioning Plan of the Nuclear Ship MUTSU', 49.
[31] Berman and Hydeman, 'International Control of the Safety of Nuclear-Powered Merchant Ships', 257–58.
[32] Berman and Hydeman, 235.

these standards.[33] In fact, nuclear cargo ships had no standards at all. Consequently, no juridical standard was made, and individual ports decided autonomously whether or not a nuclear merchant ship could enter.

More recently, academics recognise this problem and plead for standardised international rules and codes.[34] That way, cases similar to the *NS Otto Hahn's* would seize to exist. The *NS Otto Hahn* was entirely dependant on bilateral agreements to circumvent the liability-problem. This meant, however, that whether the *NS Otto Hahn* could dock was dependent on an international agreement, which would limit the possible berths. For this reason, the Soviet *NS Sevmorput* has not berthed outside the Soviet Union and later Russia. It is indeed imaginable that companies would refrain from investing in the developments of nuclear merchant ships when it is not clear whether the ship can actually be used internationally. Then, if this was not clear beforehand, why were nuclear merchant ships built in the first place? For that, the ideological perspective provides more clarity.

## 2.4 – Ideological perspective.

Academic literature places nuclear merchant ships in a broader narrative of nuclear power, more specifically, in the pursuit of a nuclear utopia. The seemingly unlimited power that nuclear technology brings was idolised as early as 1913 when the popular novelist H.G. Wells wrote about the possibility of a nuclear utopia, albeit after a destructive nuclear disaster. Led by nuclear scientists, mankind built a society powered – quite literally – by nuclear energy.[35] During and after the Second World War, optimists like David Dietz, a journalist and novelist, and Glenn Seaborg, who was the Chairman of the Atomic Energy Commission between 1961 and 1971, followed Wells' suit.[36] Dietz wrote, for example, that all of society would run on nuclear fission. Instead of bi-weekly filling a car with gasoline, the car could run a year on a tablet of nuclear material the size of an aspirin. Glenn Seaborg envisioned a world with nuclear-powered earth-to-moon shuttles, artificial hearts, fission-heated swimming pools, and many more luxuries and wonders that were made possible by nuclear fission.[37] In that period,

[33] Berman and Hydeman, 238.
[34] N.S. Khlopkin and A.P. Zotov, 'Merchant Marine Nuclear-Powered Vessels', *Nuclear Engineering and Design* 173, no. 1–3 (October 1997): 1–7.
[35] Wells, *The World Set Free: A Story of Mankind*.
[36] D. van Lente, ed., *The Nuclear Age in Popular Media* (New York: Palgrave Macmillan US, 2012), 3.
[37] B.K. Sovacool and S.V. Valentine, *The National Politics of Nuclear Power: Economics, Security, and Governance*, 1 edition (London ; New York: Routledge, 2012), 68.

especially larger nuclear fission projects were set-up, such as nuclear power plants, fission-powered submarines, and, of course, nuclear weapons.[38]

Nuclear power was, however, dichotomously portrayed in popular media, as historian Dick van Lente showed.[39] Innovative technology is generally bravoed and booed at the same time by the public. In this case, the booing addressed the potential danger of nuclear power, as well as the constant increase of the destructive properties of nuclear weapons. For example, a thermonuclear weapon – which is an atom bomb based on fusion technology, as opposed to a fission bomb like the ones used on Hiroshima and Nagasaki – was tested on the Pacific atoll Bikini in March 1954.[40] The thermonuclear weapon's radioactive residue that was blasted into the sky, also called nuclear fallout, reached farther than expected. The blast was so great that surrounding islands had to be evacuated immediately. Japanese fishermen that fared outside of the outlined danger zone got showered in fallout in the form of white powder and fell deadly ill on their way back to Japan. The image of these fishermen and the escalation of the nuclear test provoked intense resistance against nuclear power.

Led by renowned scientists and supported by celebrities, the antinuclear movement grew exponentially after the March 1954-test on Bikini Atoll. The growth of the antinuclear movement was not met with enough compromises by the governments in their nuclear armament campaigns. This resulted in many protests, especially in the United States, Great Britain, Germany, and Japan.[41] In order to continue with their nuclear campaigns and projects, the government needed a change in the public perception of nuclear power.

The United States' government initiated pro-nuclear propaganda that took the form of the 'Atoms for Peace' programme. This programme was aimed at the global public and needed to show the public that nuclear fission is not something to be feared, but to be embraced, to be used, and to be celebrated. Concretely, peaceful prototypes of fission-technology were made public. Among these peaceful applications was a prototype of a nuclear fission-reactor that was shown at the international conference on peaceful nuclear power in Geneva in 1955 and plans for building the American *NS Savannah* (figure 2.2) in 1956.[42] Ergo, Warren Donnelly and James Bauman, nuclear scientists at the time, connected

[38] Donnelly, *Nuclear Power and Merchant Shipping*, 8–15.
[39] van Lente, *The Nuclear Age in Popular Media*, 9–15.
[40] van Lente, 13.
[41] Lefort, *Nuclear Chemistry*, 202.
[42] van Lente, *The Nuclear Age in Popular Media*, 14–15; Donnelly, *Nuclear Power and Merchant Shipping*, 8.

Figure 2.2 - *The NS Savannah entering New York for the first time.*

the interest for nuclear merchant ships to the Atoms for Peace programme.[43] The development of nuclear cargo ships was, in a way, thought a step towards a nuclear utopia.

Nuclear merchant ships were in their early days successful in propagating civilian implementation of nuclear power. As a floating tool of propaganda, the *NS Savannah* sailed from port to port to welcome the total of 1,400,000 visitors and showed them that nuclear power can be implemented in a civilised manner.[44] The West-German-made *NS Otto Hahn* was another product of the Atoms for Peace programme proved to be a popular attraction as well. Her development and early life went without serious public hiccups like protests or blockades. So, both the *NS Otto Hahn* and the *NS Savannah* successfully generated general goodwill towards the development of nuclear merchant ships.[45] This, however, changed in 1974.

In the sense of ideology, the year 1974 was a bad year for nuclear merchant ships. The two then actively used nuclear merchant ships, the *NS Otto Hahn* and the *NS Mutsu*, were met with increasing protest. The Japanese-made *NS Mutsu*'s reactor started leaking hazardous radiation on her maiden voyage in 1974.[46] It had to return immediately to its city-port for repairs. However, fishermen, supported by local inhabitants and the port authorities, blocked the port with their boats because they opposed the *NS Mutsu* returning. After negotiating for quite a while, they all agreed to let the *NS Mutsu* dock if she would never return to the city after the necessary repairs. The *NS Mutsu* would not leave the port for over a decade, awaiting refuelling. Her reactor was eventually decommissioned and replaced by a diesel-engine in 1995.[47]

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[43] J.R. Bauman, 'Analysis of Past, Present and Future Applications of Nuclear Power for Propulsion of Marine Vehicles.' (Massachusetts Institute of Technology, 1972), 12; Donnelly, *Nuclear Power and Merchant Shipping*, 3.
[44] Adams, 'Why Did The NS Savannah Fail? Can She Really Be Called a Failure? - Atomic Insights'.
[45] J. Edwards, 'Report on the OECD Nuclear Energy Agency/International Atomic Energy Agency Symposium on the Safety of Nuclear Ships, Hamburg, 5–9 December 1977', *Annals of Nuclear Energy* 6, no. 1 (January 1979): 26–28, https://doi.org/10.1016/0306-4549(79)90092-6.
[46] Adachi et al., 'The Decommissioning Plan of the Nuclear Ship MUTSU', 49.
[47] Adachi et al., 50–51.

The dichotomy of nuclear power – it was awesome on the one hand, but dangerous on the other – became outspoken. At first, the governments of the Netherlands and West-Germany agreed on *NS Otto Hahn* entering Dutch territorial waters and docking in the ports of Rotterdam and Vlaardingen. In 1974, the owner of the *NS Otto Hahn* tried to get permission to dock in other Dutch ports as well. Amsterdam, Ijmuiden, and Terneuzen denied access. Those municipalities thought their regions too densely populated to take on the risk of allowing the *NS Otto Hahn* to dock. Moreover, their inland position meant that the ship would need to cross many sluices, which would amount to additional risk.[48] The municipalities' aversion towards the *NS Otto Hahn* is arguably connected to the *NS Mutsu*'s leakage, but the academic literature does not make this connection. Nuclear scientists Halvor Schøyen and Kenn Steger-Jansen solely maintain that because more port authorities denied access to the *NS Otto Hahn*, including the authorities of the Suez Canal, her nuclear reactor was decommissioned and replaced with a diesel engine in 1979.[49]

A similar fate struck the Soviet-made *NS Sevmorput*, be it some decades later, as she was also denied access to ports after a nuclear disaster. In the 1980s, the Soviet Union made plans to use nuclear power to propel a merchant ship. The Soviet Union had an equivalent programme to the Atoms for Peace programme, in order to get public approval for their nuclear aspirations.[50] That is why the *NS Sevmorput* was, after being built, immediately put to commercial use under the state company Murmansk Shipping Company.[51] However, the 1986 Chernobyl disaster reminded the public of the ever-present dichotomy of nuclear power. During the weeks following April 26, Europe was being tormented by a radioactive cloud as a result of a reactor exploding inside the nuclear power plant in Chernobyl, sparking a negative attitude to nuclear power.[52] Consequently, when the *NS Sevmorput* was in use in 1989, she was denied entry to four major ports at the Soviet Far East due to intense protests against the *NS Sevmorput.* Indeed, for the public, the Chernobyl-disaster proved nuclear fission too dangerous.

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[48] Edwards, 'Report on the OECD Nuclear Energy Agency/International Atomic Energy Agency Symposium on the Safety of Nuclear Ships, Hamburg, 5–9 December 1977', 33.
[49] H. Schøyen and K. Steger-Jensen, 'Nuclear Propulsion in Ocean Merchant Shipping: The Role of Historical Experiments to Gain Insight into Possible Future Applications', *Journal of Cleaner Production* 169 (December 2017): 156.
[50] D.L. Augustine, 'Learning from War: Media Coverage of the Nuclear Age in the Two Germanies', *The Nuclear Age in Popular Media*, The Nuclear Age in Popular Media, 2012, 82–83.
[51] 'Nuclear Powered Fleet: Nuclear Powered Vessels Nuclear Powered Vessels Characteristics, Maintenance, Nuclear Power Unit: The "SEVMORPUT" Nuclear Powered Lighter-Aboard Ship'; Schøyen and Steger-Jensen, 'Nuclear Propulsion in Ocean Merchant Shipping', 156.
[52] B. Verplanken, 'Beliefs, Attitudes, and Intentions toward Nuclear Energy before and after Chernobyl in a Longitudinal within-Subjects Design', *Environment and Behavior* 21, no. 4 (July 1989): 372–73.

In sum, contemporary academic literature explains the significant role of the post-war pursuit of the nuclear utopia, be it as a rhetorical device to gain the public's support for nuclear armaments or as an ideological endeavour. Either way, all four nuclear merchant ships originated from the Atoms for Peace programme or its Soviet equivalent. The four nuclear merchant ships were, ideologically speaking, proving that nuclear energy could be harnessed for civilian purposes. However, the public was constantly reminded of the danger that accompanied nuclear power. Ironically, the nuclear merchant ship *NS Mutsu* played her part in the latter because she demonstrated how scary nuclear power was when things went south. Generally speaking, 1974 marked the beginning of the public disapproval towards nuclear merchant shipping in the West because the leaking *NS Mutsu*. The Soviet Union had first-hand experience of the danger with the Chernobyl disaster, which had impact on the Soviet's public opinion on the *NS Sevmorput*. It is possible that other events than the *NS Mutsu*'s leaking and the Chernobyl disaster contributed to the shift in the ideological perspective on nuclear merchant shipping as well, but academic literature does not explicitly make any of those connections.

## 2.5 – Sample-size is too small

The available academic literature on nuclear merchant shipping tries to prove the feasibility of this endeavour on the one hand; and tries to explain why no more than four nuclear merchant ships sailed the globe on the other. This explanation is based on economic, technical, juridical, and ideological perspectives. The literature maintains that nuclear merchant shipping might be economically feasible, even though the upfront costs are considerably higher than conventional powered ships; it is believed, however, that nuclear merchant ships will be cheaper overtime. This hypothesis stays theoretical, since the nuclear merchant ships that were operational were never intended to generate income. So, to explain the lack of more developed nuclear merchant ships from an economic perspective would be false; there is simply no empirical evidence that support the claim that nuclear merchant ships are not economically viable.

Explaining the lack of more nuclear merchant ships from a technical perspective raises more questions than it answers. Indeed, the fact that four nuclear merchant ships sailed proves their technical feasibility. However, as the danger of nuclear fission is directly translated to nuclear shipping. Is it not a question of safety instead? To analyse the safety of ships and its effect on the use of nuclear merchant ships, one resorts to the juridical approach. Like conventional ships, when a disaster occurs, the liability needs to be clear beforehand.

However, given the novelty of nuclear fission in the 1960s and 1970s, it was simply unclear what damage and destruction a nuclear merchant ship would bring in case of an accident. From liability agreements and special rights to insurance, the danger that nuclear power poses goes beyond just shielding the engine.

The juridical uncertainties in the 1960s and 1970s are an expression of ideological problems when nuclear power is involved. For example, bilateral agreements between the nuclear merchant ship's owner and the authorities of a harbour must be forged when a nuclear merchant ship wants to berth somewhere. If nuclear power is primarily seen as something dangerous, one of the stakeholders might prevent the berthing of nuclear merchant ships, but if nuclear power is seen as the future of propulsion, this will spell fewer problems.

It all boils down to the sample-size which is used to analyse the viability of nuclear merchant ships. Solely using four nuclear merchant ships, which were experimental no less, means too many variables are uncovered. Where are the analyses of the nuclear ships that were planned but eventually were cancelled? Surely, these cases provides more insight.

There is, arguably, a connection between the public and political perception on nuclear merchant shipping and nuclear merchant shipping itself, but the academic literature on nuclear merchant shipping ignores this side. To analyse this connection, one must dive deeper into the public opinion on nuclear merchant shipping, starting in the 1950s, and also focus on the plans to build nuclear merchant ships but were eventually never realised.

# Chapter 3:
# Love thy nuclear future

Evidently, the theoretical viability of nuclear merchant ships does not mean that they will be built with numbers. The American *NS Savannah* pioneered a technology that needed substantially more evolution to be broadly implementable. Countries such as West-Germany, Norway, the United Kingdom, Italy, the Soviet Union, and Japan also had the intend to produce commercial nuclear ships. Most noticeable, of course, were West-Germany, Japan, and the Soviet Union, as they made intent into reality. The Netherlands was close to realising the concept of nuclear merchant shipping, as the Dutch government wanted to fund the development of a prototype to the likes of the *NS Savannah* and the *NS Otto Hahn* in the 1950s and 1960s. Even though this prototype was never realised, the intentions of the Dutch are informative still. Indeed, the Dutch case raises question: on which factors was the Dutch public opinion on nuclear merchant shipping based in the late 1950s and early 1960s?

## 3.1 – The first Dutch plans for nuclear merchant shipping

Dutch politicians shared the global post-war ambition to increasingly base society on nuclear power. In 1946, the Dutch government founded the foundation for basic research into matter (*Stichting voor Fundamenteel Onderzoek der Materie* or FON), which was a scientific trust to encourage and fund physics research into nuclear-based technology.[53] The FON coordinated scientific, non-commercial research and managed patents that would derive from that research. In the early 1950s, the FON suggested to the Dutch government to put theory into practice. The Dutch Reactor Centre (*Reactor Centrum Nederland* or RCN) was founded by a combination of scientists, businesses, and the government as a result.[54] Since its genesis on 19 July 1955, the RCN's main goal was to implement nuclear technology in a peaceful manner for the benefit of society. This primarily encompassed research into the use of nuclear reactors to power merchant ships and secondarily the development of land-based nuclear reactors to power cities. Indeed, the FON focused on the research and the RCN focused on the implementation of what the FON researched.

[53] 'Algemene informatie', NWO-I, accessed 1 April 2018, https://www.nwo-i.nl/onderzoek/fom-instituten/algemene-informatie/.
[54] J. Cals and J. Zijlstra, 'Nota inzake het in Nederland te verrichten onderzoek op het gebied van kernreactoren en hun toepassingen' (The Hague, 14 July 1955), 1–2.

Extensive plans to make the first-generation Dutch nuclear merchant ships were published in the RCN December-bulletin just two years after the RCN was founded.[55] The bulletin reported on the challenges surrounding the use of nuclear reactors on ships. Concretely, using pressurised steam to propel the turbine means having to operate the nuclear reactor under the enormous pressure of 100 standard atmosphere (atm) – or one hundred times more pressurised than air on sea-level – in order to superheat the water. This technique is called a Pressurised Water Reactor, or PWR, since it pressurises water in the reactor, so it does not boil and keeps the excellent heat transfer properties of liquid water. However, the downside of using a PWR is that refuelling is dangerous under that amount of atm, since the fuel-rods needed to be slid in, which could then potentially be launched out of the core again due to the immense pressure built there.

To counteract that danger, the RCN proposed to make use of boiling water in the kettle and with it, lowering the pressure to 40 atm. They asserted that nuclear submarine *Nautilus* also used this technique and proved it to be effective. Using boiling water instead of high-pressurised water, though, resulted in cooling problems. The heat pump had trouble cooling the reactor sufficiently enough. Instead of using water or heavy water – which is a more dense and heavier isotope of water – the closed circulations would be filled with diphenylbenzenes, a hydrocarbon that is a potent heat transfer agent and more effective than heavy water.[56]

A third and highly experimental variation on the PWR was to directly connect the reactor to the turbine, without the use of a heat pump. The heat transfer agent in the kettle can run even less hot, but the risk for contamination is higher, as the heat transfer agent is not in a close circulation and therefore subject to the fuel-rod's radiation. The RCN argued the second design best, as it was not only the safest option, but also the one that was proven to work.

So too were the advantages of a PWR on ships proven, as maintained by the RCN. For one, the profitability of a PWR on merchant ships would be easier and earlier achieved than a land-based nuclear power plant.[57] Thus, in 1955, the RCN thought a PWR more effective when powering a merchant ship than powering a city. Second, and severely endorsed by the RCN, the fuel consumption would be more efficient compared to conventional propulsion solutions. Instead of burning tonnes of oil, it would only take a few grams of uranium-235.[58] Third, nuclear power excretes no smoke or harmful gasses as opposed to conventional propulsion. In sum, the experts at the RCN saw three major advantages in their plans for

[55] M. Muysken, 'Kernreactoren Voor Scheepsvoortstuwing', *RCN-Bulletin*, December 1957, 3.
[56] Muysken, 4–5.
[57] Muysken, 6.
[58] Muysken, 7.

nuclear merchant shipping: it is supposed to be economically advantageous, efficient in its fuel-use, and not polluting at all. Still, potential dangers were not ruled out, which made the RCN weary to put the technology into practice yet.

Given the fact that the RCN was the leading research institution in the Netherlands that focused on the development of nuclear technologies. It is therefore expected that the Dutch public opinion was based on similar advantages and disadvantages as the RCN showed. However, this was not the case.

## 3.2 – Interpretation of newspaper articles and their arguments

To create an overview of the Dutch public opinion towards nuclear merchant ships, Dutch newspaper articles of the 1950s and 1960 are dissected into the arguments that are either positive towards nuclear merchant ships or negative. An argument is positive if it supports the development of nuclear merchant ships; it would be negative if it argues against nuclear merchant ships. So, for example, arguing profitable fuel costs would be a positive argument, whereas highlighting the dangers of nuclear merchant ships would be a negative argument. Dissecting newspaper articles into multiple smaller arguments combats the problem of neutrality, which occurs when a newspaper article is enumerating both positive and negative arguments in a well-weighted overview of existing arguments on the matter.

In those cases, it is unclear whether the article has a positive or negative effect on the public opinion on nuclear shipping. For example, when a newspaper article contains five positive arguments and one negative argument, it could appear neutral and balanced, as both sides of the debate are mentioned. However, when noticing the discrepancy of representation of both sides (a 5:1 ratio), it becomes clear that it is not neutral or balanced.

Still, using arguments out of newspapers and claiming them as the public's view on the matter is a bold claim that needs further nuance. Political scientist Thomas Patterson argues that it would be wrong to value every newspaper article the same when determining the public opinion.[59] Patterson maintains that the problem of measuring political opinion by news stories resides in 'three distortive orientations of the press', which are those to novelty, events, and leaders.

Basically, novelty means that news is constantly replaced by the *next new thing*. Something could be prime news on the one day, but can be totally forgotten the next day,

[59] Thomas E. Patterson, 'The News as a Reflection of Public Opinion', in *The SAGE Handbook of Public Opinion Research*, by Wolfgang Donsbach and Michael Traugott (1 Oliver's Yard, 55 City Road, London EC1Y 1SP United Kingdom: SAGE Publications Ltd, 2008), 37, https://doi.org/10.4135/9781848607910.n4.

which suggest a shallow role of news. In other words, deep underlying societal problems are rarely discussed in newspapers.[60] This is also seen, partly, in the press' orientation towards events – the second distortive orientation.

If no event occurs, certain long existing problems will never be reported, even though the public thinks it important.[61] Damaged roads would be a fine example. It is uncomfortable to ride on and the car wears out faster, but if no major accident occurs, the public opinion towards bad roads can never be measured since it never will be reported in newspapers.

The third and last distortive orientation is the fact that news resorts mostly to leaders, experts, or government officials when an event needs to be explained. In these cases, the public opinion and – for example – academic opinion might be confused. Patterson blames deadlines for this, as journalists seek fast and easy explanations and background information on the event. This, according to Patterson, is not representative for the public opinion per se.[62] A fitting example for this thesis, if one scientist is repeatedly asked for an opinion on nuclear merchant ships, the public opinion gets increasingly aberrant from what appears in the newspapers. This one expert's opinion gets disproportionately represented.

Patterson believes that newspapers do not represent the public opinion due to distortive orientations. However, this is circumvented when understanding the meta-narrative in newspaper articles. The meta-narrative is, basically, the overarching arguments used throughout multiple newspapers over a larger timespan.

Indeed, more can be concluded from newspapers than Patterson insinuates, as newspapers need to make profits and therefore need to appeal to the public. Whether the newspaper reports on the public opinion or the public opinion is formed by the newspapers is in this case irrelevant. The basic premise on which this analysis is conducted is that the frequency of arguments and sources given in newspaper arguments illustrates the public opinion one way or another. Either the public influences the newspaper or the other way around. In other words, sources and different arguments used are important metrics.

Especially in light of the argumentation and meta-narrative is it relevant to know what the arguments in newspaper articles are based upon. Rapports of Dutch committees on the implementation of nuclear power are consulted to find similarities – or differences – in argumentation compared to the newspaper articles. Concretely, analysing the Dutch scientific debate on the subject during that time and mapping the arguments chronologically ensures

[60] Patterson, 38.
[61] Patterson, 40.
[62] Patterson, 48.

comparable information in line with the relevant newspaper articles. This comparison shows whether or not the conclusions of the scientific debate spilled over to the Dutch public opinion.

So, arguments used in newspaper articles can provide useful information when placed correctly into context, meaning to keep the three distortive orientations of the press in mind. Categorising arguments based on the sources (from whom stems the argument), longevity (how long does newspapers continuously make the same argument), and timing (to which event is the argument tied, if at all). Then, the arguments can be sorted by type and positivity – or negativity for that matter – providing the actual ratio of arguments.

## 3.3 – The silent treatment

When taking the actual ratio of arguments in mind, and not the positive:negative ratio, an unbalance in the Dutch newspapers' view on nuclear merchant shipping is obvious, in the sense that it is one-sidedly positive in the 1950s and 1960s.[63] The arguments given are convincingly positive towards nuclear merchant shipping and are solely countered by economic arguments that state that nuclear merchant shipping would, in fact, not be economically viable. There is, thus, a discrepancy between the RCN's bulletin and the public opinion portrayed in the media, since potential hazards are never mentioned and instead, the media focuses primarily on three positive arguments.

The most prominent positive arguments given in newspaper articles are future-based, general economic, and fuel-based arguments. First, future-based arguments are, just like the FON emphasised, arguments that come down to nuclear power as a promise of the future. It means that the next step in society's development is based on progress in nuclear technology. The investment into said progress is, therefore, crucial. This counteracts, almost pre-emptively, all potential counter-arguments, since those are deemed temporary and occurring potential problems would be solved shortly. This reasoning is especially expressed as an answer to projected economic problems of nuclear merchant shipping. Newspaper articles cling on to a rhetoric like: *nuclear merchant shipping is in the long term economically viable, and it will become the standard in shipping once it achieves this status; and it will, in time, be inevitably economically viable.* Indeed, chapter two speaks of widely-spread optimism towards nuclear merchant ships' future and, as these newspaper articles show, this is also the case in The Netherlands.

[63] Based on qualitative research on 76 relevant Dutch newspaper articles of the 1950s and 1960s.

Second, general economic arguments made in newspaper articles about nuclear merchant shipping are based on the premise that nuclear merchant ships are, in fact, profitable. This also include references to experts that claim nuclear merchant ships will be profitable in the future for one reason or another. This is, of course, complementary to future-based arguments. To support claims of economic viability, calculations of fuel-consumption are considered. However, fuel costs are not used in this type of argument. This means that calculations of fuel-consumptions are only used when it is explicitly supporting economic viability claims, *id est* higher travel speeds because of the type of fuel and more cargo space because of the lack of bunkering masses of oil. Keep in mind that the first nuclear merchant ship was not yet operational, so hidden costs like insurance costs, higher operational costs, and higher maintenance costs were not yet accounted for.

Third, arguments are seen as fuel-based whenever fuel-consumption is compared with conventional fuel-use. This includes favourable comparisons with conventional merchant ships on fuel-use and efficiency calculations – *id est,* fuel-use per tonne mile and potential harmful by-products. This argument is also complementary to the future-based argument, as linear extrapolation of the growth in size of 1950s' and 1960s' merchant ships suggest that the mere size of future ships renders conventional propulsion obsolete. Indeed, it would take too much fuel to propel a ship of the projected size, which necessitates nuclear power.

Table 3.1 – *distribution positive and negative arguments in and among newspapers, N=76.*

| | Positive arguments | Negative arguments |
|---|---|---|
| General economic argument | 24 (40%) | 12 (100%) |
| Future-based argument | 44 (73%) | 0 (0%) |
| Fuel-based | 16 (27%) | 0 (0%) |

*Source: Dutch Newspapers from the 1950s and 1960s, own calculations.*

Table 3.1 shows that positive newspaper articles used future-based arguments most of the time. In 73 percent of the time, newspaper articles maintain that it is inevitable that nuclear merchant shipping will be the new standard and will replace conventional fossil fuel-based merchant ships. Most noticeable examples of this are the articles countering the negative newspaper articles that followed the Lloyd Register of Shipping reports, an annual classification of ships and merchant fleets.[64] The Lloyd Register of Shipping reports stated, in the late 1950s and early 1960s, that nuclear merchant ships are economically unattractive, for it would take years before they break even in costs and projected returns. Evidently, even

[64] 'About Us | LR Foundation', accessed 20 February 2018, http://www.lrfoundation.org.uk/about-us/.

positive newspaper articles questioned the economic viability of nuclear merchant shipping but emphasised the need to invest heavily in its development, for it would still remain the future – as per the rhetoric.[65] They might not be appealing today, those articles said, but in the near-future, nuclear merchant ships will take over the conventional-powered merchant ships. Indeed, the future-based argument seemed to be complementary to a negative general economic argument. Two things stand out from these examples: first, economic reasons to develop nuclear merchant ships are not accepted by the public, even though academics think it one of the unique selling points; and second, the Dutch public did believe that nuclear merchant shipping was inevitable.

The Dutch public thought economic reasons important still, though to a lesser degree than academics, and certainly less unequivocally than future-based arguments would imply. Especially when newspapers referred to the RCN's plans, forty percent of the positive newspaper articles use the general economic argument. In the late 1950s and early 1960s, nuclear merchant ships were purely theoretical, which means that their economic viability was theoretical too. Thus, using economic arguments to justify developing and even building nuclear merchant ships illustrates the positively opiniated public. As for what these arguments entailed: newspaper articles mentioned the higher travel speeds, lower fuel costs per tonne mile, and additional cargo space compared to conventional merchant ships. In short, these arguments were similar to those of the RCN. Another, yet a lower represented argument is the economic independency from Middle-Eastern oil-states. Only one newspaper mentions that switching to a purely nuclear-powered merchant fleet would result in Western independency of Middle-Eastern oil. It is somewhat ironic indeed, that the first plans of nuclear merchant ships were building nuclear oil ships.

The most scarcely-used argument in positive newspaper articles is the fuel-based one, yet it is extensively used in flyers, invitations to press conferences, and political speeches.[66] The fact that fuel-based arguments appear less in newspaper articles, and more in opiniated media such as pamphlets, suggests that the public opinion thought not highly or frequently of the fuel-based argument. Indeed, experts who were positive towards nuclear merchant shipping tried to convince everyone that low fuel consumption was one of the best features of the ships. For example, when journalists received invitations for press conferences or tours on

[65] 'Binnen Vijftien Jaar Atoomschepen', *Gereformeerd Gezinsblad*, 24 February 1956; 'Kernenergie-Vrachtschip van de Toekomst', *Gereformeerd Gezinsblad*, 24 April 1961; 'Kernreactors Op Schepen Te Duur', *Amigoe Di Curacao: Weekblad Voor de Curacaosche Eilanden*, 15 May 1964.
[66] Barend Maaskant, 'Rapport Barend Maaskant on Guide on Board the *NS Savannah*', 1965, Maritiem Museum Rotterdam, DB4162.

the *NS Savannah*, the invitation and accompanying brochure highlighted the efficient fuel consumption instead of economic or future-based arguments.[67] The fact that tonnes of oil would be replaced by mere grams of uranium-235 sounded important for the experts or marketeers of the nuclear ships but newspapers somehow refused to follow these experts in their rhetoric.

RCN's bulletin also explicitly mentions the lack of exhaust gasses as a major advantage, but this is entirely ignored in the newspaper articles.[68] Again, looking at invitations, scientific articles of the 1950s and 1960, and minutes of press conferences with experts, the lack of exhaust gasses is frequently mentioned by experts, but – similar to the fuel-based argument – newspaper articles do not deem them important enough to mention. This again suggest a discrepancy between academic debate and public debate, or at least between the Dutch ones. The negative arguments used in newspaper articles confirm this. Arguments that the RCN made against nuclear merchant shipping were not picked up by the media. Moreover, when voicing negative arguments, the media referred to other experts than the RCN.[69] It can thus be concluded that, in the 1950s and 1960s, the Dutch public opinion was influenced by foreign experts. American and British ones to be precise; and Dutch experts received the silent treatment.

## 3.4 – Angel-Saxon influence on nuclear merchant shipping

Chapter two mentions it already with the Atoms for Peace programme: during the 1950s and 1960s, the Dutch public opinion was severely influenced by American propaganda, which exceeds just influencing the opinion on nuclear merchant shipping.[70] Indeed, the United States were the *liberators*, which implied that they would know best politically. For example, the Netherlands joined the United States in the Korean war in the 1950s and expanded the defence budget up to 20.4 percent of the total national budget in 1955 at the American's request, which are unique events in the broad Dutch history of political neutrality.[71] Historian Dick van Lente analysed Dutch narratives and counternarratives on nuclear power using illustrated magazines and saw a significant influence of President Eisenhower's 'Atoms for

[67] American Export Isbrandtsen, 'Brochure *NS Savannah*', 1 May 1964, DB4162, Maritiem Museum Rotterdam, H2794.
[68] Muysken, 'Kernreactoren Voor Scheepsvoortstuwing', 7.
[69] Of the total 72 analysed articles, 12 articles were negative towards nuclear merchant shipping.
[70] A.A. de Boer, *Economische Aspecten van de Ontwikkeling Der Kernenergie* (Leiden: H.E. Stenfert Kroese, 1962); B. van der Boom, *Atoomgevaar? Dan Zeker B.B: De Geschiedenis van de Bescherming Bevolking* (Den Haag: Sdu, 2000), 14–17.
[71] van Lente, *The Nuclear Age in Popular Media*, 151.

Peace'-speech on the portrayal of nuclear power in popular media. Van Lente saw an influx of positive reports on peaceful implementations of nuclear power shortly after the introduction of the Peaceful Atom rhetoric but argued that it was quickly overshadowed by damaging reports on the danger of nuclear power. Accidents and examples of the early 1950s, through which it became clear that governments had little control over nuclear power, led to general distrust.

This distrust, however, is not shown in Dutch newspaper articles on nuclear merchant shipping, as they continuously show positive rhetoric towards nuclear merchant shipping. Still, Van Lente's analysis proves that American narrative influences Dutch public opinion, which explains why the arguments that fuel the public opinion differ so much from those of Dutch researchers. In contrast to the Dutch public opinion, Dutch researchers were completely independent from American politics, as they had access to forty tonnes of yellow cake without the United States' knowledge. Forty tonnes of high-enriched uranium facilitated plenty independent research. Of course, Dutch politics were still under the American influence, but this was most likely not translated to the RCN, as they were completely depoliticised. Indeed, the RCN only reported to the minister and did not answer to him. So, the RCN was theoretically independent from any outside influence.

Where the debate on nuclear power as a whole changed sentiment in the United States and Great-Britain, the debate on nuclear merchant shipping in the Netherlands remained the same. These are indeed two different subjects, it seems. On the one hand, nuclear power is still an umbrella term which also covers nuclear merchant shipping. Thus, a general distrust towards nuclear power would also mean a distrust towards nuclear merchant shipping. On the other hand, peaceful applications could receive the benefit of the doubt where nuclear weapons clearly could not. Take for example the escalated nuclear weapon test on Bikini Atoll of March 1, 1954.[72] The bomb that was tested more than doubled the expected yield with its 15 megaton of TNT. It was measured a thousand times more powerful than the bombs used on Hiroshima and Nagasaki. This event clearly showed that nuclear power was as dangerous as it was unpredictable. Van Lente shows this specific event as a turning point in Western media narrative: from a pro-nuclear narrative to a counter-nuclear narrative, with the Netherlands as the exception. Then again, the Netherlands did not own nuclear weapons nor supported the use of nuclear weapons. Perhaps this was why foreign misuse of nuclear power had little to no effect on the Dutch peaceful implementations.

[72] 'Operation Castle', accessed 28 May 2018, http://nuclearweaponarchive.org/Usa/Tests/Castle.html.

A more logical explanation for why the Dutch so stubbornly loved the idea of a nuclear utopia lies in the prospect of nuclear shipbuilding. The Dutch, with their rich shipbuilding history, would be more focussed on the positive developments that nuclear merchant ships would bring to Dutch shipbuilding-industry. This is, as previously pointed out, supported by the majority of arguments used in newspapers: the future-based argument and the role that the Dutch shipbuilders might play in this future. This is perhaps a sincere expectation or plain wishful-thinking; or maybe a bit of both.

## 3.5 – Even more questions left unanswered

The Dutch public opinion towards nuclear merchant shipping was not based on the assessments of Dutch nuclear experts. There is, indeed, a discrepancy between the RCN's plans and the public opinion. When the public opinion is measured by the argumentation used in newspaper articles, it is clear that the public mostly thinks that nuclear merchant shipping is the inevitable future. Furthermore, the public believed to a lesser extent than academics that nuclear merchant shipping is economically viable. Fuel-based arguments are the least common as an explanation to why nuclear merchant shipping is beneficial. Still, above all, the public trusted the revolutionary technology, for not only were the majority of newspaper articles ideologically positive towards nuclear merchant shipping, but the practical side of nuclear merchant shipping was embraced too.

So, in the 1950s and 1960s, the public was susceptible to nuclear merchant shipping. Dutch nuclear scientists even made plans for more nuclear merchants ships. Yet, these plans for Dutch nuclear merchant ships were never covered in newspapers, whereas plans for American and British nuclear ships were extensively covered. This illustrates the Anglo-Saxon influence on Dutch public opinion. Dutch news outlets, thus, never bothered with Dutch plans – or Dutch experts for that matter. So, the Dutch public was looking forward to nuclear merchant ships, though not necessarily Dutch ones.

Still, even in the case of those British and American nuclear ships, it is presently clear that most of those plans were never concretised. This raises a lot of new questions, the most important of which: what actually happened with this positive image of nuclear merchant ships; why has this positive imagery never led to a wide implementation of nuclear merchant ships?

# Chapter four:
# From powerful ally to dangerous enemy

In the 1980s, the world's oceans were woefully devoid of Dutch nuclear merchant ships. Surely, when public opinion is that positive towards this technology, it should have materialised. But it did not. The reason for which might lie with the Dutch public's shift in opinion. It is important to learn when this shift happened, whether it happened suddenly or gradually, and what elements influenced this. Moreover, the question as to why nuclear merchant ships were eventually disfavoured needs to be answered.

## 4.1 – Something changed, but when?

In the year 1963, plans to develop a Dutch nuclear merchant ship that the RCN so avidly voiced were still not realised. Mere months after the *NS Savannah*, Dutch newspapers reported on an American plan of building yet another nuclear merchant ship.[73] Unlike the *NS* Savannah, this ship would be fitted with an economically viable reactor. The time of nuclear ships had thus arrived, at least, one would think. Yet the construction of this nuclear ship never began. Later, in 1967, the same newspaper announced three new American-built nuclear merchant ships.[74] The development of these ships would be heavily subsidised by the American government but, for reasons unknown, were never realised. It did not end here: Dutch newspapers announced that even more nuclear merchant ships were to be built, this time by the Dutch shipbuilders themselves.[75] They would even be built in series, as American companies had simultaneously ordered the construction of six new nuclear merchant ships. Those ships themselves would, then, spark a chain reaction that eventually was to lead to the evolution of the nuclear merchant ship towards the new standard in merchant shipping. Because of these newspaper articles, the Dutch public was familiar with the plans to make nuclear merchant ships the new standard. Still in 1967, this vision of the future that was heftily reported in Dutch newspapers was accompanied by positive remarks towards nuclear merchant ships.

Fast forward to the late 1980s, when newspaper articles did seldom mention the building of nuclear merchant ships anymore, and whenever a nuclear ship is mentioned – at

[73] 'Nog 'n Atoomschip in VS', *Het Vrije Volk: Democratisch-Socialistisch Dagblad*, 23 November 1963.
[74] 'Savannah in de "Motteballen", Maar Toch... Plan Voor 3 Nieuwe Atoomschepen', *Het Vrije Volk: Democratisch-Socialistisch Dagblad*, 11 April 1967.
[75] 'Voor Nucleaire- En Procesindustrie: Drukvatenfabriek RDM Geopend', *Algemeen Handelsblad*, 24 June 1970; 'Verolme-Concern Vordert Met Onderzoek Voortsturing Door Middel Kernenergie', *Trouw*, 27 March 1969.

this point those are solely nuclear naval ships – it is in the context of resistance or protest. These ships were thought to be too dangerous for urban areas, and environmental activists like Greenpeace demanded their banishment from Dutch harbours.[76] Obviously, there is a big discrepancy between the announced plans to make more nuclear merchant ships in the late-1960s and the outspoken resistance against all forms of nuclear ships in the late-1980s. The public opinion has thus changed between the 1960s and 1980s, but when exactly, and what sparked that change?

There are several hypotheses for when the shift in Dutch public opinion happened. First, the rise – or rather the professionalisation – of environmental activists in the 1950s and 1960s, who opposed the use for nuclear power in general, caused the demise of the nuclear merchant ship's demise.[77] It could be that the increase of hostility of environmental activists towards nuclear power is directly translated into an average discontent towards nuclear merchant ships in the public's eye. Even though the newspaper articles of those years do not mention the rise of environmental activists in the context of nuclear merchant ships, the rise of environmental activists in the 1950s could have initiated a gradual and latent downtrend in popularity of nuclear merchant ships. Historian Christian Pfister calls it the 1950-syndrome, which describes a broad rise against the established scientists that promised certain technologies would be harmless.[78] In the 1950s, it became clear that the supposed harmless technologies were very toxic and the established scientists were either ignorant or lying about their innocuous nature. Among these technologies were dichlorodiphenyltrichloroethane – better known as the carcinogenic pesticide DDT – thalidomide, and indeed nuclear fission. Since the 1950 syndrome, environmental activists would emerge and over time professionalise, making them more proficient in exclamating dangers. This hypothesis would be plausible when newspaper articles would increasingly, yet gradually, connect nuclear merchant shipping to environmental dangers, parallel to the development of environmental activists.

The second hypothesis for when the public's opinion changed is precisely timed: in the year 1974. This year, as chapter two summarised, was allegedly detrimental to nuclear merchant ships. Indeed, the *NS Mutsu* went on her maiden voyage in that year and started

[76] 'Greenpeace: Kruiser Met Kernwapens Moet Haven Uit: Risico's Voor Dichtbevolkte Gebieden Te Groot; Goed Rampenplan Is Niet Voorhanden', *Het Vrije Volk: Democratisch-Socialistisch Dagblad*, 29 June 1989; 'Greenpeace Start Campagne Voor "Kernvrije Zeeen"', *De Waarheid*, 10 July 1987; 'Greenpeace: "Onderzoek Naar Nucleaire Schepen"', *Nieuwsblad van Het Noorden*, 6 August 1987.
[77] van Lente, *The Nuclear Age in Popular Media*, 149.
[78] Joachim Radkau, *Nature and Power: A Global History of the Environment*, 1st English ed, Publications of the German Historical Institute (Washington, D.C. : Cambridge ; New York: German Historical Institute ; Cambridge University Press, 2008), 252.

leaking radioactivity immediately, even though her reactor ran at just three percent of its capacity. Hypothetically, this would prove the danger of nuclear merchant ships and discourage building more. Surely, this would spark a public upset towards this technology. Also, the *NS Otto Hahn* was met with local resistance when she tried to get permission to berth at more Dutch harbour cities in that same year. Vlaardingen, Amsterdam, and Ijmuiden, among others, barred the *NS Otto Hahn* from entering, deeming her too dangerous. Prior to the *NS Mutsu's* critical failure, talks of risks were uncommon, which suggests the events of 1974 as a turning point because it is plausible that safety is questioned openly thereafter.

Another, third, hypothesis is that the public's opinion changed sour in 1979. Given the established fact that American propaganda influenced Dutch media, an American domestic nuclear disaster would surely influence Dutch public opinion.[79] Such a disaster struck in 1979 in Harrisburg, when in the middle of the night on March 28, a mechanical malfunction in the Three Miles Island nuclear power plant resulted in the drainage of the nuclear reactor's cooling solvent, which overheated the reactor, which then had a meltdown.[80] Even though the containment building surrounding the reactor reduced most radioactive spillage, this incident vividly proved to the public that nuclear power is unsafe. Consequently, the American public disapproved of the technology henceforth.[81] The Dutch public would follow suit soon, given the interconnectivity of said public opinions. This hypothesis suggests that the link between nuclear powerplants and nuclear merchant ships would be strong.

## 4.2 – Using sentiment analysis

To prove or disprove these hypotheses, a technique called *sentiment analysis* is used to measure the longitudinal change in public opinion towards nuclear merchant ships, as represented in newspaper articles.[82] Basically, sentiment analysis, or opinion mining, is an algorithm that measures whether a newspaper article is positively or negatively opinionated.

Data scientists use sentiment analysis on digital sources to help them understand how and why people think on certain subjects.[83] This can be achieved accurately by letting an

[79] See chapter three, also: Van Lente, 151.
[80] 'NRC: Backgrounder on the Three Mile Island Accident', accessed 9 April 2018.
[81] J.W. Gofman and A. R. Tamplin, *Poisoned Power: The Case against Nuclear Power Plants before and after Three Mile Island* (Emmaus, Pa: Rodale Press, 1979), 206.
[82] This sentiment analysis is comparable with contemporary methods used in present-day data science projects as seen in: Ali Hasan et al., 'Machine Learning-Based Sentiment Analysis for Twitter Accounts', *Mathematical and Computational Applications* 23, no. 1 (27 February 2018): 11; Xiaowen Ding, Bing Liu, and Philip S. Yu, 'A Holistic Lexicon-Based Approach to Opinion Mining' (ACM Press, 2008), 231.
[83] Pim Huijnen, 'From keyword searching to concept mining', *Pim Huijnen's blog* (blog), 3 December 2015, https://pimhuijnen.com/2015/12/04/from-keyword-searching-to-concept-mining/.

algorithm analyse written texts. The algorithm analyses sentence structure and meaning of the used words to calculate polarity, which is nothing more than a determent to illustrate whether a text is positive (a polarity between 0 and +1) or negative (a polarity between -1 and 0).[84] A polarity of +1 is unequivocally positive, whereas a polarity of -1 is unambiguously negative.

To maximise the measured polarity of texts, data scientists used to filter out neutral statements – *id est* neutral nouns or adverbs – so that only negative or positive statements are measured.[85] This heavily influences the average polarity, and analysed texts therefore show false or, at least, misleading results. In this thesis, no such filtering occurs because neutrality plays a significant part in newspaper articles. This means that analysing newspaper articles differs from analysing – for example – reviews of some kind. In analysing reviews, dichotomy is important, in that the difference between positive and negative reviews is key – not the difference between negative and negative. In this thesis' research, on the contrary, differences between two negative newspaper articles are also important. This is because the development needs to be analysed and not necessarily a turning point.

Sentiment analysis of each individual newspaper article that has nuclear merchant shipping as a subject is calculated. That calculation entails nothing more than arithmetically handling the polarity of words, which is defined and listed in a wordlist or lexicon. The polarity of each word is calculated by using the Natural Language Toolkit (referred to as NLTK in academic literature), a freely-available and open-sourced toolkit developed by a research group at Stanford University and updated by the NLTK-community for, among other things, computational linguistics using Python – the language wherein this thesis' sentiment analysis is conducted.[86] The polarity of each individual word is calculated using Bayesian inference, which means that each word is categorised as positive or negative according to its most-probable position on the polarity-spectrum (*id est*, between -1 and +1). The following formula of the Bayesian theorem is relevant for the Bayesian interference:

$$P(H|E) = \frac{P(E|H) * P(H)}{P(E)}$$

Wherein:

- | means 'given an event', so that (A | B) means A given B happens.

[84] Bo Pang and Lillian Lee, 'A Sentimental Education: Sentiment Analysis Using Subjectivity Summarization Based on Minimum Cuts' (Association for Computational Linguistics, 2004), 5.
[85] 'The Importance of Neutral Class in Sentiment Analysis | Datumbox', accessed 30 April 2018, http://blog.datumbox.com/the-importance-of-neutral-class-in-sentiment-analysis/.
[86] 'The Stanford Natural Language Processing Group', accessed 28 May 2018, https://nlp.stanford.edu/software/CRF-NER.shtml.

- H means the hypothesis or hypotheses that might or might not be affected by data or evidence as called below.
- P(H) means the prior probability. In other words, it is the hypothesis prior to being affected by the event.
- E means the event actually occurring, thus creating evidence and data.
- P(H | E) means the posterior probability, which means the probability of H given E.
- P(E | H) means the probability of observing the event or data when the hypothesis or hypotheses are true.
- P(E) means the total probability of the event or data occurring, which is calculated by:

  $$P(E|H) * P(H) + P(E|-H) * P(-H)$$

  or with the approximation of positive and negative texts as seen below.

Using Bayesian interference to calculate the polarity of words works as follows: first, the variable P(H) needs to be defined. Indeed, this is the hardest part of establishing the polarity: what is the expected polarity without testing it yet? There are two possible solutions to this problem: one, guessing the prior probability; or two, counting the times the word in question is used in negative and positive texts. This would need prior information about texts, which can be present when using texts that are also scored or valued, such as movie or book reviews that are accompanied with grades or an assigned score. This way the P(H) can be calculated by using these allotted polarity. For example, a word is used 40 times in positive movie reviews and 20 times in negative movie reviews, the prior probability (or P(H)) would then be:

$$P(H) = \frac{Number\ positive\ texts}{Total\ number\ texts} = \frac{40}{60} = \frac{2}{3}$$

$$P(H) = \frac{Number\ negative\ texts}{Total\ number\ texts} = \frac{20}{60} = \frac{1}{3}$$

Next, second, the P(E) needs to be defined. As previously mentioned, this can be calculated by multiplying the probability of the hypothesis, or the probability that a certain polarity is correct of a given word (P(H)), with the probability of the event, or probability that the text

has a certain polarity given the hypothesised polarity of that word (P(E |H)) added by the negative probabilities of both P(H) and P(E| H).[87]

The strength of Bayesian theorem is the constant adjustment of P(H) to new evidence. So, the polarity of a word is constantly getting more precise when analysing more texts. NLTK uses Bayesian theorem as a machine learning principle to increasingly make the polarity more probable. The polarity of each word is determined and adjusted by applying Bayes interference on movie reviews for the English lexicon and book reviews for the Dutch lexicon.

It is problematic that this thesis analyses newspaper articles from the 1950s to the late-1980s, whilst the lexicon is calibrated with present-day movie reviews. Indeed, this lexicon does not account for different cultural contexts or for longitudinal changes of general emotional expressions. As per the time of this thesis, no such lexicon can be made, even though calibrating the lexicon to newspapers of the 1950s to the 1980s would be optimal. This remark must, therefore, taken into account when qualitatively analysing the newspapers. Yet, sentiment analysis is solely used for source selection, which allows for more leeway, as direct conclusions will not be made on sentiment analysis only.

```
<word form="great" cornetto_synset_id="n_a-525317"
wordnet_id="a-01123879" pos="JJ" sense="very good"
polarity="1.0" subjectivity="1.0" intensity="1.0"
confidence="0.9" />

<word form="great" wordnet_id="a-01278818" pos="JJ"
sense="of major significance or importance" polarity="1.0"
subjectivity="1.0" intensity="1.0" confidence="0.9" />

<word form="great" wordnet_id="a-01386883" pos="JJ"
sense="relatively large in size or number or extent"
polarity="0.4" subjectivity="0.2" intensity="1.0"
confidence="0.9" />

<word form="great" wordnet_id="a-01677433" pos="JJ"
sense="remarkable or out of the ordinary in degree or
magnitude or effect" polarity="0.8" subjectivity="0.8"
intensity="1.0" confidence="0.9" />
```

Figure 4.1 – *Four strings of code from the lexicon referring to the word 'great'.*

[87] A more elaborate explanation can be found in 'Naive Bayes Classifier', accessed 28 May 2018, http://www.statsoft.com/textbook/naive-bayes-classifier; X. Falco, R. Witten, and R. Zhou, 'Report Sentiment and Objectivity Classification' (Stanford University, 2009).

Going from polarity per word to determine the overall polarity of a newspaper article brings up some challenges too. Polarities of multiple words are multiplied with each other to eventually come to a polarity of the analysed text. The difficulty, however, lies in homonyms, like the word *great*. Indeed, different meanings and polarities for one word hardens the calculation. Figure 4.1 shows four lines of code that refer to the word *great*. The challenge is to let the algorithm know when to use which definition and corresponding polarity. WordNet is used to determine the contextual meaning of these words.

Table 4.1 – *Meaning of labels of the parts of speech of traditional grammar*.

| Label | Long name | Example |
|---|---|---|
| NN | Singular noun | Atom |
| NNS | Plural noun | Molecules |
| NNP | Proper noun | Atomflot |
| VBD | Past tense verb | Claimed |
| VBZ | Third person singular present tense verb | Is |
| VBP | Non-third person singular present tense verb | Have |
| VBN | Past participle | Found |
| PRP | Pronoun | They |
| PRP$ | Possessive pronoun | Their |
| JJ | Adjective | Nuclear |
| IN | Preposition / complementiser | In / that |
| DT | Determiner | The |

WordNet is a semantic, or lexical, database developed by the department of psychology and computer science of Princeton University. The lexical database groups words – like *great* – into synonym rings or synsets, which are groups of words that semantically have the same purpose.[88] In this case, great and outstanding are obviously semantically equal, but great and capital as well – since a capital letter can also be referred to as a great letter.[89] Clearly, both uses of *great* have different allotted polarities. Another pattern module, next to WordNet, is used: *pattern.web*.[90] This is an API that deals with automatic translation,

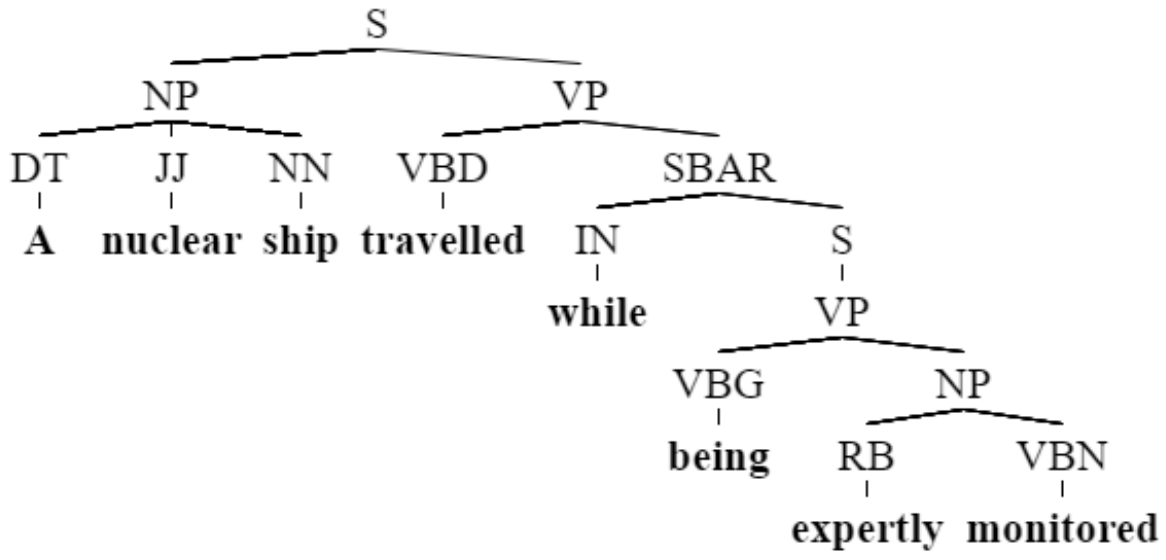
[88] 'WordNet | A Lexical Database', accessed 30 April 2018, https://wordnet.princeton.edu/.
[89] 'WordNet Search - 3.1', accessed 30 April 2018, http://wordnetweb.princeton.edu/perl/webwn?s=great&sub=Search+WordNet&o2=&o0=1&o8=1&o1=1&o7=&o5=&o9=&o6=&o3=&o4=&h=.
[90] 'Pattern.Web | CLiPS', accessed 15 June 2018, https://www.clips.uantwerpen.be/pages/pattern-web.

developed by the Computational Linguistics and Psycholinguistics Research Centre (CLiPS) of Antwerp University. It also deals with brand names and other specific nomenclature.

The position on the *syntax tree of natural language* and the location in the WordNet combined grants the correct polarity to each word. Concretely, the lexicon states what meaning a word can have in the syntax or how the word corresponds to the *parts of speech* of traditional grammar – as seen in table 4.1. The analysed word's location in the syntax tree (figure 4.2), and with it the right correspondence with the part of speech, is telling for its definition.[91] Using a syntax tree to understand the meaning of words has another advantage: it groups words on which they exert influence. For example, figure 4.2 shows a sentence (or *simple declarative clause* or S), which is divided into two parts, namely the noun phrase (NP) and the verb phrase (VP) – the first branch. The NP states that the words *a nuclear ship* are connected, just as the VP is connected. Clearly, in this example, the VP is constructed more complex, as the VP consists of a subordinate clause (SBAR), which consists of a preposition or subordinating conjunction (IN) and a separate S. In this example, the word *nuclear* influences the word *ship*, whereas the word *expertly* influences the word *monitored*.

This influence is concretised quantitively in the lexicon by using the attributed intensity as seen in figure 4.1. When the polarity of a sentence or text is calculated, not just the polarity is taken into account but the intensity and negational properties of words as well. The algorithm that calculated the polarity takes the intensity into account. Intensity is the factor with which the next word is modified. In the case of *very great*, the intensity of *very* is

Figure 4.2 – *An example of a syntax tree with the sentence "A nuclear ship travelled while being expertly monitored.*




[91] Andrew Carnie, *Syntax: A Generative Introduction*, Third Edition, Introducing Linguistics 16 (Hoboken, New Jersey: Wiley-Blackwell, 2013).

1.3, which makes *very* a modifier. The polarity of both *great* and *very* stays the same but is multiplied by intensity instead. *Very great*, thus, has a polarity of 1, since it cannot succeed one and (0.8*1.3)=1.04.

Negation words create the opposite meaning of what a word normally means. So, *not great* creates a negative polarity. More specifically, given the fact that the polarity of texts is arithmetically determined, negation simply multiplies the polarity by -0.5. Which means, as per figure 4.1, that the polarity of great equals 0.8 but changes to -0.4 when used as *not great*. Using both a negation and a modifier – such as *not very great* – results in:

$$polarity = -0.5 * \frac{1}{1.3} * 0.8 = -0.31\sim$$

This is due to the fact that when the modifying word is multiplied by a negative, the multiplicative inverse is used. Indeed, theoretically, the modifying word is x/1 or $x^1$ unless it is negative, then: 1/x or $x^{-1}$.

Many Dutch newspapers from the 1950s to the 1980s are digitised by the Dutch Royal Library (Koninklijke Bibliotheek or KB) and the KB also provides an automated read-to-text algorithm called Optical Character Recognition (OCR).[92] The latter technique is used to simplify searching all newspapers between 1959 and 1990 on certain keywords. In the case of this sentiment analysis, the following query is used: `(kernvoortstuwing or (Nucleaire schepen) or kernschepen or atoomschepen)`. This query searches newspaper articles where at least one of these four phrases appears, which also include articles about nuclear military ships. Unless nuclear commercial ships are also mentioned, these articles will not be analysed any further and do not influence the average polarity later.

To determine the moment or moments where the Dutch public opinion shifted from a positive attitude to a negative one, the average polarity of each year is calculated. Sudden negative and positive developments are then followed by qualitative newspaper analysis. Indeed, a shift in average polarity suggests, at the least, a shift in rhetoric: more or fewer positive words used. Analysing and comparing the arguments of the newspapers just before, during, and after shift(s) sheds light on elements that influenced the development of the public opinion.

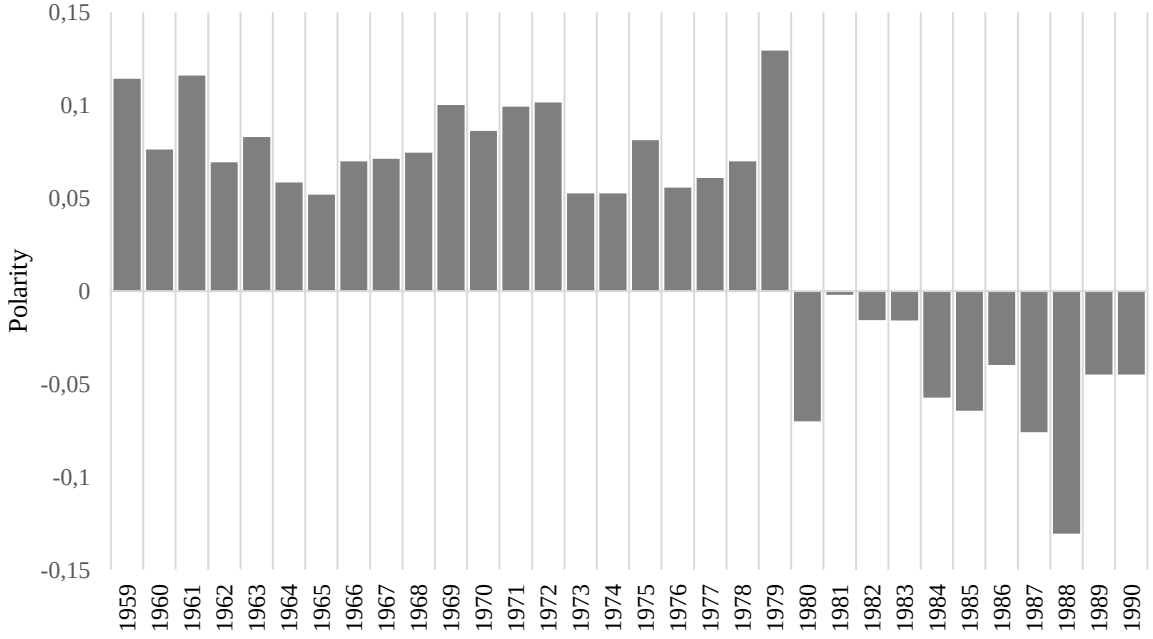
[92] 'Delpher Platform Digitale Publicaties', accessed 1 May 2018, https://www.delpher.nl/nl/platform/pages/helpitems?nid=372.

## 4.3 – What the data shows

Sentiment analysis of 826 Dutch newspaper articles between 1959 and 1990 shows a different timing of the shift in public opinion than all previously mentioned hypotheses maintain. Figure 4.3 shows the average polarity against time. From 1959 until 1979, the mean-polarity stays well above 0, which insinuates a positive attitude towards nuclear merchant ships in newspaper articles. The mean-polarity peaks in 1979. Then, in 1980, a shift is clearly visible. The mean-polarity of 1979 is 0.1295, whereas 1980 shows – for the first time – a negative mean-polarity, -0.0701. At least up until 1990 would the mean-polarity never exceed the zero mark again and the lowest bottom was in 1988 with a mean-polarity of -0.1305. The question arises: what do these mean-polarities actually mean?

It would be false to claim that fluctuations of less than 0.15 polarity are minor, even though the polarity fluctuates between -1 and +1 at the maximum. Remember that neutral statements are taken into account too in this analysis. Normally, data scientists only use words that have an assigned polarity (*id est*, words that are defined in the lexicon) whereas this analysis also uses neutral, or undefined, words with a polarity of zero. This brings the mean-polarity naturally closer to zero. On top of that, newspaper articles tend to be more informative than opiniated, which means superlatives are less common. This also adds to the reason why newspaper articles tend to stay close to zero in terms of polarity. With this in mind, sudden shifts in mean-polarity of 0.15 are really suspect. It generally means a total – or at least significant – shift in rhetoric. Concretely, more frequent use of negation words can be

Figure 4.3 – *Average polarity per year, 1959-1990; N=826.*




*Based on sentiment analysis of newspaper articles from 1959-1990, own calculations.*

expected in the case of a downwards shift, giving a negative tone to the entire article. A shift the other way around would probably involve more superlatives or positive modifying words.

From 1959 onwards, the newspaper articles are fairly positive towards nuclear merchant ships. From what chapter three shows, this was also the case in the years prior. The relative minor changes in mean-polarity between 1959 and 1979 can be attributed by the sporadic number of superlatives or the occasional opiniated column. Generally speaking, negation words or downright negative words are avoided in newspaper articles, for journalists want to report events neutrally. For example, the word *future* has a polarity of 0.0 and an intensity of 1.0, which means *future* is a neutral word and has no effect on the next word. If nuclear merchant ships are seen as a *gamechanger*, however, which has a polarity of 0.3, than that would positively influence the mean-polarity quite a lot. If a newspaper article reports on the future *danger* of nuclear merchant ships, which has a polarity of -0.6, than the mean-polarity would clearly come out negative. Still, most words used in newspapers have a small polarity. Also, words considered to be very negative, like *deadly* (-0.5), have a surprisingly small, be it a negative, polarity. So to change the mean-polarity with 0.3 either way needs quite a lot of what is generally considered strong words – like *deadly* or *dangerous*.

Some mean-polarities of specific years need more nuance, such as 1979. The mean-polarity of all years is the highest in 1979, which suggests a significant event during that year. This can be attributed to a specific event that is often portrayed in newspaper articles that year. In half July 1979, Nedlloyd, the largest shipping company in the Netherlands at that time, announced that ships would likely be powered by coal again. Nedlloyd explicitly stated that nuclear merchant ships were deemed less likely to be the standard than coal merchant ships.[93] These articles about Nedlloyd are positively flagged because the coal price dropped significantly, which meant that coal was a cheap alternative of oil-powered merchant ships. Cheap, for example, has a polarity of 0.7 and an intensity of 1.0. The algorithm flagged this as positive and the sheer amount of these Nedlloyd-articles heightened the mean-polarity of that full year, which is problematic because the positive polarity referred to coal-powered ships and not nuclear merchant ships.

This problem, though, is inherent to sentiment analysis. Computer scientist Bing Liu, who is specialised in data mining, acknowledges that lexicons are most effectively calibrated on reviews, which inevitably comes with a disadvantage. When data-mining a text, in this

[93] As can be seen in: 'Nedlloyd Wil Schepen Weer Met Kolen Stoken', *Trouw*, 14 July 1979; 'Nedlloyd: Kolen Weer Interessant Voor Scheepvaart', *De Telegraaf*, 14 July 1979.

thesis's case a newspaper article, one deals with multiple objects.[94] The object would be *nuclear merchant shipping,* and data mining in respect to nuclear merchant shipping need therefore be prioritised. The challenge is to let the algorithm ignore opinions that have nothing to do with nuclear merchant shipping; that would be, in this case, coal being cheaply implementable. The solution in line with what Liu suggests would be to structure the objects hierarchically, so that sentiment towards other objects would weigh little towards the mean-polarity. In this thesis, sentiment towards other objects in the articles of 1979 are now completely ignored. So, when adjusted for these Nedlloyd-articles, 1979 falls in line with the previous year, in that the mean polarity does not exceed 0.05.

So, what does figure 4.3 precisely mean when falsifying the aforementioned hypotheses? When studying figure 4.3, the earlier mentioned hypotheses seems, in fact, aberrant. The first hypothesis – that states that the evolution of environmental activist groups resulted in a similar devolution of public opinion towards nuclear merchant shipping happened – appears false; no such downtrend is noticeable. Also the second hypothesis is improbable. The year 1974 was not a disaster-year for the public's opinion towards nuclear merchant ships, as the mean-polarity scores positive still and does not seem lurchy in any way during that time period. Warnings of the dangers of nuclear merchant shipping would be calculated as a negative by the algorithm. The mere fact that no drop in polarity occurred in 1974 disproves this hypothesis. Furthermore, it would be expected that 1975 would also show a drop in polarity, since the aftermath of the *NS Mutsu* would at least continue in 1975. Yet, 1975 shows a rise in mean-polarity. Which means that the events of the *NS Mutsu* and the *NS Otto Hahn* had little to no impact on the public opinion on nuclear merchant shipping.

Events of the year 1979 were, surprisingly so, also not directly connected to nuclear merchant shipping. Apparently, the disaster of Harrisburg remained separate from nuclear merchant shipping. This could have several reasons. For one, the American public and politics had, over time, lost their strong influence on the Dutch public or, second, nuclear merchant shipping was truly an independent topic.[95] The sentiment analysis points to 1980 and the following years as a breaking point. This raises the question: what happened in 1980 that actually influenced the way newspaper articles talked about nuclear merchant ships? Two observations can be made when analysing the development of the narrative in newspaper articles post-1980.

[94] Bing Liu, 'Sentiment Analysis and Subjectivity', n.d., 3.
[95] Based on the assumption that the events in Harrisburg significantly influenced the implementation of nuclear merchant ships in the United States.

## 4.4 – Observation 1: General protests against nuclear armament

Nuclear power was introduced to the public when it was used to bomb Hiroshima and Nagasaki. Atomic bombs gave reasons enough to fear nuclear power. However, the actual effect was the opposite.[96] In the late-1940s, the atom bomb was thought of aa something liberating, which had saved thousands of American troops. Having a weapon which could force an empire like the Japanese's on its knees was appealing to politicians and they argued that nuclear weapons are beneficial for security. Historian Lawrence Wittner showed, however, that the public grew weary of these weapons over time, starting in the 1950s. An ever-increasing amount of anti-nuclear weapon movements stood up against the politician's nuclear ambition. By 1956, United States' ambassador to the United Nation acknowledged that nuclear weapons had grown 'a bad name'.[97] Anti-nuclear weapon movements successfully demonised nuclear weapons, forcing politicians to tread more carefully with nuclear proliferation.

The Dutch public would, in the early 1960s, also increase their resistance to nuclear armament.[98] In 1967, this resistance turned on steam when the peace and disarmament movement Pax Christi and the Dutch Reformed church founded the inter-Church Peace Council (Interkerkelijk Vredesberaad or IKV).[99] The IKV took part in many initiatives in the 1960s and early-1970s, such as protests against malicious investment activities in conflicted areas of Africa, and collaboration with Amnesty International and Medical Committee Vietnam-Netherlands for developmental projects. Protesting and arguing against nuclear weaponry was also on the agenda, but the focus was not yet present.

IKV was, up until 1977, actively trying to unveil general structural societal problems in the hope that politicians would resolve these problems. Chapter one points it out briefly: newspaper articles do seldom report on structural problems and focus primarily on significant events – whether or not such events are utterances of structural societal problems.[100] IKV tried to do the opposite with their newspaper the Vredeskrant. The Vredeskrant (roughly translated as the Peace Papers), reported on the perpetual underlying and mostly latent problems and relied on its readers to submit new items, columns and letters on all that is wrong with society. With a relatively small community, this poses no problem. However, as

[96] L. Wittner, *Confronting the Bomb: A Short History of the World Nuclear Disarmament Movement.* (Palo Alto: Stanford University Press, 2009), 221-222.
[97] Wittner, 79.
[98] van Lente, *The Nuclear Age in Popular Media*, 150.
[99] P. P. Everts, G. Walraven, and M. van Alphen, eds., *In Actie Voor Een Vredesklimaat: Twintig Jaar IKV*, Vredesboek 11 (Amersfoort: De Horstink, 1987), 35.
[100] Patterson, 'The News as a Reflection of Public Opinion', 38.

generally happens to activists groups during times of crises, the IKV enjoyed strong growth in public support in the 1970s. This was problematic, as the combination of a vague and unfocused newspaper and a rapid growth of membership-count led to an unreadable large newspaper.[101] At the end of 1976, the board of the IKV acknowledged that it had lost focus and that the passive approach was fruitless. They set course on a 'concrete and clear plan of action'.[102] A direct campaign against nuclear armament followed.

IKV's new approach was effective, as a million-and-a-half Dutchmen signed a petition against storing nuclear weapons on Dutch soil in 1977.[103] The petition was a reaction to the American plan to deploy nuclear cruise missiles in NATO countries to strengthen their position against the Soviet Union. NATO countries could decide up to December 1981 if they wanted to join the United States in this nuclear strong-arming campaign against de Soviet Union. Concretely, if European governments would permit the United States, intermediate-range nuclear missiles would be placed in their respective countries. The IKV, in its focused remonstrance, rallied Dutch people against the American plans. Still, even this approach turned out too passive.

The NATO Double-Track Decision was made in 1979, which came down to the immediate instalment of 572 intermediate-range nuclear missiles in Europe – and 48 of them would be placed in the Netherlands – to force the Soviet Union into more nuclear disarmament talks. This added oil to the fire of the public opinion and resulted in Europe-wide protests. American lobbyists, however, managed to ignore this public movement. Dutch politicians eventually caved to American lobbyists and agreed to the instalment of these 48 missiles. This sparked one of the largest demonstrations in Dutch history: 420,000 people went protesting in Amsterdam on the 21st of November, 1981.

This rather heated Dutch debate on nuclear proliferation did not reach articles on nuclear merchant ships until 1980. Already during the 1970s, newspapers linked civilian and military use of nuclear propulsion by reporting quite frequently on nuclear merchant ships and nuclear marine vessels in the same articles. Not surprisingly, nuclear marine vessels and merchant ships were compared in its efficiency. For example, the fact that nuclear merchant ships are viable was based on the use of nuclear marine vessels: *if one ship can run on nuclear fission, then surely others can too*.[104] Yet, nuclear weapons were deemed something

[101] Everts, Walraven, and Alphen, *In Actie Voor Een Vredesklimaat*, 42.
[102] Everts, Walraven, and Alphen, 41.
[103] D. Barton, 'Nuclear Message from the Dutch', *The Christian Science Monitor*, 1981, 1.
[104] '"Kernenergie in Schip Kan Nu Met Stookolie Concurreren"', *Het Parool*, 2 August 1971; 'Kernenergieschepen Niet Tegen Te Houden', *NRC Handelsblad*, 11 October 1974; 'Volgend Decennium Meer Atoomschapen Voor Koopvaardij', *NRC Handelsblad*, 8 August 1977.

entirely different. In other words, there was a clear distinction between nuclear weapons and peaceful applications like nuclear merchant shipping. Even nuclear naval ships were not considered weaponry but were solely thought as a showcase of nuclear power for future civilian uses.

However, the discussion on nuclear proliferation trickled to the debate on nuclear merchant ships. Since 1980, newspaper articles started to mention nuclear weapons and nuclear merchant ships in the same articles. This happened in multiple ways. In some cases, conventional ships were called nuclear ships when carrying nuclear weapons. An example presented itself during the 1982 events of the Falklands War. Dutch media reported an Argentinian attack on the British Naval fleet and confused a ship carrying nuclear weapons with a nuclear-powered ship.[105] This illustrates the slim-grown border between nuclear weapons and nuclear ships.

In other cases, nuclear merchant ships – or peaceful nuclear applications as a whole – were directly attacked. A newspaper article from 1980, strongly titled 'a new argument against nuclear energy', maintains that peaceful uses of nuclear power do not exist.[106] Peaceful applications, in fact, habituate the public on the notion that nuclear power, and with that inherently nuclear weaponry, equates to progress; which would suggest that nuclear power would be a good thing happening to human kind. In other words, supporting nuclear merchant ships would be the equivalent to supporting nuclear weapons. This train of thought makes debating the possible implementation of nuclear merchant ships even harder, especially in the Netherlands, where the majority of people were against nuclear weapons. Hence began the stigmatisation of nuclear merchant ships: debating in favour of nuclear merchant ships was no longer acceptable.

"[The] era of nuclear ships is over", claims a newspaper article in March 1980, saying that no shipping company believes in nuclear merchant ships anymore.[107] There were no arguments given as to why the shipping companies refused to invest in nuclear merchant ships, it was just observed and stated as fact. Though, the reason why no shipping company was attracted to nuclear merchant shipping was likely due to the expected public reaction on nuclear ships. The countries that allowed nuclear ships to berth would then – as per the newspaper articles – be tortured by protests. In the following years, more newspaper articles point at the stigmatisation of nuclear merchant ships with clear rhetoric. Such protests would

[105] 'Zwarte Dag Voor de Britten Op de Falklands', *Nieuwsblad van Het Noorden*, 10 June 1982.
[106] 'Zowaar: Een Nieuw Argument Tegen Kernenergie', *NRC Handelsblad*, 26 February 1980.
[107] 'Tijdperk van de Atoomvaart Voorbij', *Het Vrije Volk: Democratisch-Socialistisch Dagblad*, 15 March 1980.

pale nuclear merchant ships into dereliction. Indeed, countries had two options: first was to simply ban nuclear ships from their waters; and second, to allow nuclear ships but endure protests and possibly improvised blockades as were seen against the *NS Mutsu*.

For example, Japan opened its harbours for nuclear ships, which implicitly – since no distinction was made anymore between commercial and naval ships – means nuclear merchant ships could also berth in Japan.[108] Still, heavy protests were immediately announced, since the public did not want any nuclear vessel to berth in Japan. Another example, and popular amongst the Dutch newspapers, is New-Zealand which refused American – or any other – nuclear ships.[109] This was followed by international political problems but, unlike the Japanese example, the public in New-Zealand obviously did not protest. Not even when the United States boycotted New-Zealand in response. In both the Japanese and the New-Zealand example, it is made clear that nuclear ships were the *bad guys*.

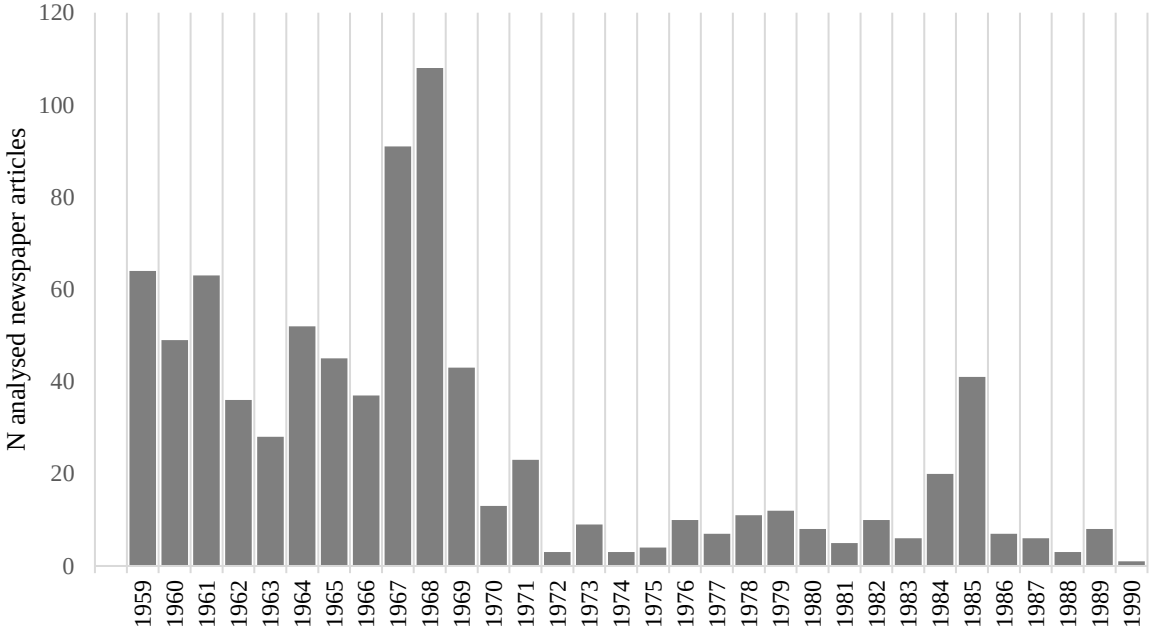
## 4.5 – Observation 2: The myth of nuclear merchant ships.

There is another difference in narrative between newspaper articles prior to 1980 and after, be it a less obvious one than the comparison with nuclear weapons: nuclear merchant ships got mythicised through time. Mythification of nuclear merchant shipping means that it fell into oblivion and, consequently, got its nomenclature confused. The latter impacted not only the sentiment analysis but impacted the public opinion on nuclear merchant ships as well. Both are important to clarify.

Slowly but surely, nuclear merchant ships were less mentioned throughout the 1970s. Figure 4.4 shows the amount of newspaper articles per year that are analysed by using sentiment analysis. Keep in mind that these are articles that are only selected if they explicitly mention nuclear ships aside from naval ships. This means that an article is included when it refers to just nuclear merchant ships and articles that mentions nuclear merchant ships next to nuclear naval ships. When articles just refer to nuclear naval ships, they get filtered out. Articles from the 1960s are fairly easily determinable, as nuclear merchant ships form their own category and nuclear naval ships form another. This means that articles mention one without the other. During the late 1970s, however, this previously clear border gets hazier because both nuclear merchant ships and nuclear naval ships are referred to as just nuclear ships. This is due to the fact that nuclear merchant ships were not only less common but also

[108] 'Japan Open Voor Atoomschepen VS', *De Waarheid*, 9 February 1983.
[109] 'Australië En VS Vragen Nieuw Zeeland Schepen Uit de VS Wel Toe Te Laten', *NRC Handelsblad*, 28 January 1985.

Figure 4.4 - *Analysed newspaper articles per year, 1959-1990; N=826.*




*Based on total analysed newspaper articles with Delpher.*

became a more distant history – the *NS Otto Hahn*, over time, became nothing more than an old example for a seemingly flawed technology. Nuclear merchant ships, thus, increasingly became a myth and nuclear naval ships became the new standard. In other words, the term *nuclear ship* became an adequate laymen umbrella term for both implementations of marine nuclear power.

This frustrated the debates on actual nuclear merchant ships, since the nomenclature is immediately associated with negativity. Indeed, the previously mentioned article on the Argentinian attack on British "nuclear vessels" calls conventional ships that carry nuclear weapons the same way as it would call the *NS Otto Hahn*. The same goes for ships that transport nuclear waste. A striking example for the effect of confused nomenclature is a letter to the editor of the newspaper *De Volkskrant*.[110] In the letter, the reader complains about a previous article that relativised the danger of nuclear waste spilling in the ocean when disaster would strike a nuclear ship – or in this case a ship transporting nuclear waste. "We are startled by the editor of this newspaper", the reader begins, "startled by the claim that nuclear waste would not damage the environment, as if the salt of the ocean counteracts the radioactivity. Mind I remind the editor that we thought the same thing about chemical waste [being diluted by the seawater], which was eventually proven very dangerous still". The reader clearly disagreed with the editor, but the reaction of the editor on that letter illustrates the confused nomenclature even better. He responded that nuclear ships almost never had accidents, and

[110] 'Kernschip', *De Volkskrant*, 27 August 1980.

with it, he called a conventional ship transporting nuclear waste the same as a nuclear-powered ship. Was the correct nomenclature maintained, then surely the *NS Mutsu* would come to the editor's mind. Yet, the same reason it did not, was presumably the same reason for the confusion in the first place: the *NS Mutsu* and any other debate surrounding nuclear merchant ships were already in the distant past.

Nuclear merchant ships became rarely discussed on their own in the 1980s. Point in case is a news article describing the 'twofold character of the nuclear revolution' as the atom bomb and nuclear propulsion of naval vessels.[111] As if nuclear technology could not power civilian ships in the future, or as if it has never done so. As if the nuclear revolution was solely a military one. In articles like these, nuclear merchant ships are only referred to – if at all – as a failed experiment. Governments that banned nuclear ships – like the New-Zealand government – made no exception for civilian nuclear ships. Their reasoning was, indeed, safety, and they thought nuclear ships (civilian, naval, transporting waste or transporting nuclear weapons) unsafe. There was simply no difference between nuclear merchant ships and other nuclear implementation as far as the public and politicians were involved, making terms as nuclear merchant ships, nuclear proliferation and nuclear naval ships interchangeable.

To make matters worse, a rapport by a private research centre was published in 1983 and the contents included information on 37 reactor leaks on nuclear ships.[112] These leaks contaminated American, British and Japanese coastal areas. The leaks allegedly caused hair loss and infertility among the crew. From then on, nuclear merchant ships' reputation got increasingly damaged, as environmental activists, such as Greenpeace, entered the fray against nuclear ships. They influenced the public intensively, especially after Chernobyl, by extensively showing the dire consequences of nuclear radiation due to unwanted spillage. Greenpeace actively tried to ban nuclear ships out of Dutch harbours in the late 1980s.[113] They did not, as was the norm, differentiate between nuclear-powered ships and ships transporting nuclear weapons or nuclear waste. Also, fundamental problems of nuclear ships were openly questioned. Among which were plans to handle nuclear calamities, general secrecy surrounding nuclear ships and their whereabouts, and alleged accidents that

[111] 'Zeeoorlog in Vier Dimensies', *NRC Handelsblad*, 20 March 1982.
[112] 'Lekkende Reactors Bij VS Kernschepen', *Nieuwsblad van Het Noorden*, 21 July 1983; 'Rapport Constateert Lekken Bij Kernschepen', *Nederlands Dagblad : Gereformeerd Gezinsblad*, 1 August 1983.
[113] 'Greenpeace Eist Vertrek Beschadigde Kernkruiser', *De Waarheid*, 29 June 1989; 'Greenpeace Start Campagne Voor "Kernvrije Zeeen"'; 'Greenpeace: "Onderzoek Naar Nucleaire Schepen"'; 'Greenpeace: Kruiser Met Kernwapens Moet Haven Uit: Risico's Voor Dichtbevolkte Gebieden Te Groot; Goed Rampenplan Is Niet Voorhanden'.

governments omitted to make public.[114] Protests were not limited to the West or Greenpeace, as the Soviets delayed new implementations of nuclear fission, amongst which peaceful applications, in the years following Chernobyl.[115] Globally, no distinction was made between peaceful or military applications, as protests left no room for nuance. At least in the Netherlands, all development towards peaceful applications of nuclear fission stopped. That is, no new nuclear power plants, no new plans for developing nuclear merchant ships. At least not until the 2010s.

## 4.6 – The principle of least effort

Sentiment analysis of newspaper articles between 1959 and 1990 shows that the public opinion on nuclear merchant ships visibly worsened since 1980. Until 1980, the mean-polarity remained positive even though the sentiment towards nuclear merchant ships fluctuated to a certain degree. The mean-polarity went sub-zero for the first time in 1980. Measured sentiment towards nuclear merchant ships only worsened in the years after.

There are two possible explanations for why this happened. First, the covering in the newspaper articles changed significantly in 1980 compared to the years prior. In the 1970s, newspaper articles reported exclusively on nuclear merchant ships, whereas in the 1980s, the articles also contained – most of the times – reports on nuclear weaponry. The Dutch public, coincidentally, were much opposed to nuclear weapons. Mentioning nuclear ships in one breath with nuclear weapons, so to speak, meant that the Dutch public grew resistant to nuclear ships as they grew resistant to nuclear weapons. They were no longer separate topics of discussion. A logical outcome of this sudden hostility is that shipbuilders felt discouraged to develop a nuclear ship, since the public responds would be to eminently oppose this, as seen by protests against nuclear weapons and naval ships alike.

Second, the nuclear merchant ships never had a breakthrough and became myths instead of images of the future. Some newspaper articles in the early 1980s called the three experimental nuclear merchant ships ‘failures’ and spoke of possible successors as improbable because of them being failures. This circular reasoning goes hand in hand with the

[114] ‘“Plan Bestrijden Kernongeval Niet Alles Omvattend”’, *Leeuwarder Courant: Hoofdblad van Friesland*, 13 February 1989; ‘Tsjernobyl Te Water: Een Onvermoede Catastrofe’, *NRC Handelsblad*, 27 July 1987; ‘Twaalf Kernwapers Op Kruiser: Greenpeace Eist Vertrek “Bainbridge” Uit Den Helder Wegens Risico’s’, *Trouw*, 29 June 1989; ‘“Veel Ongelukken Op Schepen VS-Marine Niet Gemeld”’, *De Waarheid*, 19 April 1990; ‘Garanties Tegen Verspreiding Kernwapens Zijn Niet Waterdicht’, *NRC Handelsblad*, 30 November 1983; ‘Her Kernarsenaal: Zeker 1300 Ongelukken Met Atoomschepen, Details Worden Verzwegen’, *De Waarheid*, 23 December 1989.

[115] ‘Sovjets Vertragen Tijdelijk Bouw Nieuwe Kerncentrales’, *Nederlands Dagblad : Gereformeerd Gezinsblad*, 29 August 1986.

change in covering. The reason for why nuclear weapons and nuclear merchant ships became inseparable and interchangeable was the fact that they were called the same in the 1980s. Thus, semantically, they were equivalents. Consequently, as the Dutch public loathed nuclear weapons, the Dutch public opposed nuclear merchant ships. As a result, there was no incentive to revaluate the use of nuclear merchant ships. Slowly but surely, the whole notion of nuclear merchant shipping slipped into oblivion, buried under hostile rhetoric.

This changed the environment in which innovations in nuclear shipbuilding could thrive. French philosopher Guillaume Ferrero understood as soon as 1894 that people naturally take the option that takes the least effort. A simple principle of incentive, but relevant to nuclear shipbuilding. In the 1960s, the public applauded new nuclear merchant ships, making the development of one easy, as it is a popular choice. However, environmental activists would make a shipbuilder that builds a nuclear ship unpopular, disincentivising investing in that technology. Shipbuilders and companies chose by the principle of least effort. Meaning that in the late-1970, and especially since the 1980s, shipbuilders and shipping companies kept developing conventional ships instead of nuclear ships.

# Chapter five:
# Nuclear merchant ships need not apply in elections

The previous two chapters show how the Dutch public opinion developed over time, however the political opinion has not been not mentioned yet. It is plausible that Dutch parties and politicians influenced the public debate and *vice versa*. Following up on that, the political context is firstly established. Secondly, the development of the political opinion on nuclear merchant ships is analysed. And thirdly, a parallel is made between the political and public opinion to understand the commonalities and differences. Formed to a question: in what way did the political opinion develop over time and what elements influenced this development?

## 5.1 – Dutch political landscape, 1956-1989

The Netherlands is a parliamentary, monarchic democracy, meaning every four years, the Dutch public directly votes 150 representatives into the parliament, colloquially referred to as the 150 seats. Like most direct democratic systems, Dutch political parties campaign their political views and future plans to allure to voters. After elections, and conform consociationalism, the Dutch parties try to form a partnership with other parties to create the aggregated-majority of seats in order to govern; this is called the coalition. Indeed, parties that want to form the coalition need to cooperate and, in most cases, comprise some of their plans to come to an agreement with the partnering-parties to form a cabinet, in the sense that they select their ministers. The symbiosis of parliament and cabinet is as follows: the parliament vote new laws and motions into force and the cabinet has executive power. New elections will be held when the cabinet has governed for four years or whenever a coalition fails. The latter happens, for example, when one of the partnering parties stops supporting the cabinet and their ministers yield their positions in the cabinet.

Similar to the previous chapters does this chapter's focus lie on 1956 until 1990. As table 5.1 shows, only three parties took the first and second place in the elections of this period. The socialist party *Partij van de Arbeid* (PvdA), the Christian party *Katholieke volkspartij* (KVP), which later fused with other Christian parties to form the *Christen-Democratisch Appèl* (CDA). Technically, thus, only two parties dominated the Dutch elections, yet they never have had the majority of seats on their own, so they relied on the support of each other and/or other smaller parties. Still, because either of those parties governed in this period, their view – and the development of that view – is therefore leading in establishing the political opinion on nuclear merchant shipping. The influence of these

parties are arguably most significant out of all parties. This is the reason why the political opinion is measured with the minutes of the meetings these parties held, motions and laws that they proposed, and the rhetoric in their respective election programs, represented by pamphlets in which the plans and political ideas of the respective party are summarised. Structuring their rhetoric in these mediums through time would give ample insight to the Dutch political opinion.

## 5.2 – Development of the political opinion

As chapter three explained, the government supported the development of nuclear merchant ships since the early-1950s. Foremost, by funding the RCN's research into this technology.[116] During this time, a coalition of PvdA, KVP, and other, smaller Christian parties governed, and actively subsidised and supported research into the development of peaceful applications of nuclear power. This is no surprise, given the praise that nuclear power enjoyed in these parties' election programs. Indeed, both the PvdA and the KVP were outspokenly in favour of peaceful applications of nuclear power in the 1956 elections.[117] The PvdA even plead for transnational European-wide initiatives. This trend of endorsing peaceful applications of nuclear power continued in the following elections of the 1950s and 1960s, as the parties promised to support further development throughout these years.[118]

The PvdA and the KVP kept their promise by heavily subsidising the RCN, which then peaked activity-wise in the 1960s. Especially in the late-1960s did the government-payed committees, such as *Commissie Ad Hoc Scheepsreactor* and *Centrale raad voor Kernenergie* (meaning 'Committee ad hoc Ship's reactor' and 'Central board for nuclear energy' respectively), voice the most advices. Basically, these were advices on which types of nuclear reactor to pursue, the predicted costs, and the hypothesised future popularity and usefulness.[119] Two things stand out in these committees' advices. First, developing and

[116] M. Muysken, 'Kernreactoren Voor Scheepsvoortstuwing', *RCN-Bulletin*, December 1957, 3.
[117] Partij van de Arbeid, 'Verkiezingsprogram 1956' (Amsterdam, 1956), 3, 5, 14; Katholieke Volkspartij, 'K.V.P.-Werkprogram 1956: Voor Christendom, Vrijheid En Welvaart' (Den Haag, 1956), 4, 9.
[118] Partij van de Arbeid, 'Verkiezingsprogram van de Partij van de Arbeid' (Amsterdam, 1959), 3–4; Partij van de Arbeid, 'Om de Kwaliteit van Het Bestaan' (Amsterdam, 1963), 5–6; Partij van de Arbeid, 'Verkiezingsprogramma 1967 van de Partij van de Arbeid' (Amsterdam, 1967), 2; Katholieke Volkspartij, 'Programma KVP Tweede-Kamerverkiezingen 1959' (Den Haag, 1959), 1; Katholieke Volkspartij, 'Werkprogram 1963: De Wereld van Morgen' (Den Haag, 1963), 16,21; Katholieke Volkspartij, 'Werkprogram 1967' (Den Haag, 1967), 2, 7, 17, 19.
[119] J. Pelser, 'Notitie Betreffende de Vergelijking Tussen de Ontwikkelingslijn Met PROTEUS Als Prototype Te Land En de Ontwikkelingslijn Met de NEREUS Als Prototype Ter Zee', Reactor Centrum Nederland (The Hague: Commissie ad hoc Scheepsreactor, 13 January 1966), 6–8, 2.14.24, Nationaal Archief; 'Enkele Opmerkingen Betreffende RCN-Tr-4000 "Vergelijking PROTEUS-NEREUS"' (Reactor Centrum Nederland, 24 January 1966), 1–2, 2.14.24, Nationaal Archief; D.G.H. Latzko et al., 'Kernvoortstuwing van Schepen En

maintaining a nuclear reactor was deemed more easily achievable and more practical if it would be powering a ship rather than powering a city. Second, the United States would not publish the results of the *NS Savannah* and kept all technological developments concerning nuclear ships a secret. They were, as the speculations of the committees expressed, hesitant to help even allies in creating a nuclear naval fleet. The United States' federal government passed the U.S. Act of Policy in February 1965 to prevent exporting the technology for nuclear ship reactors in order to keep the American navy unrivalled.[120] All developments and experiments on nuclear shipping needed to come from European committees, further adding to the necessity of a transnational European-wide cooperation. However, any European governmental cooperation on this subject would lack in the following years.

Table 5.1 – *The first and second place of the Dutch elections and the amount of seats.*

| Year of elections | First place | Second place |
|---|---|---|
| 1956 | PvdA (34) | KVP (33) |
| 1959 | KVP (49) | PvdA (48) |
| 1963 | KVP (50) | PvdA (43) |
| 1967 | KVP (42) | PvdA (37) |
| 1971 | PvdA (39) | KVP (35) |
| 1972 | PvdA (43) | KVP (27) |
| 1977 | PvdA (53) | CDA (49) |
| 1981 | CDA (48) | PvdA (44) |
| 1982 | PvdA (47) | CDA (45) |
| 1986 | CDA (54) | PvdA (52) |
| 1989 | CDA (54) | PvdA (49) |

*Source: 'Verkiezingsuitslagen', accessed 9 May 2018, https://www.verkiezingsuitslagen.nl/.*

Still, the RCN would work together with companies, Dutch or otherwise, to develop other peaceful nuclear implementations. Companies that wanted to review nuclear possibilities contacted government-funded committees for information and advice. For example, Dutch shipbuilder Verolme United Shipyards wanted to invest in nuclear merchant

Nederlands Prototype Scheepsreactor' (The Hague: Commissie ad hoc Scheepsreactor, April 1966), 1, 12–14, 20–25, 553, Nationaal Archief.

[120] Latzko et al., 'Kernvoortstuwing van Schepen', 12.

ships in April 1969 and worked together with the RCN.[121] This idea was later dismissed by Verolme because ships had not grown in size quickly enough to justify the extra costs of nuclear reactors as opposed to conventional propulsion.[122] Another example was the cooperation between Royal Machine factory Stork NV and the RCN, where, also in April 1969, scenarios to build a nuclear park in West-Germany was analysed internationally.[123] A centralised reactor park would be able to power whole countries, but was deemed impossible since it would drain the Rhine entirely of its water, rendering transport by ship over the Rhine impossible. Also, the transport of the electricity would be costly and inefficient, since it would cost more energy to transport the energy than it would actually transport.[124]

Both Verolme's and Stork's interest into nuclear power were the last to enjoy Dutch politicians' support. Indeed, the fact that the government allowed government-funded committees to work with companies on the development of nuclear applications in the 1960s suggests at the least that the government approved research into peaceful nuclear applications. The Dutch parliament showed similar approval. When looking at the amounts of debates in the Dutch parliament on nuclear power, it is noteworthy that most debates took place in the early-1960s to mid-1960s and diminished in numbers towards the late-1960s. This is most notable when analysing minutes of smaller meeting of parliamentary committees on specific topics such as energy or transportation.[125] In discussions on energy and transportation, smaller workgroups often tended to involve nuclear technology. This would be a rarity in the late-1960s.

The most parliamentary questions and debates, however, were legislative in nature. As mentioned in chapter two, the *Convention On The Liability Of Operators Of Nuclear Ships* of 1962 asked for national legislation on the liability question on nuclear ships.[126] This was especially the case in 1963.[127] With only a few exceptions, all negotiations, questions, and

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[121] 'Verolme Denkt Aan Kernenergieschip', *Atoomenergie En Haar Toepassingen*, April 1969, 96, 2.06.101, Nationaal Archief.
[122] As mentioned in chapter two, the projected growth in size of ships, especially after the containerisation, would justify the use of nuclear reactors because those would be more powerful and efficient after a given size.
[123] M. Muysken, 'Het Nucleaire Park-Concept', *Atoomenergie En Haar Toepassingen*, April 1969, 2.06.101, Nationaal Archief.
[124] A.H. de Haas van Dorsser and W.W. Nijs, 'Commentaar Op Tempo-Rapport', 9 June 1969, 2–6, 2.06.101, Nationaal Archief; J.H. Bakker, 'Commentaar Op Het Rapport The Future of Power Production', 5 September 1969, 1–3, 2.06.101; Latzko et al., 'Kernvoortstuwing van Schepen', 2–4.
[125] 'Minutes: 34ste Vergadering' (Eerste kamer, 20 May 1964); 'Minutes: 3de Vergadering' (Eerste kamer, 1 March 1967).
[126] 'Convention On The Liability Of Operators Of Nuclear Ships | International Environmental Agreements (IEA) Database Project', accessed 9 June 2018, https://iea.uoregon.edu/treaty-text/1962-liabilityoperatorsnuclearshipsentxt.
[127] Tweede Kamer, 'Fiscale Faciliteiten Voor Bezitsvorming Niet Betrekking Tot Effecten: 47ste Vergadering', 1962–1963 § (1963); Tweede Kamer, 'Behandeling van Wetsontwerpen: 48ste Vergadering', 1963–1964 § (1963); Tweede Kamer, 'Regeling van Werkzaamheden - Behandeling van Wetsontwerpen: 49ste Vergadering',

remarks during that year were aimed to update Dutch legislation in conformity with the 1962 convention. It is therefore hard to say whether the parliament was actively pursuing nuclear merchant ships or more general nuclear ambitions. Though, at the very least does the legislative debate insinuate that the parliament was not explicitly against peaceful nuclear developments. The convention was ratified after all.

The last time that parliament mentioned nuclear merchant ships as a viable replacement of conventional ships was in 1974; in a rapport on energy policy.[128] In that same rapport, parliament suggested that the RCN would work together with Dutch shipbuilders to research the technical possibilities of nuclear merchant shipping. Of course, this is something the RCN had already done in 1969. The fact that the RCN's activities are not noticed or considered by parliament shows a disconnect between parliament and the RCN. A contributing factor is the apparent unpopularity of discussing nuclear merchant shipping. Concretely, the report, minutes or document that mentioned nuclear merchant shipping prior to the energy rapport of 1974, was published in 1970; four years earlier. It was a letter of consent from parliament for welcoming the *NS Otto Hahn* to Dutch territorial waters and harbours of a few years prior.[129] Clearly, nuclear merchant shipping was no priority for parliament, as the consent for harbouring the *NS Otto Hahn* happened years after she actually berthed.

This indifference towards nuclear merchant shipping lies embedded in the ideas, or lack thereof, expressed by KVP, PvdA, and later CDA. Starting in 1967 for the PvdA and in 1971 for KVP, these parties stopped mentioning nuclear power as a spearhead during election campaigns. KVP focussed primarily on European cooperation, albeit to further nuclear disarmament instead of transnational development of peaceful nuclear power like in the 1960s.[130] The PvdA, on the other hand, had taken a far more aggressive position against nuclear power. In 1971, just like the KVP, the PvdA pleaded only for European-wide denuclearisation and did not mention peaceful applications of any sorts.[131] However, when PvdA formed a new government in 1972 with two other progressive parties, strong language

1963–1964 § (1963); Tweede Kamer, 'Regeling van Werkzaamheden: 63ste Vergadering', 1963–1964 § (1963); Tweede Kamer, 'Mededeling van Een Besluit van de Centrale Afdeling: 65ste Vergadering', 1963–1964 § (1963).

[128] 'Energienota', Pub. L. No. 13122, 1974–1975 2 (1974), 139–40.

[129] 'Goedkeuring van de Op 28 Oktober 1968 Te 's-Gravenhage Tot Stand Gekomen Overeenkomst Tussen Het Koninkrijk Der Nederlanden En de Bondsrepubliek Duitsland over Het Gebruik van Nederlandse Territoriale Wateren En Havens Door Het n(Ucleaire) s(Chip) Otto Hahn', Pub. L. No. 10383, 1969–1970 4 (1970).

[130] Katholieke Volkspartij, 'Programma KVP Tweede-Kamerverkiezingen 1971' (Den Haag, 1971), 13.

[131] Partij van de Arbeid, 'Partij van de Arbeid - Lijst 2' (Amsterdam, 1971), 14.

followed, arguing heavily against peaceful nuclear applications too.[132] Nuclear power, the new government stated, comes with an unavoidable danger and the only research into nuclear power should be into the most efficient way to be independent from nuclear power. This hostility towards nuclear power explains the lack of nuclear power as a subject in parliamentary debates in that time period. The fact that nuclear power was still mentioned in the 1974 energy rapport as a possible replacement for fossil fuels can be explained as an incidental train of thought due to the 1973 oil-crisis. Indeed, the reliance on oil in that time-period became painfully obvious, which led to a government that was much against nuclear power actually discussing nuclear power as a possible solution.[133] Still, this idea was soon forgotten, just as it was between 1970 and 1974.

During the following elections in 1977, CDA made its debut and voiced concerns towards nuclear power, just like the PvdA. Overall, the CDA-campaign strictly separates their outspoken opinion against nuclear weapons and their concerns with the dangers of peaceful nuclear power.[134] Even when actually referring to peaceful applications, CDA does not go as far as PvdA, in that CDA promises caution toward future nuclear developments, whereas PvdA outright promises to abolish any plans to build new nuclear reactors.[135] Also in the later elections of 1982, 1986, and 1989, CDA did not disapprove peaceful nuclear technologies nor any research therein.[136]

In campaigning for the 1981-elections, PvdA expressed even more resolute than they did in prior elections. They maintained that all existing nuclear reactors should be decommissioned as soon as technically possible.[137] Furthermore, all investments into nuclear technology should be cancelled except for medical use. In their revised version for the 1982-elections, PvdA argued that tolerating even peaceful applications hardens combatting nuclear proliferation.[138] PvdA resumed this rhetoric in the elections of 1986 and 1989. Generally, all

[132] Partij van de Arbeid, Democraten ’66, and Politieke Partij Radicalen, ‘Keerpunt 1972: Regeerakkoort van de Progressieve Drie’ (Den Haag, 1972), 35, 41.
[133] Energienota, 3.
[134] Christen-Democratisch Appèl, ‘Niet Bij Brood Alleen: CDA-Verkiezingsprogram 1977-1981’ (Den Haag, 1977), 31, 56.
[135] Partij van de Arbeid, ‘Voorwaarts: Het Verkiezingsprogramma van de Partij van de Arbeid Voor de Tweede Kamerverkiezingen Op 25 Mei 1977’ (Amsterdam, 1977), 58.
[136] Christen-Democratisch Appèl, ‘Om Een Zinvol Bestaan: Nieuwe Wegen Naar Een Verantwoordelijke Samenleving’ (Den Haag, 1981), 79–80; Christen-Democratisch Appèl, ‘Om Een Zinvol Bestaan: Geaktualiseerde Versie Juli ’82’ (Den Haag, 1982), 53, 59; Christen-Democratisch Appèl, ‘Programma CDA Tweede-Kamerverkiezingen 1986’ (Den Haag, 1986), 7, 14, 43; Christen-Democratisch Appèl, ‘Verkiezingsprogramma CDA Tweede-Kamerverkiezingen 1989’ (Den Haag, 1989), 27, 80.
[137] Partij van de Arbeid, ‘Weerwerk: PvdA-Verkiezingsprogram 1981-1985’ (Amsterdam, 1981), 7, 23.
[138] Partij van de Arbeid, ‘Witsenkader: Eerlijk Delen’ (Amsterdam, 1982), 42.

forms of nuclear technology (except medical) were deemed too hazardous and indirectly countered efforts to stagnate and decrease nuclear proliferation.[139]

## 5.3 – Parallels between political and public opinion

When comparing the development of the political opinion with the rhetoric used in the newspaper articles as seen in chapter three and four, two similarities stand out. First, just as seen in the newspaper articles, PvdA blurred the line between nuclear weapons and peaceful nuclear power, stating that one leads to the other. Given the timing of the elections, this rhetoric began in 1981, instead of in 1980 like the newspaper articles showed. This delay, of course, can be attributed to the fact that the elections were held in 1981. CDA, on the other hand, kept nuclear weaponry and nuclear merchant ships (and nuclear power as a whole) separated and maintained that cautiousness and transnational cooperation would suffice to avoid nuclear disasters. Still, CDA was much aware of the dangers and would only apply nuclear technology when absolutely needed. It was not specified further as to when it was absolutely needed.

Second, nuclear merchant shipping is mythicised earlier in politics compared to the public opinion represented in newspaper articles. Already in 1971, the government would not actively support nuclear merchant shipping and practically ignored all progress made by businesses and committees alike. The debate surrounding nuclear merchant shipping was politically forgotten in 1974 and was only parenthetically brought up as a remedy for the 1973 oil crisis. Indeed, no references were made to earlier experiments or plans, which suggest political obliviousness. The RCN, though, officially continued to conduct research into nuclear applications until 1976. Its findings were not to reach parliament. There was, however, some correspondence between the RCN and the minister of economy in the 1970s. This correspondence might reveal some political activity on this subject but the Dutch government as per 2018 restricts viewing these files until 2022 due to ‘national security and the security of her allies’. Still, given the political sensibility of nuclear power in the 1970s, these files probably show, just like the correspondence in parliament, a nuclear dead end.

Aside from the two similarities, there were some differences between the public and political opinion as well. For one, the political developments had a different time course, especially when the mythification of nuclear merchant ships is considered. The amount of

[139] Partij van de Arbeid, ‘De Toekomst Is van Iedereen: Verkiezingsprogramma ’86-’90 Voor Werk En Eerlijk Delen’ (Amsterdam, 1986), 32; Partij van de Arbeid, ‘Programma PvdA Tweede-Kamerverkiezingen 1989’ (Amsterdam, 1989), 7, 36–37.

mentions of nuclear merchant ships in newspaper articles show a decline in the mid to late-1970s, whereas parliamentary documents show a decline in the mid to late-1960s.[140] The timing differed, but the effect was similar: references towards nuclear merchant shipping developed to just references to peaceful nuclear applications and later solely nuclear power, which then also includes nuclear weapons.

Another difference is the nuance portrayed in the political debate as opposed to the general lack of nuance in the newspaper articles. Nuance, in this case, means the multiple sides of the debate that are covered. Indeed, this is inherent to a democracy, as multiple political parties tend to disagree with each other much. Yet, it might give the impression that nuclear implementations, given the disagreement, was a well-discussed subject. The earlier mentioned mythifications and Dutch consociationalism, however, suggest that even though the debate appears more nuanced, the end-result was the same as the public debate: nuclear merchant shipping became a forgotten technology. Indeed, nuclear power was debated during elections but was rarely touched as a subject in actual governance.

## 5.4 – Denuclearisation of the political rhetoric

The Dutch political opinion influenced the development of nuclear merchant shipping similarly as the public opinion. In the 1960s, just like the public, there was explicit support for research and development of nuclear technologies, among which was nuclear merchant shipping. This enthusiasm inspired government-funded committees to work together with companies to explore nuclear opportunities. This happened under the approval of the minister of economic relations. Politics lost interest in the late-1960s and early-1970s, due to economic setbacks and, most importantly of all, the potential danger associated with nuclear power.

Most notable were the initiatives of companies and the cooperation with government-funded committees in 1969. These initiatives lacked political acknowledgement, illustrating the disinterest of the politicians. This disinterest turned into disapproval, given the 1970s progressive governments' opinion, which equated to explicitly arguing against nuclear implementations of any kind (except medical applications). This fear for the dangers of nuclear power was since then widely present in the political landscape. So wide-spread, in fact, that a lesser-progressive government in the early-1980s also argued against peaceful nuclear implementations.

[140] See chapter 4.3 for the longitudinal analysis of the representation of nuclear merchant ships in newspaper articles.

The government even caught up with the public rhetoric: there is little to no difference between nuclear weaponry and peaceful nuclear technology. One seemingly innocent application imminently leads to another dangerous application. So thought the two largest and most popular political parties. Only total denuclearisation was the answer, rendering the use of nuclear merchant ships useless in the process.

# Chapter six:
# No utopia in sight

## 6.1 – Preventing the sailing route to utopia

Some present-day nuclear scientists maintain that it is possible and advantageous to use nuclear fission to propel nuclear merchant ships. They recognise previous endeavours to develop nuclear merchant ships and they give explanations as to why previous nuclear merchant ships were never followed-up on. Economically, nuclear merchant ships are seven times more expensive to build than conventional ships. According to the nuclear scientists, these immense initial costs prevent large-scale investments into nuclear merchant ships. It is financially just too risky for companies to invest.

Technically, nuclear merchant ships are feasible, but also risky, given the enormous amount of energy involved with nuclear fission. Not less is the radiation and nuclear waste as by-products, which necessitates precise security measures; a challenge on itself.

Juridically, these by-products poses problems as well. Unlike the broadly accepted use of fossil fuels, nuclear fission is still a novelty, which makes governments tread carefully when nuclear merchant ships are involved. Multilateral agreements that would provide nuclear merchant ships international passage and berth rights never got forged. Given the international nature of merchant shipping, juridical insecurity discouraged the use of nuclear merchant ships.

Though, present-day nuclear scientists overlook the importance of the public and political opinion towards nuclear merchant shipping. So, how did the Dutch public and political opinion develop longitudinally and how did this affect the use of nuclear merchant ships in the Netherlands?

Both the public and the political opinion were positive towards nuclear merchant shipping in the 1950s. It was dubbed the unavoidable future for marine transportation in the public opinion. This opinion was strengthened by the announcement and visits by actual, but experimental, nuclear merchant ships. The *NS Savannah* and later the *NS Otto Hahn* proved the viability of nuclear merchant ships and even left the impression that nuclear merchant shipping would surely take over the world as the new standard in shipping.

The political opinion clearly was as positive and optimistic towards nuclear merchant shipping. The establishment of the foundation for basic research into matter (*Stichting voor Fundamenteel Onderzoek der Materie* or FON) and later the Dutch Reactor Centre (*Reactor Centrum Nederland* or RCN) proves that there was actual political willpower and nuclear

ambition. The baseline opinion for both public and politics was roughly the same in the 1950s and early-1960s: optimistic and certain about the future wherein nuclear merchant shipping would be the new standard.

This idea changed. The measured polarity – which is a positive or negative sentiment towards nuclear merchant shipping – in newspaper articles showed a steady trend from the 1950s until the 1970s, which indicates that the public opinion stayed positive towards nuclear merchant ships until at least the late-1970s. From 1980 onwards, the polarity sank into negativity, proving that the public opinion changed for the worst in 1980.

Qualitative research shows two causes for this phenomenon, both of them are highly rhetorical. The first cause is that the debate on nuclear weapons became interwoven with the debate on nuclear merchant shipping. Indeed, the Dutch public was already against the use of nuclear weapons in the 1950s and cried out for nuclear disarmament. The public debate surrounding nuclear weapons was held completely separately from the debate on nuclear merchant ships. Yet, since 1980,because of the rise of environmental activists in the late 1970s, the separate debates on nuclear weapons and nuclear merchant ships fused into one where the conclusion was also singular: it was bad.

The fusion of these debates is also clear in the second cause for the change in public opinion: the mythification of nuclear merchant ships. Through time, the concept of nuclear merchant ships became forgotten, or mythicised. Nuclear merchant ships became a failed concept from a bygone era. The latter is not hard to image, since the mere fact that no more nuclear merchant ships than the original three were developed proves that it was a failed concept to begin with. No article in the 1980s referred back to nuclear merchant ships, aside from one article that underlined the failure that nuclear merchant ships truly were. It is likely that the mythification of nuclear merchant ships led to the fusion of the multiple subjects in the public rhetoric: nuclear merchant ships, nuclear naval ships, nuclear weapons, and ships transporting nuclear waste became interchangeable.

The Dutch politics shared this confusion in nomenclature to a certain extent. A clear distinction between peaceful nuclear applications and nuclear weapons was always maintained in election-programs and parliamentary documents. Still, and especially in the 1980s, peaceful nuclear applications were seen as a *gateway*-technology towards nuclear proliferations. This, of course, only added to the risk that peaceful nuclear technologies brought as well; namely the ever-present danger of a meltdown and the vague and unknown properties of radioactivity, as well as the actual nuclear disasters such as the *NS Mutsu*, Harrisburg, and Chernobyl.

Both the changed public and political opinion discouraged any nuclear development and initiatives by the private sector. For one, as existing literature already showed, investing in nuclear technology is costly. In the United States, the government subsidised around one-third of the costs per nuclear ship, which led to some plans for new nuclear merchant ships. The United States government understood the financial risks nuclear merchant ships brought, but wished for the private sector to invest in and further the development of nuclear merchant ships still. When the Dutch government would not directly subsidise nuclear merchant ships, Dutch private companies did not even dare to take on the risk. Indeed, the Dutch government, unlike the United States government, believed that private companies needed to invest themselves. Though, with the FON and the RCN, the Dutch government indirectly helped companies explore new nuclear possibilities.

But even if companies thought nuclear merchant ships a reasonable investment, nuclear merchant ships would still have been a lacklustre option for companies, since, given the hostile public opinion, nuclear ships would meet protests everywhere when entering harbours. Both from an investment and operational perspective, the private sector was discouraged into taking the risk.

Exactly that is the crux. As research already showed, economic, technical, and juridical problems can explain the discontinuation of the development of nuclear merchant ships only partly. Public and political willpower is needed to pursue the standardisation of nuclear merchant ships. The investments and operational difficulties associated with nuclear merchant ships is nothing but an obstacle, which is overcome in the past already in the cases of the *NS Savannah,* the *NS Otto Hahn,* the *NS Mutsu,* and the *NS Sevmorput*; not to mention the nuclear naval ships. Still, even with these examples of when the obstacle is overcome, it easier said than done, as the virtual sailing route to a nuclear utopia, which was so vividly imagined in the 1950s, was stopped when leaving the harbour out of fear for the scenario that the destination would not be a utopia, but the apocalypse instead.

## 6.2 – Reflection

Though this thesis adds new information and a new methodology to the debate on nuclear merchant ships, some things are left to be desired. First, the sentiment analysis used for source selection in chapter four can only be used for just that: preparatory work. With some adjustments, however, sentiment analysis could be used for more. In this thesis, the lexicon is calibrated to contemporary movie reviews and does not account for contextual lingual change in the 1960s to 1980s. Using newspapers of select timeframes – for example ten years – the

lexicon could be more reliable, thus the conclusions would be more reliable. When analysing the public opinion on nuclear merchant ships, or on any other subject for that matter, said calibration is recommended.

Second, some sources that could be useful for establishing the political opinion on nuclear merchant shipping are blocked by the Dutch government due to national security and that of her allies. These documents include correspondence between the minister and the RCN on plans to develop new nuclear merchant ships in the early-1970s. Until 2022, access will be restricted to said documents. Given the absence of any concrete evidence on the ambition to build a Dutch ship in the 1970s, the conclusions that can be drawn from those documents will most likely be in line with this thesis's conclusions.

Third and last, the Netherlands is used as a case study but historical research into nuclear merchant shipping should not be limited to the Netherlands. The public and political opinion of other countries should also be analysed. Primarily those of the United States, Japan, and maybe even other shipbuilding countries like South-Korea.

To summarise: the use of digital humanities should be further developed, documents that are now restricted might offer some insight in 2022, and this research should be replicated to other countries as well.

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