Chapter 6

Koeberg Controversies

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6.1 Introduction

South Africa has always heavily relied on coal-fired power stations for its electricity provision, but as early as the 1950s, there were discussions about diversification through other means of energy generation. This included the use of nuclear power, which was viewed as a viable alternative owing to its lower carbon emissions and operating costs relative to coal-based power generation. Subsequently, in 1966, a farm near Cape Town was purchased, where South Africa's (and Africa's) first nuclear power station was built by the French company Framatome between 1978 and 1984. It is still the only nuclear power station in Africa. It supplies 1,860 MW to the national grid and initially supplied 100% of all the Western Cape's energy demands, but increased demand has brought this down to 50% by 2017. The power station was built to accommodate several additional nuclear power reactors, were the need to arise (KPMG 2017; Winkler 2022).

Koeberg was granted a 40-year operational licence, which aligns with international practice. Koeberg Unit 1's licence expired in July 2024 and was subsequently extended to 2044. Unit 2's licence expiry date is 9 November 2025, with an extension hinging on the completion of various prerequisites (Ramdass 2024). Some civil society groups have called for the facility's closure; however, KPMG and others have argued that,

given South Africa's protracted electricity crisis, such a closure would be difficult to absorb (KPMG 2017; Winkler 2022). A recent study by the Council for Scientific and Industrial Research (CSIR) suggests otherwise, noting that the national grid can run without Koeberg (Kemp 2023). Nonetheless, Eskom, the national electricity provider who also operates Koeberg under the Nuclear Installation License, NIL-01 Variation 19 (as amended from time to time in terms of section 23 of the National Nuclear Regulator [NNR] Act (NNR 2023), regards the long-term operation (LTO)[1] of the nuclear power station up to 2045 as a vital part of the electricity provider's energy planning strategy (IAEA 2019) and Generation Operation Recovery Plan[2]. As noted by then Eskom chief executive officer, André de Ruyter, in December 2021, "Koeberg station is Eskom's cheapest electricity generation option, costing about 42 cents per kilowatt-hour generated. This is around half the cost of coal-fired generation … This is probably one of the most lucrative projects and economic projects in Eskom. As far as Eskom is concerned, life extension for Koeberg is a no-brainer" (Metelerkamp 2021).

Eskom decided in 2010 to pursue Koeberg's LTO and engaged with the NNR about extending the operating licence for an additional 20 years beyond 2024 (NNR 2023). The South African government subsequently endorsed the Koeberg LTO, in its 2019 Integrated Resource Plan for electricity, for a total lifespan of 60 years for each Koeberg unit. The extension was deemed achievable in the short term and financially defensible compared to the prohibitively expensive and time-intensive construction of new power plants (Winkler 2022). Eskom

1 "LTO of nuclear power plants is defined as operation beyond an established time frame determined by the license term, the original plant design, relevant standards, or national regulations. As stated in the IAEA safety standards, to maintain a plant's fitness for service, consideration should be given to life-limiting processes and features of systems, structures, and components (SSC), as well as to reasonably practicable safety upgrades for enhancing the safety of the plant to a level approaching that of modern plants" (IAEA 2019).

2 The Generation Operation Recovery Plan was launched in April 2023 following extensive stakeholder engagements. It aims to address challenges affecting South Africa's energy availability factor within a two-year timeframe (Arnoldi 2024).

subsequently embarked on the LTO project but has faced numerous obstacles and delays that have shrouded the project in controversy. These are expanded upon in the forthcoming chapter through a historical and chronological narrative and analysis based on desktop research of primary sources such as archival documents, online newspapers, official documents from government departments, Eskom, and the NNR, as well as secondary books and journal articles.

6.2 Building Koeberg: a tale of negotiation and high drama

The early history of the Koeberg nuclear power station was typified by hurdles and high drama, from tugs-of-war about who would supply the reactors to a face-off with the United States (US) regarding the fuel needed to start up the reactors to a bombing by the exiled African National Congress (ANC) in 1982, which delayed Koeberg's start-up by many months. It took almost seven years to find a site on which to build South Africa's first nuclear power station. Ultimately, Koeberg's selection boiled down to its position: "It fitted national grid requirements, it was in a sparsely populated area, it is on the coast—so seawater can be used to cool the condensers; and the ground conditions were suitable for the construction of a nuclear station with its enormous loads" (Eskom 2022a). To ensure that there would be no shortage of essential data, the site's geology, hydrology, seismology, and meteorology were investigated by working groups (Eskom 2022a).

South Africa approached the Nixon Administration in the US in 1971 with a request for enriched uranium for two nuclear power-generating reactors for Koeberg. The US firm General Electric was approached to put in a tender for a 600 MW nuclear power reactor, as well as Canadian, British, West German, and French firms (Nixon Presidential Materials 1972). Despite some initial reservations, due mainly to the South African government's apartheid policy and the possible military application of the technology and materials involved, the Nixon Administration and the South African Atomic Energy Board signed a contract in 1973 for the US to supply enriched fuel

for Koeberg (Nye 1977). In 1975, the agreement was amended to note that US fuel deliveries to Koeberg would continue for 25 years after the plant went critical as planned in 1982. In addition, in August 1974, Eskom and the US Energy Research and Development Administration (ERDA) signed contracts to enrich South African-supplied uranium at US facilities to 3% or less for delivery to Eskom. The contracts were later transferred to the US Department of Energy (Walters 1987:91; Ronald Reagan Library n.d.; DIRCO Records Division 1981).

Substantial Congressional opposition to the prospective General Electric sale caused Pretoria to instead award the sale to the French consortium Framatome (O'Toole 1976:1). In 1978, the US passed the Nuclear Non-Proliferation Act, which embodied much of the US policy for dealing with the linkage between nuclear power and nuclear proliferation, that is, the risk that the "materials, technologies, equipment, and facilities associated with civilian nuclear power programs could be of use in the production of nuclear weapons" (Nuclear Non-Proliferation Act 1978: 44). The legislation was expected to affect directly, or indirectly, most nuclear power programs in the non-communist world, given that the US was the leading supplier of equipment and services in the nuclear field (Nuclear Non-Proliferation Act 1978:44). South Africa was no exception: the US resolved not to supply the LEU for the two Koeberg power reactors, unless South Africa acceded to the Nuclear Non-Proliferation Treaty (UK National Archives 1977).

When the Reagan Administration came to power in the US in 1981, Pretoria tried to get the LEU fuel supply for Koeberg back on track. But, despite some positive signs from Washington, it was ultimately Framatome that would export 100 tons of LEU to South Africa to start up the plant (Murphy 1981; Parker 1983:153–54; O'Toole 1982:A5). However, the completion of Koeberg was set back significantly when it was bombed in December 1982 as part of the exiled ANC's strategy to destroy crucial infrastructure in its fight against apartheid. Koeberg was but one of a variety of strategic facilities that were targeted. It would appear, though, that Koeberg was explicitly targeted due to the ANC's belief that it was a cover for a nuclear

weapons programme and that plutonium for the latter would be produced there (Van Wyk & Van Wyk 2024). The bombing caused significant damage, and construction was delayed for about 18 months. Ultimately, Unit 1 went online in July 1984 and Unit 2 in November 1985.

6.3 Life extension controversies

The looming licence expirations in 2024 and 2025 meant that Koeberg was on the verge of being closed unless it could be successfully refurbished and relicensed (Ebrahim & Paton 2024; Ramdass 2024; Slabbert 2023). The LTO process was a race against time and shrouded in multiple controversies. Faced with several of its coal-fired power stations being at the end of their lives, endless problems with new coal-fired power stations, organisational chaos, corruption, and a debt of more than R420 billion, Eskom determined that it could not lose Koeberg's 1,840 MW power in order to limit load-shedding, which was costing the country an estimated R411 billion a year in economic losses by 2022 (Taylor 2024). But for Eskom to apply for the necessary approvals to extend Koeberg's operating license with the NNR for another 20 years, specific technical work was required, for example, replacement of worn-out parts and modifications based on lessons learnt. Overall, while an LTO programme is complex and technically demanding, it is not unheard of and was also done in France with 56 reactors, many of which have the same design as Koeberg (Eskom 2022a; Taylor 2024).

Eskom started planning for Koeberg's LTO in 2010 (Slabbert 2023). At this stage, the life-extension project was budgeted at R20 billion, with the most significant single item in the scope of work being the replacement of three steam generators in each Koeberg unit. This was estimated to cost R5 billion. The initially planned completion date was 2018, but a court case, significant manufacturing problems, and delays in the replacement of the steam generators delayed the project to December 2022, when Unit 1 was finally shut down for maintenance, refuelling, and installation of the new generators (Yelland 2021b; Slabbert 2023; Illidge 2022a).

The first step in commissioning the LTO was contracting an overseas firm to replace the steam generators. Invitations for tenders went out in 2012. Subsequently, a R5 billion contract was awarded to the French nuclear power firm Areva (Framatome, since January 2018) in August 2014, despite the US-based firm Westinghouse being less expensive. Westinghouse had designed Koeberg and was Areva's only competitor for the contract, but the Eskom board tender committee decided on Areva due to "strategic considerations" (Slabbert 2023). Westinghouse challenged the decision, leading to a protracted legal battle (Parliamentary Monitoring Group 2022). The Constitutional Court finally upheld the awarding of the contract to Areva, based on the legal and technical consideration that the latter was the only company that indicated it would be able to meet the project timelines and deliver the generators by 2018 (Slabbert 2023; Parliamentary Monitoring Group 2022). 2018 came and went, however, with no steam generators installed. Instead, Areva/Framatome's casting of the six steam generators in France ended in disaster. Eskom and Framatome then agreed to fly the 320 tons-a-piece generators to a partner in China, for fixing. Once in China, however, it was found that the generators were unusable, and production had to start from scratch (Slabbert 2023) at Framatome's cost. This resulted in a delay of three years (Yelland 2021a).

It was projected that each Koeberg unit would need to be shut down for five months for general maintenance, steam generator replacement, and upgrades required to secure the 20-year operating licence extension (Metelerkamp 2021; Winkler 2022). The shutdown for Unit 2 was planned for January 2022, and if all were to go well, Unit 1 would be shut down in October 2022. This meant that in total, Eskom would be without at least 920 MW of supply from Koeberg for about 10 months between January 2022 and February 2023, leading to an average energy availability factor (EAF) probably dropping below the prevalent 62% and an increased probability of load-shedding (Yelland 2021a). Meanwhile, Unit 1 had been on an extended outage of six months since January 2021, prompting Eskom to investigate matters at the power station (Arnoldi 2021). While reassuring the public that there were no nuclear safety concerns at Koeberg,

Eskom noted that it was important to take the required time to complete outstanding routine maintenance work and refuelling before the unit could be returned to the grid (Eskom 2021).

By the end of 2021, there were already several signs that the LTO project was faltering. In addition to the delays caused by Framatome, Eskom had failed to submit a crucial safety case report for the LTO project to the NNR for approval. The report was due in November 2021 and left a very small window for Eskom to address any issues raised before the first scheduled shutdown in January 2022 (Yelland 2021b). Furthermore, when the Framatome workers arrived at Koeberg in January 2022 to replace Unit 2's generators, they discovered a containment building that was supposed to store the old radioactive steam generators after removal from Unit 2 had not been completed. This was a serious lapse on the parts of both Eskom and the NNR. Framatome's specialists had to leave as the work had not been done, and the project was postponed so that Unit 2 could be online during the winter peak demand period (Slabbert 2023; Illidge 2022a). This never happened, though. After discovering that the containment building was not completed, the maintenance schedule was adjusted in March 2022. The plant was initially planned to return to service at the end of June 2022, but the date was pushed to mid-July because of defects picked up during commissioning. Then, unexpected issues were detected in the unit's polar crane, which pushed the date back to the end of July. Unit synchronisation only began on 5 August, however, and on 19 August, the unit had to be taken offline again so that a mechanical problem with the control rod could be addressed. On 3 September, the unit tripped at full capacity during a control rod test, and 920 MW of generating capacity was again wiped off the grid (Labuschagne 2022). The unit was ultimately returned to service on 25 September, but in April 2023, it tripped again and went offline for a day (My Broadband 2023). The irony is that each time one of the reactors had to be started up, it required electricity to avoid a meltdown. Hence, instead of providing electricity, which was its sole purpose, Koeberg put demand on the grid every time a reactor tripped or was taken offline (Feldman 2023).

The serious lapse of Eskom and the NNR, in not having the containment building ready by the first scheduled shutdown in January 2022, resulted in serious delays. Together with a high number of breakdowns at the coal-fired power stations, South Africa's energy supply was severely hampered (Illidge 2022a; Illidge 2022b). Initially, Ridewaan Bakardien, Eskom's Chief Nuclear Operator, blamed limitations and travel restrictions caused by the COVID-19 pandemic for difficulties in getting the LTO under way timeously (Illidge 2022b). However, Eskom later explained that the deferred outage for the steam generator replacement had to be re-planned entirely in view of its impact on the country's overall outage scope. Additional scope also had to be added to inspect and maintain the existing steam generators until replacement could take place. Emergent technical issues, coupled with maintenance and LTO project work, delayed the return of Unit 2 to service. Eskom admitted that the delay was a key component of the Stage 6 load-shedding[3] experienced in 2022 because it coincided with peak demand during the winter season (Parliamentary Monitoring Group 2022).

Eskom's Chief Nuclear Officer, Keith Featherstone, also later explained that Unit 2's deferred outage for generator replacement was due to several serious deficiencies in the front-end loading of the LTO project, which would have caused significant delays to the outage—something that Eskom and the country could ill afford. Featherstone noted that both Framatome and Eskom had contributed to these deficiencies, with several associated disputes being dealt with through dispute adjudication. Eskom's role in the delay included the incomplete facilities where the old steam generators would be stored. Other contributing factors included poor project

3 The load-shedding implemented by Eskom is a controlled process that responds to unplanned events to protect the electricity power system from a total blackout. According to Eskom (n.d.), it is used only under emergency conditions, for limited periods. Eight stages were developed based on the level of the risk, ranging from 1,000 MW of national load to be shed at Stage 1, to 8,000 MW shedding at Stage 8, in blocks of 2–4.5 hours at a time, depending on the area. The stages are meant to ensure that load-shedding is applied in a fair and equitable manner (Eskom n.d.).

management, inadequate contract management, and a lack of financial discipline (Parliamentary Monitoring Group 2022). Up to that point, three senior employees had already been placed on precautionary suspension with full pay (Parliamentary Monitoring Group 2022). In addition (if all this wasn't already ominous enough), one of the new steam generators was dropped inside the Chinese factory contracted by Framatome. Eskom insisted that the damage was minor, as confirmed by an expert review by a panel of internal Eskom staff and independent industry experts. Eskom foresaw that the generator would be delivered by December 2022 (Magubane 2022).

Human error at Koeberg also caused significant concerns. In March 2022, while Unit 2 was still offline, a worker cut a safety valve at Unit 1 instead of the same valve at Unit 2, resulting in Eskom nearly losing 920 MW of power to the grid—in addition to the 920 MW already lost due to Unit 2's maintenance outage. Eskom admitted that it was a significant error that could have resulted in the loss of Unit 1 (Omarjee 2022a; Taylor 2023) but then claimed that Koeberg's high safety measures managed to identify the error in time and, as such, avoided any damage. What was concerning, though, was that it was the second time that this incident had happened during Unit 2's outing, prompting Eskom to refer to "very poor human performance and … an unacceptable practice" in an internal Eskom newsletter (Omarjee 2022a).

Meanwhile, Eskom was also conducting benchmarking activities with other global utilities and requested assistance from international safety review bodies, including the International Atomic Energy Agency (IAEA), the Institute for Nuclear Plant Operators, and the World Association of Nuclear Operators (Omarjee 2022b). The IAEA conducted SALTO (Safety Aspects of Long-Term Operation) reviews at Koeberg as part of Eskom's preparations for the LTO project. This was a necessary exercise, as nuclear activities in South Africa are controlled and regulated by the NNR, which is expected to be guided by IAEA recommendations (Winkler 2022; Illidge 2022b). SALTO reviews focus on ageing management of several aspects related to mechanical, electrical, civil systems, structures and

components, knowledge management, and human resources (Omarjee 2022b).

The first SALTO mission to Koeberg occurred in 2015, the second in 2019, and the third in 2022. The missions focused on aspects of the safe LTO of both Koeberg units, based on IAEA safety standards and Eskom's preparedness and programmes for safe operation. During the 2019 and 2022 missions, the SALTO team, consisting of ten international experts and two IAEA staff members, found Koeberg staff to be professional, open, and receptive to suggestions for improvement and observed that the plant had made progress in ageing management activities and preparation for LTO since the first SALTO mission in 2015, despite many challenges and delays (IAEA 2019; Illidge 2022b; Omarjee 2022b). The SALTO mission of 2019 also identified some good practices, which they noted would be shared with the nuclear industry globally. These included: "A water chemistry programme implemented in line with IAEA safety standards, supporting ageing management for safe LTO; a surveillance programme to monitor vessel embrittlement under operation for all relevant plant conditions, including LTO; and the use of a simulator of mechanical, electrical, chemistry and radiation protection processes to improve staff performance and plant safety in these areas" (IAEA 2019). Recommendations for further enhancing the preparations for LTO safety included: empowering plant management and staff with all necessary mandates and processes, which must include adequate resources to achieve safe LTO promptly; adequately planning and implementing impressed cathodic protection of the reactor containments, including tests with a mock-up to further improve corrosion prevention; and developing and implementing a knowledge management programme (IAEA 2019).

At the end of March 2022, the SALTO team left Koeberg with serious concerns, despite noting some significant improvements and elimination of several deviations in ageing management activities and preparations for safe LTO (Illidge 2022b). The team's report listed fourteen safety issues for further improvement. The report was not intended for public consumption (Taylor 2023); however, the Democratic Alliance

(DA)[4] had long-standing concerns over Koeberg's safety and lodged a successful PAIA[5] application to Energy Minister Gwede Mantashe for access to the complete report. Once the full report was released, it became shockingly clear that the LTO project was in a crisis (Mileham 2022). The SALTO Team found the following deficiencies:

1. Koeberg would not be able to implement all activities promptly to demonstrate preparedness for safe LTO without effective management of the LTO programme (IAEA 2022; Koeberg Alert Alliance 2022).
2. Complete safety documentation for LTO could not be ensured without an adequately updated safety analysis report (IAEA 2022; Koeberg Alert Alliance 2022).
3. Ageing management and the safety function of some structures, systems, and components (SSCs) critical to safety could be compromised due to incomplete or inconsistent scope setting (IAEA 2022; Koeberg Alert Alliance 2022).
4. The safety function of SCCs in the scope of plant programmes could not be ensured without comprehensive revision and implementation (IAEA 2022; Koeberg Alert Alliance 2022).
5. The ageing management review of mechanical SSCs could not be effectively done without consistent management and documentation of information (IAEA 2022; Koeberg Alert Alliance 2022).
6. Koeberg could not ensure preservation of the safety function of SSCs for LTO without complete ageing management programmes (IAEA 2022; Koeberg Alert Alliance 2022).
7. The safety function of safety-related cables could not be demonstrated without implementing a comprehensive cable ageing management programme. Koeberg's cabling did not meet IAEA safety standards. Wetted cables, problems

4 The Democratic Alliance is a broadly centrist party and the second biggest political party in South Africa. Since 2024, it has been part of the Government of National Unity.

5 Promotion of Access to Information Act, 2000 (Act 2 of 2000). The purpose of the Act is to give effect to the constitutional right of access to any information held by the State and private bodies that is required for the exercise and protection of any rights (PAIA 2000).

identifying individual cables, overloaded cable trays, cables bunched together as they passed through firewalls, and poor illumination in some cable corridors meant that the control room could be left blind in the case of a cable failure. Particularly concerning was that Eskom had been fully aware, since 2009, that it would need to replace cables and switchboards (IAEA 2022; Koeberg Alert Alliance 2022; Taylor 2023).

8. Koeberg's ability to perform safety functions could not be demonstrated for LTO, as a complete revalidation of environmental qualification of the relevant SSCs had not been done (IAEA 2022; Koeberg Alert Alliance).
9. The safety function of electrical components related to electromagnetic compatibility had not been thoroughly assessed, despite it being known since 2015 that there was a need for an assessment. The compatibility was crucial, as it would prevent the kind of electromagnetic interference that had caused safety problems in other plants, such as emergency reactor shutdowns, erroneous readings in the control room, and false dosemeter readings (IAEA 2022; Koeberg Alert Alliance 2022; Taylor 2023).
10. The safety functions of qualified cables for LTO could not be demonstrated without a complete revalidation of environmental qualification (IAEA 2022; Koeberg Alert Alliance 2022).
11. Koeberg risked unavailability of SSCs critical to safety, as a proactive approach to technological obsolescence management had not been fully implemented (IAEA 2022; Koeberg Alert Alliance 2022).
12. Koeberg had not comprehensively validated the Time Limited Ageing Analysis (TLAA) for concrete structures and, therefore, could not demonstrate maintenance of its safety functions (IAEA 2022; Koeberg Alert Alliance 2022).
13. The intended safety function of reactor containment structures during LTO could not be demonstrated as the containment monitoring system was not fully functional. This was one of the biggest concerns because it meant that Eskom could not accurately determine the pressure inside the containment structure. Furthermore, cracking concrete,

large-scale delamination, and corrosion of reinforcing bars in Koeberg's containment structures were very concerning. While Eskom had made temporary repairs since 2000, it admitted in 2017 that delayed maintenance and environmental conditions had caused further damage (IAEA 2022; Koeberg Alert Alliance 2022; Taylor 2023).

14. Preservation of safety functions could not be ensured without the complete implementation of ageing management programmes for civil SSCs. A concerning issue was that Eskom's subscription to Westinghouse's POMS software system had expired. This system tracks obsolescence in 12 million plant components and provides an up-to-date database of 30,000 suppliers. Letting the subscription expire was a serious issue; without the software, Eskom would not know when individual parts would reach their end of life or whom to buy replacements from. According to the SALTO report, "the plant does not have access to any tool to proactively identify obsolescence" (IAEA 2022). Furthermore, when the SALTO team visited Koeberg, the software tracking for the LTO process was unavailable due to technical problems (IAEA 2022; Koeberg Alert Alliance 2022; Taylor 2023).

In connection with point (13) above, the SALTO team emphasised that Koeberg should ensure the full functionality of the containment structure monitoring system. It was also deeply concerning to the team that Eskom had not yet conducted fast fracture analyses at the time of the inspection. The leak-tightness and structural integrity of the containment building had to be checked to ensure that the structure would not be breached in the case of reactor malfunction and a subsequent rise in pressure. Eskom conducted the last integrated leak test for both reactor units in 2015, and the next test for Unit 1 was only slated to occur after the July 2024 deadline for the renewal of the operating licence. Furthermore, Eskom needed to replace components of the containment monitoring system, but the safety case report merely stated that a purchase request had been initiated and that repairs would only be done after July 2024 (Taylor 2023). It also noted that the "current condition of

the buildings remains fit for purpose and suitable for long-term operation" (Taylor 2023).

The SALTO team further noted that Unit 2's spent fuel pool, which contained highly radioactive contents, had leaked sometime during Koeberg's life, but the cause of the leak had not been discovered. This came on the back of Koeberg's fuel pools, which were already seriously overloaded with spent fuel due to Eskom's lack of a long-term plan for what to do with spent fuel. In light of this and numerous other concerns, the IAEA concluded that "management of the LTO programme [was] not effective to timely complete all actions to prepare for LTO" (Overy 2024).

Koeberg management expressed a determination to address the areas identified for improvement (IAEA 2022) and invited the IAEA to do a SALTO peer-review follow-up mission in 2024 to ensure that Koeberg achieve the highest level of safety on par with best practices globally (Illidge 2022b). The follow-up mission took place in September 2024, resulting in a positive response, with the IAEA noting that the plant "has made significant improvements in ageing management and resolved most of the issues identified in 2022" and, as such, was on track to complete the remaining items in a reasonable timeframe (IAEA 2024). Meanwhile, in December 2022, Koeberg Unit 1 was shut down for what was only supposed to be 180 days to replace the steam generators, with a completion date set for June 2023. This date was repeatedly pushed back, the ultimate date being 1 November 2023. This created a critical concern, as Unit 2 was scheduled to be decommissioned on 7 November 2023 for the same procedure. Another concern was the billions of rands the Koeberg project was costing, with Eskom persisting with Framatome, arguing that the contractor could not be replaced at this late stage of the project despite a game of claims and counterclaims. Both entities had been hit with huge penalties because of the delays (Slabbert 2023). As Pieter Becker of Koeberg Alert pointed out, "there are now over 100 active contractual disputes between Eskom and Framatome" (Fraser 2023a). In March 2023, an adjudication ruling awarded Framatome a whopping R950 million due to Eskom's

postponement of the planned maintenance work on Unit 2 in 2022. This followed on the heels of the Constitutional Court upholding a R650 million cost order from the Supreme Court of Appeal in favour of Framatome. This pushed the refurbishment cost at Koeberg far beyond Eskom's initial costing of R20 billion, to an estimated R40–70 billion (Fraser 2023a).

During 2023, South Africa experienced its worst load-shedding ever, at a time when Koeberg was scheduled to undergo steam generator replacements. By August 2023, the work was already significantly delayed. Unit 1's completion moved from June to November 2023, which was close to the 7 November date on which Unit 2 had to be decommissioned for the same work. If Unit 1 was further delayed, it would mean that the national grid would lose Koeberg's full generating capacity of 1,840 MW (equivalent to two extra stages of load-shedding) (Slabbert 2023). In addition, once the steam generator project was completed, Eskom intended to conduct pressure tests on the reactor containment buildings, requiring another 200-day outage for each unit (Polity News24Wire 2023). However, Unit 1's timeline had to be extended when unanticipated logistical obstacles and issues related to the integration of a local workforce caused delays that doubled the time it took to complete the work (Bloomberg 2023; My Broadband 2023). To further exacerbate matters, Unit 2 tripped in April 2023, which meant that both units were out for 48 hours, causing an additional 920 MW power loss to the grid (Feldman 2023).

Unit 1 came back online and synchronised with the national grid only in November 2023—after almost a year's delay (Ebrahim & Paton 2024). According to Eskom, returning Unit 1 to service was "intentionally thorough" because it was essential to ensure all the safety systems were functioning correctly (Patel 2023). Ultimately, Unit 2's scheduled shutdown was pushed to 25 November 2023. It was delayed because the NNR first had to approve Unit 1's return to operation (Smit 2023) and to avoid both units being out at the same time. Given the rolling load-shedding in South Africa at the time, the delays in refurbishment meant a continued absence of 920 MW on the grid, which was equivalent to almost a stage of load-shedding

(Wilson 2023; Omarjee 2024a). Unit 2 was on its scheduled outage by the beginning of 2024 and was expected to be online again only by September 2024 (Omarjee 2024a). By 12 February 2024, however, Unit 2's synchronisation was already 107 hours (or four days) behind schedule (Ebrahim & Paton 2024), which did not bode well for on-time synchronisation following LTO.[6]

Meanwhile, the accumulation of delays at Koeberg had prompted the Minister of Electricity, Kgosientsho Ramokgopa, to state in July 2023 that while nuclear technology was one of the safest in the world, "the longer the refurbishment was delayed, the greater the concern created in the market that something was brewing that might be a safety concern" (Wilson 2023). He did not want this view to gain traction, so he escalated the matter to the Eskom board. Ramakgopa also claimed that even after receiving an extensive presentation from the Koeberg project team, he still did not have a clear picture of the situation (Wilson 2023). Also, the delays and the likelihood of having both units offline simultaneously risked the possibility of disastrous consequences for the economy, as it would mean vastly increased load-shedding (Fraser 2023b). Furthermore, Koeberg played a key role in ensuring power supply in Cape Town (Patel 2023), and any prolonged outage would put pressure on the city, which would then have to rely solely on electricity supply from the northern parts of the country. Indeed, the country was already at 3% less generating power, which was expected to persist for the next two years (My Broadband 2023).

These were not the only signs of turbulence at Koeberg. Other concerning issues over the preceding months involved the delayed application to the NNR to extend Koeberg's operating licence; the controversial dismissal of Koeberg Alert Alliance's Peter Becker from the NNR; and a spate of resignations of senior staff at Koeberg. While there were no signs that the departure of senior staff members, such as Eskom's Chief Nuclear Officer, Riedewaan Barkadien, and Koeberg's Acting General Manager, Nomawetu Mtwebana, were caused by the LTO delays or other sinister reasons, it did raise concerns about lost expertise and

6 Ultimately, Unit 2 was successfully synchronised with the national grid on 30 December 2024 (Eskom 2024).

created speculation that the LTO exercise was in difficulty (Winkler 2022; Illidge 2022c). Statistics tell their own story: between 2021 and 2022, about 250–300 skilled employees left Koeberg (Taylor 2023). As early as November 2021, Eskom's Chief Operations Officer, Jan Oberholzer, commented that the loss of crucial skilled personnel at Koeberg posed a significant risk to the LTO (Yelland 2021b). He remained confident that additional planning would enable Eskom to complete the project properly and without any significant issues. However, the National Union of Mineworkers was not convinced and raised concerns about "a huge exodus of their [*sic*] nuclear plant licensed operators … to the point where they [*sic*] had been left with one extra operator to carry on producing electricity [at Koeberg]" (Parliamentary Monitoring Group 2022).

And then, another large elephant entered the room: future fuel for Koeberg. The US firm Westinghouse Electric lost its licence from the US Nuclear Regulatory Commission to export fuel-assembly components to Koeberg after the Agreement for Cooperation in Peaceful Uses of Nuclear Energy between the US and South Africa expired on 4 December 2022. Eskom tried to downplay the issue by noting that no fuel shortage was expected at Koeberg in the immediate future, as Westinghouse had already delivered the fuel that would be loaded on Unit 1 during the maintenance it was undergoing at that point, while Framatome, which had also been maintained as a nuclear fuel supplier for Koeberg, would provide fuel for Unit 2 (Tirone & Burkhardt 2023). (Unit 1 has always relied on fuel from Westinghouse and Unit 2 from Framatome.) Eskom's Keith Featherstone later added that further fuel from Westinghouse for Unit 1 would only be needed by about mid-2024. At the time of the statement, the South African government had just over a year to re-establish the agreement. The Department of Mineral Resources and Energy ((DMRE) 2019) indicated that, despite no immediate crisis, an urgent resolution was needed to allow Westinghouse to provide future fuel for Unit 1. The DMRE noted that it had initiated negotiations in 2018 and was working with other government departments to expedite the talks (Omarjee 2023). US President Joe Biden was poised in August 2022 to extend the agreement; however, the licence was

allowed to expire for unknown reasons (Tirone & Burkhardt 2023). According to Featherstone, finding a new nuclear fuel supplier was not considered an option, as it takes quite a few years to get the fuel qualified for use in Koeberg. Hence, Eskom felt "it would be better just to revive the agreement with the US for Westinghouse to continue to supply fuels" (Omarjee 2023).

6.4 Licence renewal controversies

Eskom applied to the NNR on 10 May 2021 for a variation of the Nuclear Installation License (NIL-01) to operate Koeberg for an additional 20 years (National Nuclear Regulator 2023). By June 2024, the NNR had not yet approved the variation, and time was running out fast. If the refurbishment was not done and the units relicensed by mid-2024 and 2025, respectively, the plant would have to close completely.

Eskom issued its annual Medium-Term System Adequacy Report, as required under the Grid Code, at the end of October 2022 (Eskom 2022b). The objective of this report is "to assess over a five-year period, the electricity supply shortfall risks that may arise based on foreseeable trends in demand and generation capacity in South Africa" (Moneyweb 2022). In the 2022 report, Eskom considered the impact of a possible two-year delay in Koeberg's LTO, with no additional capacity, resulting in a loss of 1,860 MW or up to 15 TWh per year. However, in 2023, the CSIR modelled the South African system and found that it could run without Koeberg, especially with increased renewable energy contributing to the national grid. Eskom also indicated that the Western Cape had stability without Koeberg, which was exemplified by a situation in April 2023, when both Koeberg units were off for 48 hours (Kemp 2023; Koeberg Alert Alliance 2023b). Nonetheless, since the steam generator replacements had already been completed in Unit 1 and were underway in Unit 2, Eskom forged ahead with the LTO project.

According to the NNR (2023), following Eskom's June 2020 indication of its intent to pursue LTO at Koeberg, the NNR established the regulatory framework for LTO after benchmarking international approaches and standards (including in France, Sweden, Switzerland, the US, Canada,

Finland, Hungary, Romania, and Spain). The framework considers administrative and technical provisions, as enshrined in the Constitution, associated legislation, and the NNR Act. As such, the LTO framework includes a variation to NIL-01 to include an operation timeframe. This was done in 2019. The framework also includes the issuing of LTO regulations and associated regulatory guidance, which happened between 2020–2021. These LTO regulations stipulate processes and requirements, including the submission of an application and a safety case. In terms of the NNR Act, submitting an application triggers the formal licensing process and associated provisions, which occurred when Eskom applied for a variation of NIL-01 on 10 May 2021, as stated earlier (NNR 2023). In December 2023, the NNR indicated that the regulatory approach to LTO would take 48 months.

Meanwhile, the application for extending the operational life of Koeberg required a public hearings process as well as the compilation of a public information document (PID), as required by regulations for any projects that are likely to have a direct or indirect impact on the lives of neighbouring communities (Matavire 2023). The licensing application and the PID had to be published in the Government Gazette and newspapers, and notices had to be served to interested and affected parties. By July 2022, none of this had happened. Eskom was also very late in submitting a safety case in support of its LTO application. At the time, the NNR nuclear power plant programme manager, Peter Bester, declared: "We are beginning a process of robust scrutiny of the safety case on which we will report our progress and findings including public comments received in a safety evaluation report to the NNR board of directors" (Parker 2022). The first set of public hearings was scheduled to be held by the NNR between February and June 2024 in the Western and Northern Cape (Omarjee 2024a; Overy 2024). This was quite late in the process, given the impending expiry date of the operating licence.

Eskom's 290-page "Safety Case for Long-Term Operation of Koeberg Nuclear Power Station" was completed in July 2022. As public scrutiny of the report was a regulatory requirement,

the NNR forced Eskom to put the report into the public domain (Taylor 2023). Eskom subsequently released a report dated 13 February 2023 to the public, but it was heavily redacted in places, especially in Appendix D, which deals with the prevention and mitigation of a nuclear accident. Sixteen of the 24 pages of this appendix were fully blacked out, and four were partly or almost entirely redacted.[7] Also, a separate confidential submission was made to the NNR, which dealt with Koeberg's physical and cyber security (Taylor 2023). As freelance journalist, Tristen Taylor, aptly points out, "the details of Koeberg's strategy to prevent, contain and deal with a meltdown, partial meltdown, reactor vessel rupture and/or explosion, [were] being withheld without good cause" (Taylor 2023).

In August 2023, the NNR asked Eskom to undertake additional engineering studies on Koeberg before it could deliberate on the extension of the LTO licence. Two weeks prior, the NNR had cancelled a scheduled press briefing on the licence without explanation, and Eskom did not deliberate on the concerns of the NNR. This was thought to be due to the repeated fears of anti-nuclear activists over the weathering and erosion of the reactor containment buildings (Polity News24Wire 2024). Eskom subsequently issued a third 295-page revision of the Safety Case for LTO in October 2023 (Eskom 2023a; 2023b).

The LTO project threatened to derail in early 2024 when it became clear that Eskom had also failed to provide crucial information regarding a tsunami and seismic survey, which was required for licence renewal. The seismic study had to be published, and the public had to have sufficient time to respond. In February 2024, Eskom indicated that it would need an additional month or two to complete the survey; however, the NNR noted that March 2024 would be the latest possible date for reception of the study, if it was to review the licence application before the existing licence expired. Furthermore, an opportunity for public scrutiny and comment on the study would need to be provided (Ebrahim & Paton 2024).

7 The report includes comments next to the redacted parts, showing the reasons for the redactions (Eskom 2023a).

A seismic evaluation dated 31 May 2022 (National Nuclear Regulator 2022) and a factsheet updated in August 2022 (Eskom 2022a) are the only documents publicly available. Briefly, the documents point to very detailed seismological studies done between 1970–1974. The factsheet briefly explains that South Africa is considered a relatively stable region for earthquakes, as it is located away from boundaries between tectonic plates. It does refer to the so-called Milnerton Fault, which runs close to Koeberg, and how it was decided that a seismic raft design earthquake protection system, called a "nuclear island", should be built under the reactor containment and auxiliary buildings. In the case of a severe earthquake of magnitude seven on the Richter scale occurring at the point of the offshore Milnerton Fault closest to Koeberg, the "nuclear island", consisting of rafts and pedestals supported by 1,829 aseismic bearings, would move, while the nuclear power station itself would remain stable (Eskom 2022a). As far as tsunamis were concerned, Eskom simply notes that there is no evidence that a tsunami has ever hit the West Coast of South Africa (Eskom 2022a). Nonetheless, during the site selection for Koeberg, tsunamis and tidal waves were considered; therefore, the terrace on which Koeberg is built is eight meters above sea level (Eskom 2022a).

Ultimately, Eskom came up with another plan to try to secure a new operating licence before July 2024. Because Koeberg's units were commissioned on different dates (Unit 1 in July 1984 and Unit 2 in November 1985), Eskom applied to the NNR for each unit to operate under separate licenses. In January 2024, the NNR decided to grant Eskom separate operating timelines. However, Koeberg would still have only one licence (Omarjee 2024a). The NNR made the decision after a safety assessment showed that the separation of the units would not impact the power station's safety (Omarjee 2024a). This did not mean, however, that the new operating licence was approved. It simply meant that Unit 2 could continue operating if a decision was not made on extending the operating licence by the time Unit 1's operating timeline expired (July 2024) (Omarjee 2024a). A final round of public hearings was completed on 8 June 2024. During these hearings, communities and environmental activists voiced broad safety issues and concerns raised by

the IAEA. Residents at the hearings also raised the issue of an evacuation plan and traffic congestion in the event of a serious radiation leak, to which city officials responded that the safety plan was updated regularly and followed best international practices (Roelf 2024).

By early July 2024, the NNR received a request from Cape Town city officials for extra time to decide. After working with the NNR and Eskom for two decades to limit urban growth to areas outside the 5–16 km emergency zone around Koeberg, city officials were fretting over land use in a key northern development node where housing complexes were mushrooming and over their operational ability to respond to a potential nuclear accident (Roelf 2024). According to a city spokesperson, Priya Reddy, city and private investors have bought vast tracks of land, which would be "effectively sterilised from development and unlikely to be used for new neighbourhoods, should Koeberg continue operating" (Roelf 2024). Meanwhile, the anti-Koeberg/anti-nuclear fraternity made sure that they were heard, as discussed in the next section.

6.5 Anti-Koeberg activism

Activism against Koeberg dates to when it was still being planned and constructed. A few property owners set up a non-profit organisation called Stop Koeberg in about 1980, which evolved into Koeberg Alert (KA) in 1983. Both entities intended to halt the construction of Koeberg. KA later became the Koeberg Alert Alliance, consisting of organisations and individuals concerned about Koeberg's current reactors. The alliance opposes the building of new nuclear reactors at Koeberg and actively spreads information about issues around nuclear power and Koeberg's latest status. It regularly lobbies decision-makers, engages with nuclear-related public participation processes, and organises anti-nuclear campaigns (Koeberg Alert Alliance n.d.).

Following the prolonged outage of Unit 1 that had dragged on since January 2021, Eskom decided to investigate matters at Koeberg. The unit was initially taken offline for repairs after an increasing leak rate was observed on one of its steam

generators. A decision was made to keep the unit offline for its routine maintenance and refuelling, initially planned for February 2021. The unit was expected to return to service in May 2021 (Eskom 2021). However, it was plagued with delays, which resulted in significant slippage on the return-to-service date. The outage also exacerbated the level of load-shedding that Eskom implemented at the time (Arnoldi 2021). In June 2021, Koeberg General Manager, Velaphi Ntuli, was suspended over performance issues (Omarjee 2024a), and Eskom Chief Nuclear Officer, Riedewaan Bakardien, was tasked with overseeing operations at the power station. The Koeberg Alert Alliance was unhappy with this and raised concerns that Bakardien would not be able to give his full attention, amid all his other responsibilities, to those aspects of Eskom's nuclear operations that might be neglected (Arnoldi 2021).

The Koeberg Alert Alliance further noted that the Eskom investigation proved that there was a lack of nuclear expertise within Eskom and too much reliance on too few people. What concerned them further was that it could be reasonably expected that an underperforming plant manager would also neglect maintenance, repairs, and emergency readiness. "Any problems in these areas may only come to light in the event of a malfunction of one of the nuclear reactors, with potentially catastrophic results", which means that the apparent message to the new person appointed to the position would be: "keep the plant running or face suspension" (Arnoldi 2021). This was deeply problematic as it would make the new manager conflicted. Eskom merely assured the public that there were no nuclear safety concerns at Koeberg (Arnoldi 2021). Ntuli was eventually cleared of the allegations and was reinstated as the general manager of Koeberg in November 2023. Eskom regarded his expertise and experience as "crucially needed", especially in securing an extended operating licence for Koeberg (Omarjee 2024a). Meanwhile, in August 2020, the Koeberg Alert Alliance used the PAIA to make two requests following notification of structural problems at Koeberg by "a concerned insider", who claimed that there was a large crack in one reactor's concrete dome (World Nuclear News 2021). This followed an admission by Eskom in 2017 that about 10% of the surface area of the

containment building had fractured into layers (delaminated) and that "chloride ingress extends past the rebar cover depth" (Overy 2024).

The first PAIA request pertained to cracks and damage to the stainless steel used in the plant structures (World Nuclear News 2021). Eskom responded by providing two heavily redacted reports. The first, titled "Plant Engineering Life of Plant Plan", was compiled in 2018 and revealed a 110m crack around the containment dome housing Unit 2's reactor and some deficiencies and malfunctioning of certain plant components (Matavire 2023b). It also referred to repairs carried out until 2018 (World Nuclear News 2021). A second report dated 2022, titled "Time Limited Ageing Analysis", covered the entire plant and identified various components, their degree of defectiveness, and the remedial actions required to repair them. Components that needed attention were listed as reactor pressure internals, cables, and pressure spray nozzles, which were cracked because of ageing (Matavire, 2023a). The proposed LTO extension was also covered in terms of the reactors' suitability to operate beyond their designed lifespan (Matavire 2023b).

Koeberg Alert Alliance's Peter Becker found the 2018 report to be "deeply disturbing and contradict[ory to] claims of safety" and pointed out that the extent of the damage or the associated costs of the repairs should not be kept hidden from the public (World Nuclear News 2021). Becker called for transparency from Eskom at a time when Koeberg's proposed LTO and additional nuclear power station builds were being debated. Eskom responded that it was well-aware of the risk of corrosion of civil structures at Koeberg. As such, a variety of quarterly and annual testing had been done at the containment buildings since construction. These tests consistently proved that the structures could withstand "the most severe accident" (World Nuclear News 2021). Furthermore, 10-year Integrated Leak Rate Tests (ILRT) "have shown conclusively that the design functions of the containment buildings are met" and that "the test results were compared with international plants of similar design and found to be in line with industry norms" (World Nuclear News 2021). Eskom further noted that, where necessary, repairs

to the concrete containment domes have been implemented "to reinstate areas of the external facades where spalling and delamination occurred due to reinforcement corrosion" (World Nuclear News 2021). The NNR, in turn, also confirmed that Koeberg was complying with regular tests as required and that, "despite the concrete cracking and delamination observed on the outer surface, the containment structures remain currently effective for protecting the environment from radiation during accident conditions". It furthermore stated that Koeberg was under continuous monitoring to ensure compliance with nuclear safety requirements at all stages of operation (World Nuclear News 2021).

In December 2021, the Koeberg Alert Alliance and the Southern African Faith Communities Environment Institute (SAFCEI) organised a protest on Bloubergstrand, a seaside suburb approximately 18 kilometres from Koeberg. The protest was directed against the Koeberg LTO project and intended to raise awareness about its operational and safety issues. It also emphasised Eskom's lack of transparency in providing the Koeberg Alert Alliance with a heavily redacted report after its 2020 PAIA request. About 50 protesters questioned Koeberg's safety and called for public participation in the decision-making processes, as, according to Becker, the project had a "moral component, a society component, an intergenerational ethics component" (Metelerkamp 2021). Protest participants were encouraged to sign an online petition to shut Koeberg down completely when its operating licence expired in 2024. The petition called on Eskom to acknowledge that the Koeberg nuclear power station would never be as safe as modern nuclear power station designs; to commit to shutting down the station in 2024; not to run the station after 2024 while it lacked modern safety features such as a core catcher[8]; to avoid unnecessary load-shedding that would result from efforts to extend the station's life; not to spend billions of rands upgrading a station

8 A core catcher, which is made from thermally resistant concrete ceramic, "is placed underneath a reactor and is designed to prevent molten radioactive fuel (corium) burning through to the bottom of the reactor and into the wider environment in the case of a core meltdown" (Overy 2024).

from the 1970s and to instead divert the funds allocated for extending the station's lifespan to support community-owned renewable energy; and to work on a permanent solution for the disposal of over 1,000 tons of high-level nuclear waste at the Koeberg site (Metelerkamp 2021). Eskom responded that it was complying with all requirements set out in legislation and would abide by all the safety requirements identified by the NRR and any procedural requirements of public engagement (Metelerkamp 2021).

Gwede Mantashe's dismissal of Peter Becker from the board of the NNR in 2022 was another unsavoury affair and highlighted the difficulties that Eskom was facing in keeping Koeberg operational until 2045. By law, a community representative must be appointed to the board by the minister. Becker had been appointed but opposed the LTO project because of Koeberg's proximity to Cape Town, where 4 million people live, and concerns about the disposal of nuclear waste and because he had a preference for wind and solar renewable-energy projects . Mantashe, by contrast, was a vocal supporter of the nuclear industry. He first suspended Becker in July 2022, but after Becker sued him, the suspension was turned into a dismissal from the board. Mantashe cited a conflict of interest and said that Becker brought the board into disrepute by publicly objecting to its decisions (Bloomberg 2022). Becker turned to the courts, and in May 2023, the Western Cape High Court found that Mantashe's axing of Becker was unconstitutional (O'Regan 2023). The Appeals Court confirmed this ruling in June 2024. The latter court found that Mantashe wrongly believed that the NNR board was supposed to "advocate for nuclear power" (Cronjé 2024).

In January 2023, the NNR started the required public consultation process. The public was asked to submit comments on Koeberg's LTO; however, they could not access the Safety Case Report. The NNR instead released the PID, which excluded technical information. According to the Koeberg Alert Alliance, the PID "reads a bit like a sales brochure for nuclear power" (Koeberg Alert Alliance 2023b). Civil society organisations did not accept the PID, and this affair, coupled with the previous,

heavily redacted reports and Eskom's unsatisfactory responses, led the civil society groups to accuse Eskom and the NNR of colluding to deliberately withhold vital safety information from the public (Koeberg Alert Alliance 2023; Matavire 2023a). According to Rodney Anderson of Save Bantamsklip, white residue and deposits observed along the cracked walls of the Koeberg containment structures (which were considered to be "very worrying radioactive leaks") sparked fear over the LTO project (Matavire 2023a). Eskom stubbornly refused to provide the unredacted reports, citing "the protection of third parties and sensitive national security information as reasons" (Matavire 2023b). Affected communities and civil society organisations stopped participating in the public consultation process and demanded the complete suspension of the comment period until they received more information (Koeberg Alert Alliance 2023a). Anderson subsequently submitted a PAIA application to Eskom as the author of the report on the state of the containment domes and to the NNR as the custodians of nuclear safety for the unredacted version of the report. Eskom responded by providing the report, but once again, about half of it was redacted. Anderson then turned to legal assistance to write formal appeals to both Eskom and the NRR, which detailed why the heavy redactions were not aligned with the PAIA and why it was important for the missing information to be released into the public domain (Koeberg Alert Alliance 2023a). Finally, in September 2023, the threat of legal action forced Eskom to release most of the previously redacted information (Koeberg Alert Alliance 2023b). While three sections in one of the reports remained redacted—due, according to Eskom, to concerns about the physical security arrangements at Koeberg, third-party information, and the personal details of non-Eskom employees being jeopardised—more information did come to light (Matavire 2023b).

Last but not least, analysts and activists had concerns about another controversial issue. A Heinrich Boll Foundation research report compared Koeberg's LTO with LTOs at similar Generation-II pressurised water reactors (PWRs) at French nuclear power stations. The French nuclear regulator insisted that all Generation-II reactors in France undergoing LTO

projects should be upgraded, in line with the new safety requirements, to comply with modern safety standards. This involved three main safety improvements. First, all reactors undergoing LTO had to be better able to control and mitigate extreme hazards such as fire, explosion, flooding, and earthquakes. Second, "the safety of spent fuel storage pools needs to be improved". And third, core catchers had to be retrofitted to mitigate the consequences of a core meltdown. The French also applied additional regulatory safety standards, such as that integrated leak tests should be conducted on reactor containment buildings every five years "to ensure they will not leak radioactive material and gases if the reactor vessel is breaching during an accident" (Overy 2024). Integrated leak tests should be undertaken every five years. Also, the licences for Generation-II PWRs in France would only be extended for 10 years. Thereafter, a comprehensive safety, ageing, and materials assessment would be conducted on each PWR (Overy 2024).

In the case of Koeberg, Eskom merely declared, contrary to the opinion of Framatome, that Generation-II safety standards are adequate. The NNR did not challenge Eskom's stance and did not insist on the retrofitting of core catchers at Koeberg, despite these being regarded as critical to the safety of commercial nuclear reactors in other parts of the world. Furthermore, in contrast to the French reactors, integrated leak tests would be undertaken only every 10 years at Koeberg, meaning that, following the last test in 2015, the next test would only be in 2025, after the NNR had either made its decision about renewing Eskom's licence or closed down the plant due to the lapse of its licence in 2024. Moreover, Eskom was asking for a 20-year LTO licence extension, as opposed to the French reactors' 10-year LTO licence extensions (Overy 2024). This was a significant cause for concern given the issues related to the cracks in the reactor containment structures.

6.6 Conclusion

It is clear from the above discussion that the Koeberg nuclear power station has been shrouded in controversy in recent years. Despite a good safety track record over its 40-year

operation, the LTO project has been the very definition of crisis management. Poor planning, consistent blunders by both Eskom and Framatome, human errors, financial disaster, load-shedding, persistent safety concerns, delayed reports, a fuel contract that lapsed, a very worrisome 110 m crack in a reactor containment structure, and admitted leaks, *inter alia*, leave one questioning whether Koeberg is a ticking nuclear time-bomb. The foregoing discussion certainly leans towards the reality that conditions conducive to disaster exist. As aptly pointed out by Taylor (2003), "the IAEA [had] serious safety concerns. Eskom [was] under tremendous political pressure to finish the LTO. A dangerous culture of secrecy prevent[ed] scrutiny. And experienced employees [were] leaving in droves." In addition, the project overrun costs significantly exceeded the R20 billion that was initially foreseen, massively exacerbated by two enormous penalties that the courts awarded to Framatome.

The substantial delays in the critical Koeberg life-extension project could be blamed on several serious blunders and delays by Eskom and Framatome and on the NNR dragging its feet about the licensing renewal. Despite all the delays, however, the IAEA expressed satisfaction with the progress made in ageing management at Koeberg, and in July 2024, Unit 1's licence was extended to 2044. In addition, the LTO for Unit 2 was completed by the end of 2024 and successfully synchronised with the national grid (ESI Africa 2025). This progress signified an important milestone in the Generation Operation Recovery Plan (Arnoldi 2024), restoring approximately 5% of South Africa's total electricity to the grid for the foreseeable future and contributing to Eskom's goal of increasing its generation capacity by 2,500 MW by March 2032 (ESI Africa 2025).

Ultimately, though, one is left with the question of whether South Africa really needed Koeberg's life to be extended by another 20 years, given the persistent safety concerns and the haphazard handling of the LTO project. There is a tendency to think that South Africa would be plunged into much worse load-shedding or even a national blackout were Koeberg to be decommissioned and that it would adversely affect the city of Cape Town, but as the CSIR shows in a 2023 study, the national

grid can run without Koeberg, especially given the increased renewable energy penetrating the grid. Also, Eskom has indicated that the Western Cape has electricity stability without Koeberg (Kemp 2023; Koeberg Alert Alliance 2023b). Despite these concerns, what the successful LTO has done is fostered new optimism for the State's plans to add nuclear energy capacity to the goal of 2,500 additional MW of power after 2030 (DMRE, 2024). Among other things, investigations have been launched into rolling out small modular nuclear reactors at old coal power stations (Omarjee, 2024b), reviving the Pebble Bed Modular Reactor programme, and embarking on new builds (World Nuclear News 2024). However, widespread pessimism and concerns persist. As voiced by Professor of Physics, Hartmut Winkler: if the "much smaller and far more straightforward" Koeberg upgrade has not gone well, how would the sector fare with a large fleet of new nuclear plants, which they ambitiously advocate for? (Winkler 2022). Only time will tell.

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