Facts and Lessons of the Fukushima Nuclear Accident

On April 23rd, 2012, Mr Kimitoshi Yahagi of the Tokyo Electric Power Company made a presentation at the University of Johannesburg on the Fukushima nuclear accident. Mr Yahagi experienced the accident first-hand, staying at the site during days 2-8 of the unfolding disaster. The transcript of his presentation follows.

The Nuclear Industry Association of South Africa (NIASA), in collaboration with the Embassy of Japan in South Africa, organised a public lecture on Fukushima at the University of Johannesburg on the 23rd of April 2012. Mr Kimitoshi Yahagi, General Manager in the Nuclear Power and Plant Siting Administrative Department of the Tokyo Electric Power Company, presented a lecture and slide show entitled 'Facts and Lessons of the Fukushima Nuclear Accident – Operator Viewpoint from Tokyo Electric Power Company.'

Mr Yahagi noted that Fukushima Daiichi nuclear power station (1F) was fatally damaged by the 2011 tsunami, while Fukushima Daini (2F) was seriously damaged, but the situation was eventually brought under control. Daiichi means 'Number one' and Daini 'Number two' in Japanese. The two nuclear plants are situated 12 kilometres apart on the Fukushima coastline. Both use boiling water reactor (BWR) type technology.

A combination of factors caused a more serious outcome at Fukushima Daiichi, where three of the plant's nuclear reactors were operating at the time of the quake, while the remaining three were closed for maintenance. All four Fukushima Daini reactors were operating when the earthquake struck. The main factors influencing the different outcome between the two power stations were the height and intensity of the tsunami at the point of impact, the design of the two facilities, the extent of flooding and the ability to maintain emergency power supply.

The seven nuclear reactors at Fukushima 1F and 2F shut down automatically after the earthquake, which caused numerous tsunamis of various magnitudes. The peaks of these tsunamis coincided at 1F, resulting in a higher tsunami that caused extensive flooding and inundated the power station with water heights of between 11.5 and 15.5 metres, while the facility was designed to withstand a maximum 5.7 metre high tsunami. The lower tsunami at 2F, where the peaks did not coincide, caused more limited flooding with inundation of between 7 and 7.5 metres, while this facility was built to withstand a 5.2 metre high tsunami.

Extensive flooding at 1F damaged major buildings and destroyed the sea water cooling system whose function was to remove residual heat produced in the nuclear reactors. The tsunami also cut the off-site power supply to 1F resulting in station black-out, the inoperability of instrumentation and safety systems and diminished contact with the emergency response room situated outside the main buildings that house the reactors.

Workers faced harrowing conditions including darkness, aftershocks, open manholes, water puddles, debris and a series of hydrogen explosions. They wore face masks with flashlights to monitor instruments, while staff car batteries were connected to provide temporary power. The hydrogen explosions interrupted early attempts to connect portable engine generators. Once mobile power was restored, the urgent task was to cool the reactors to prevent a nuclear meltdown. In 1F's unit 1, damaged fuel had fallen to the bottom of the reactor pressure vessel (RPV) and caused a core concrete reaction.

Early attempts to use a diesel-driven fire protection pump to inject fresh water failed because of mechanical problems, flooding and high pressure in the RPVs. Fresh water lines had been damaged during the earthquake and fresh water supply from an underground water tank did

not last for long. Later, permission was given to use fire engine pumps to inject seawater. Helicopters were also used to drop water onto the reactors. Heat exchangers were later used to stabilise temperatures in the accumulated water pools.

Nine months after the earthquake, on December 16th 2011, Japanese Prime Minister Yoshihiko Noda announced Fukushima Daiichi had achieved a condition equivalent to 'cold shutdown', thereby ending the accident phase of the disaster. The decommissioning of Units 1 to 4 at 1F is expected to take up to 40 years and will occur in three phases. The main targets are removing fuel from the four used fuel pools, removing melted fuel from the three damaged reactor cores and the final demolition of the reactor facilities.

At Fukushima Daini, damage to the emergency core cooling systems at three of the four nuclear reactors had led to the announcement of emergency status. However, power supply was maintained and a secondary cooling system was used to maintain cooling while the emergency core cooling systems were restored within three days. By March 15th, all four of 2F's reactors had achieved cold shutdown without any radioactive leakage. The emergency declaration at 2F was lifted in December 2011.

In closing Mr Yahagi noted that Tepco had learned a number of lessons from Fukushima and the utility was beefing up preventive measures as a result. These include constructing a seaside embankment to halt tsunamis; installing barriers and watertight doors for nuclear reactor buildings; providing backup mobile power plants, fresh water supplies and fire engines; and ensuring critical equipment is stored in a safe place on higher level ground.
