Federal Ministry
Republic of Austria
Climate Action, Environment,
Energy, Mobility,
Innovation and Technology

Technology Geriatrics 1 – Lifetime Extensions Are Dangerous

Some countries plan to keep the oldest nuclear power plants running way beyond their original lifetimes. That is dangerous.

The Volkswagen Beetle 1200 was manufactured from 1974 to 1985. Later it was considered technically outdated and replaced by a new model. Today, the 1200 Beetle is on display in a museum (see photograph). Occasionally, an aficionado with a special permit and an “H number plate“ (H for “historical“) can be seen driving the streets in this vintage model.

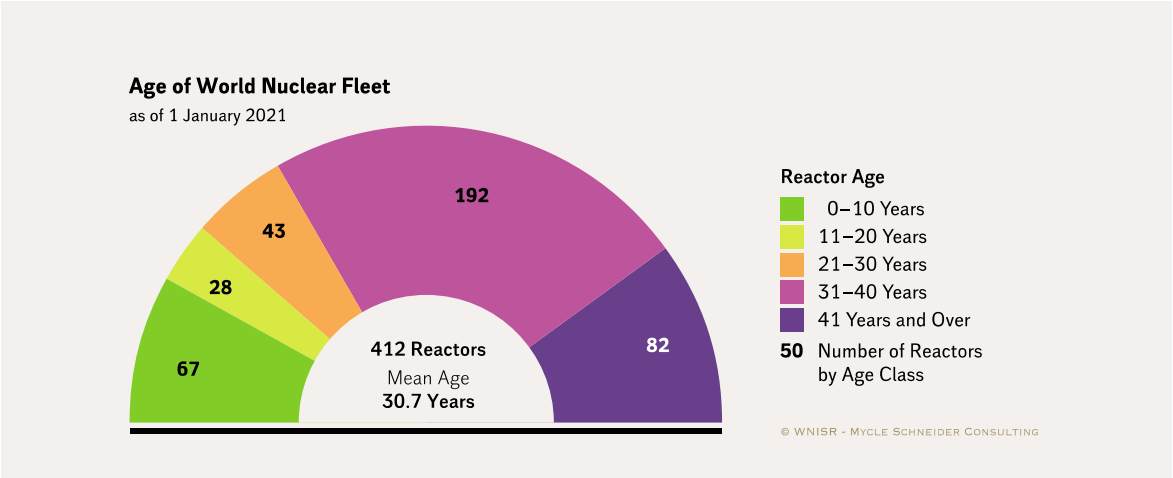
Figure 1: Photograph of the German Postal Service’s (Deutsche Bundespost) VW 1200 in the depot of the Museum for Communication in Heusenstamm (Germany).

File: VW 1200 Heusenstamm 05082011 01.JPG,
Source: https://commons.wikimedia.org/w/index.php?curid=16136415

Nuclear power plants are treated differently: 179 reactors around the globe, commissioned at around the same time, continue to operate to this day. Some are advocating the idea of keeping them splitting atoms for another ten or twenty years – a risky game.

Two thirds of the 412 nuclear power plants operating around the world at the beginning of 2021 are 31 years or older (Figure 1)[1]. They are becoming increasingly prone to incidents.

Figure 2: Age Distribution of Operating Reactors in the World



Source: WNISR, with IAEA-PRIS, 2021

Nuclear power plants from the beginnings of the commercial use of nuclear power were usually designed to operate for 30 to 40 years. Experts make a distinction between ageing and obsolescence. What is true for both is that the frequency of incidents increases.

- **Ageing**[2] is the time-dependent change of function-related characteristics of technology components, materials and operating systems relevant to safety, documentation – and personnel.

[1] Mycle Schneider et al., "World Nuclear Industry Status Report 2020", September 2020.
[2] RSK, "Recommendation - Management of ageing processes at nuclear power plants", 374th Meeting, 22 July 2004

- Obsolescence affects facility concepts, technological processes or administrative regulations because the state of the art of science and technology advances with time.

In all technical systems, including nuclear power plants, ageing causes the quality and reliability of components to gradually deteriorate with operating time[3]. The consequences of this ageing process are what is known as fatigue and embrittlement of materials, which can ultimately lead to the formation and propagation of cracks.

The negative consequences of ageing materialize in two different ways:

- On the one hand, ageing causes progressive weakening of highly irradiated reactor materials, which, in the case of safety-relevant components, can lead to failure with disastrous results.
- On the other hand, there is an increase in the number of minor disruptions, incidents and outages due to minor leaks, cracks or short circuits.[4]

Obsolescence of facility concepts is a category that includes risks that are unknown or incorrectly assessed at the time of power plant development and construction – underestimated hazards resulting from site-specific risks (earthquakes, tsunamis) or terrorist attacks, for example. Nobody would have considered the possibility of passenger airplanes being misused as guided missiles or remote-controlled armed drones prior to the attacks on the World Trade Center in New York City in 2001.

Three major reactor accidents have occurred in the past forty years – Three Mile Island (1979), Chernobyl (1986), and Fukushima (2011) – as well as a large number of near-disasters.[5] Today, the accumulation of insights gained from historical nuclear disasters forms the basis of the safety standards for nuclear power plants that are currently under construction and also for those scheduled to continue to operate beyond their originally envisaged operational lifetimes.

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[3] German Nuclear Safety Standards Commission (KTA), "KTA 1403 – Ageing Management in Nuclear Power Plants", Version of November 2017.
[4] Federal Office for the Safety of Nuclear Waste Management, "Kernkraftwerke in Deutschland, Meldepflichtige Ereignisse seit Inbetriebnahme", 6 October 2019, see https://www.base.bund.de/DE/themen/kt/stoerfallmeldestelle/ereignisse/akw/akw_node.html.
[5] See Mycle Schneider et al., "Restrisiko", 2007.

Extensive and costly replacements of equipment are necessary to ensure that vintage plants retrospectively comply with current safety standards. Furthermore, in practice, it is impossible to replace several key components including the reactor pressure vessel and the containment. However, through ageing, their condition systematically deteriorates over time. This leads, despite elaborate testing programmes, to an increased risk of failure of safety-relevant components, especially in the case of lifetime extensions.[6]

However, nuclear power plants must be designed so that they can—as claimed—withstand extreme events from first to last day of operation. In other words: To ensure compliance with the standards of the International Atomic Energy Agency (IAEA), they must seek to comply with the state-of-the-art until the end of their operational lifetime.[7]

In the real world, the safety level of vintage facilities usually fall short of today's requirements by a large margin. Increasingly expensive retrofitting measures may help, but this approach has its limits. In particular, design-based safety deficiencies cannot be fully remedied through subsequent measures. Vintage plants regularly give the lie to their claims to comply with state-of-the-art safety standards up to the end of their technical lifetime. Precisely for that reason, many of them belong where the VW Beetle 1200 has long been: in a technology museum.

[6] Yves Marignac, "Zusammenfassung der Studie 'Reduktion der Sicherheitsmargen von Alt-KKW. Der Fall Beznau'", WISE-Paris, 2016.

[7] According to IAEA Safety Principle 5: "Protection must be optimized to provide the highest level of safety that can reasonably be achieved."; see "Principle 5: Optimization of Protection", in IAEA, "Fundamental Safety Principles", IAEA Safety Standards Series No. SF-1, Vienna, 2006.