Review of Impact Factors on Decommissioning Strategies

Taesik Yun, Hyejin Jung, Younggook Kim *
Decommissioning Technology Team, Central Research Institute, KHNP
70, Yuseong-daero 1312beon-gil, Yuseong-gu, Daejeon, 34101, Korea
**Corresponding author: kim.090909@khnp.co.kr*

1. INTRODUCTION

In respond to the Korean government's decision in June 2015 of the permanent shut-down of Kori-1 nuclear power plant, Kori-1 unit will be the first commercial nuclear power plant being decommissioned in Korea, which has generated the capacity of 576 MWe electricity capacities since 1978, plus a refurbishment for 10-year continued operation. This article is prepared to factor out decommissioning strategies mostly appropriate to the decommissioning Kori-1 nuclear power plant.

Terms used to delineate the lifetime of an authorized facility and of the associated licensing process consists of six core stages such as siting, design, construction, commissioning, operation and decommissioning. The term decommissioning implies the administrative and technical actions taken to allow the removal of some or all of the regulatory controls from a facility except for the part of a disposal facility in which the radioactive waste is emplaced [1]. Whole range of each process of decommissioning should be considered throughout the other five stages. The decommissioning process is typically composed of its planning, conducting actions and terminating the authorization.

2. DECOMMISSIONING STRATEGY

In order to accomplish successful decommissioning, strategies for decommissioning adopted should be the essential element. Normally, immediate dismantling and deferred dismantling are suggested as the principle consideration for the decommissioning applicable for all nuclear related facilities [1, 2].

Immediate dismantling could be apt to the case that decommissioning actions begin shortly after the permanent shutdown. Equipment and structures, systems and components (SSCs) of a facility containing radioactive material are removed and/or decontaminated to a level that permits the facility to be released from regulatory control for unrestricted /restricted use on its future use. On the other hand, deferred dismantling is an alternative to apply to the case that after removal of the nuclear fuel from the facility, all or part of a facility containing radioactive material is either processed or placed in a safe storage and the facility maintained until it is subsequently decontaminated and/or dismantled. A combination of these two strategies may be considered practicable under the circumstance not to violate safety and environmental requirements, technical availability, local conditions. Entombment is not an option in the case of planned permanent shutdown. It might be considered only under exceptional circumstances such as the Fukushima event [3]. The table 1 shows the status of nuclear power shut-down in USA as of January 2016.

Table 1. Shutdown nuclear power in USA

Country	Name	Type	Gross electrical capacity	Decommissioning status
United States	Big Rock Point	BWR	71 MW	ISFSI only
	BONUS	BWR	18 MW	Entombed
	Crystal River-3	PWR	890 MW	Deferred
	Carolinas-Virginia Tube Reactor	PHWR	19 MW	Licence terminated
	Dresden-1	BWR	207 MW	Deferred
	Elk River	BWR	24 MW	Licence terminated
	Fermi-1	FBR	65 MW	Deferred
	Fort St. Vrain	HTGR	342 MW	ISFSI only
	Haddam Neck	PWR	603 MW	ISFSI only
	Hallam	EGSR	84 MW	Entombed
	Humboldt Bay	BWR	65 MW	Deferred 30 years
	Indian Point-1	PWR	277 MW	Deferred
	Kewaunee	PWR	595 MW	Deferred
	Lacrosse	BWR	55 MW	Deferred
	Maine Yankee	PWR	900 MW	ISFSI only
	Millstone-1	BWR	684 MW	Deferred
	Nuclear Ship Savannah	PWR	Naval	Deferred
	Pathfinder	BWR	63 MW	Licence terminated
	Peach Bottom-1	HTGR	42 MW	Deferred
	Piqua	EOMR	12 MW	Entombed
	Rancho Seco-1	PWR	917 MW	ISFSI only
	San Onofre-1	PWR	456 MW	Deferred
	San Onofre-2 and 3	PWR	2 x 1 127 MW	Deferred
	Saxton	PWR	3 MW	Licence terminated
	Shippingport	PWR	68 MW	Licence terminated
	Shoreham	BWR	849 MW	Licence terminated
	Three Mile Island-2	PWR	959 MW	Deferred
	Trojan	PWR	1 155 MW	ISFSI only
	Vallecitos	BWR	24 MW	Deferred
	Vermont Yankee	BWR	535 MW	Deferred
	Yankee NPS (Rowe)	PWR	180 MW	ISFSI only
	Zion-1 and 2	PWR	2 x 1 085 MW	Deferred 15 years

AGR – Advanced gas reactor; BWR – Boiling water reactor; EGSR – Experimental graphite-sodium reactor; EOMR – Experimental organic moderated reactor; FBR – Fast breeder reactor; GCR – Gas-cooled reactor; HTGR – High temperature gas reactor; HWGCR – Heavy water gas-cooled reactor; ISFSI – Independent spent fuel storage installations; LWGR – Light water graphite reactor; PHWR – Pressurised heavy water reactor; PWR – Pressurised water reactors; SGHWR – Steam generating heavy water reactor.

source: NEA No. 7201, (OECD, 2016)

3. IMPACT FACTORS ON STRATEGY [2]

3.1 Legislative and regulatory requirements

Each single countries having nuclear power plants under construction or in operation or in consideration of decommissioning has different regulations governing decommissioning strategies. For instance, the US Nuclear Regulatory Commission (NRC) limits the safe enclosure period up to 60 years, UK, however, allows dismantling to be delayed for Magnox reactors and for them to be kept in a safe enclosure mode for more than 100 years. Such a long period allows levels of radioactive decay so that workers could work on a Magnox reactor without limitation, and also allows the accumulation of decommissioning funds. However, this policy is being reconsidered.

From the perspective of responsibility, a facility's operator has the primary responsibility for all technical and financial measures except for the disposal of radioactive waste which is under the supervision of national regulatory bodies or national agencies.

3.2 National waste management strategies

The most crucial regulatory requirements are related to clearance criteria. International recommendations for exemption and clearance have been issued by IAEA and European commission. These specify radiological concentrations below which material can be considered to be non-radioactive and released from regulatory control. Such protocols are now established in many countries such as Germany, UK, USA, South Korea etc. Each nation has its specific policy to operate disposable sites and facilities.

3.3 National spent fuel management strategies

Experience shows that spent fuel management strategies can be a strong impact factor on the selection of a decommissioning strategy. When facilities to store, dispose of or reprocess are not be readily available, the fuel must remain in the reactor facility. It is the common strategy in the USA that a few nuclear facilities have been fully dismantled with spent fuel stored at the nearby independent facilities. Some cooled water moderated power reactor(WWER) operators such as Paks, Dukovany, and Mochovce) have built on-site wet and dry interim storage facilities. On the other hand, a great deal amount of spent fuel is transferred from Central and Eastern Europe reactors to the Russian Federation for reprocessing.

3.4 Future use of site

An alternative of decommissioning strategy would rely on the planned future use of the site. In case of lacking of sites for new plant construction, the owner may choose to reuse a site for a new plant. In this case, immediate dismantling may be the good choice. If the plant to be decommissioned is in the multi-plant site, safe enclosure may be the preferred choice. In this case, the necessary security, surveillance and maintenance for the shutdown facility could be provided by the remaining operating facilities. The examples of reuse of the sites decommissioned are such that the turbine building of a decommissioned plant was reused for a fossil fired plant (Fort, St. Vrain, USA), the chinon-1 nuclear power plant in France was converted into a museum, Part of the Greifswald nuclear power plant in Germany is being converted into a biodiesel production facility.

3.5 Radiological factors

While the remaining residual radioactive will present smaller risks compared to that of an operating reactor, it should be taken good care for the workers, the public and the environment during decommissioning. Currently technological breakthroughs in electronics, robotics and remote handling have considerably reduced the hands-on works to highly contaminated area. Hence, it has set aside the importance of radiological factors in selecting a decommissioning strategy.

3.6 Availability of technology and other resources

In general, decommissioning technology is more available in countries with much experience. Such countries have both expertise and experience related to their nuclear technologies and resources In this sense, technology setting is also one of the important factor to perform a decommissioning.

3.7 Stakeholder considerations

Due to widespread heightened public sensitivity to environmental protection, any waste management or decommissioning decision will typically require thorough public examination and the involvement of many stakeholders. The diversity of relevant social, political, economic, and cultural environments makes it difficult to develop universally applicable guidance. However, we have to find in the experience of other good practices that can be adapted to our own project.

3.8 Decommissioning cost and funding

Whatever choice and decisions are made, it is the responsibility of the plant owner to make financial provisions sufficient to cover the cost of all stages of decommissioning in accordance with pertinent national legislation and funding requirements. Korea has established legal provisions to decommission Kori-1 and accumulate appropriate liability for the reaming facilities.

3.9 Knowledge management and relevant industry nurturing

The policy to acquire and maintain all records and to nurture the relevant industry should be given emphasis from the earliest stage of its life cycle.

4. CONCLUSION

Technically, decommissioning is a mature industry; many steps and processes are similar to maintenance, storage, and transport procedures experienced during the operation. However, to minimize hazardous and radioactive materials as much as possible produced in process of decommissioning should be the focused issue for the protection of workers, the public and the environment. In order to achieve the successful decommissioning, the impact factor on the strategy should be analyzed and evaluated to optimally apply to Kori-1 project. From my perspective, among eight factor, stakeholder’s consideration and spent fuel management are considered the key elements we have to concentrate on to smoothly go ahead for successful decommissioning of Kori-1.

REFERENCES

[1] ASME(2004), “The decommissioning handbook”.
[2] IAEA(2005), “ Selection of decommissioning strategies: Issues and factors, IAEA-TECDOC-1478

[3] Daniel et. al (1986), “Guideline for producing commercial nuclear power plant decommissioning cost estimates”, AIF/NESP-036