Assessment of Decommissioning Strategies

Michele Laraia, former IAEA Unit Leader on Nuclear Decommissioning, consultant michele.laraia@aon.at
OUTLINE

• Factors relevant to formulation of a decommissioning strategy (economic, technical, national policy, others)
• Overview of typical decommissioning strategies for large nuclear facilities
• Historical evolution of relevant factors and decommissioning strategies
• Current status and trends
Two prevailing strategies: immediate or deferred dismantling

(in-situ disposal being re-considered in some countries for special cases)
Stigma on entombment being gradually lifted: P-reactor, Savannah River Site, USA
In a deferred dismantling strategy, typical variants relate to safe enclosure duration (short 10-20 years; medium 40-50 years; longer times) or extent of partial dismantling prior to safe enclosure.
Main strategic criteria:

- radiological factors
- waste management and disposal incl clearance
- financial resources and funding
- land use
- public opinion
- regulations dictating strategy
- “ethical” factors
Other strategic factors:

- interactions with other national nuclear programmes
- experience & expertise
- R&D and technological spin-off
- project complexities
Radiological factors

- in light-water reactors, dose rates level off at a 40-50 years’ deferral time
- longer-lived isotopes (fission products from reactor fuel failures, NFC facilities)
- lower occupational doses in research reactors making deferral unnecessary
- remote operation to reduce doses in immediate dismantling
- man-Sv savings as a strategy factor

- safety and radiological protection aspects (e.g. occupational exposures) not a decisive factor in selecting a strategy due to technological progress in remote operation and robotics
Financial resources and funding

- funding mechanisms in place in many countries now (practical implementation difficult in some e.g. CEE)
- long term assurance, financial crises
- premature shutdown still an open issue
- cost uncertainties
- Total normalized costs for immediate or deferred dismantling the same order of magnitude, but cash flows different
Waste management and disposal incl clearance

- difficulties in siting new disposal facilities (regional sites ?)
- repatriation of spent fuel
- SF and HLW repositories (Yucca Mountain ?), onsite SF storage plants (US NPPs)
- escalating waste disposal costs
- VLLW
- onsite storage now accepted if disposal not available (German reactors)
- intact management of large components
Arguments for Greifswald NPP to pursue immediate dismantling

- Economically depressed area (former East Germany): need to reduce unemployment
- Start of decommissioning project with RW disposal site available (later on closed)
- Funds from Government (no previous funding mechanism)
- Expertise available in (former) West Germany incl full set of regulations
- Plant design not conducive to safe enclosure (lack of secondary containment)
• Problematic materials (e.g. graphite, asbestos)
• International clearance criteria promulgated by IAEA and EU, but national criteria still prevailing
• Decommissioning waste volumes, burden on existing repositories > VLLW sites (France, Spain etc)
• Pressure to reduce decommissioning waste generation – see use of smelting/recycling facilities (e.g. Studsvik Sweden for UK generated waste)
Vandellos Safestore: the safe enclosure strategy was determined by the lack of disposal options for graphite.

Another Spanish NPP, Jose Cabrera, being immediately dismantled after shutdown.
Land reuse

- successful achievements (ORNL, research reactors)
- deferred decommissioning at multi-unit sites (Dresden, USA; Gundremmingen, Germany etc)
- land at a premium (Japan)
- site conversion (e.g. gas-fired plants)
- Land reuse not a decisive factor now, bound to become more and more important
Fort St Vrain NPP, USA. Turbine building - slightly contaminated - reused for fossil-fuelled plant
Experience and expertise

- Generally available in industrialized countries, based on D&D of smaller or prototype facilities
- In less developed countries, international market can support local efforts (e.g. through the IAEA or EC)
- In some countries, full reliance on contractors is the rule; in others, D&D is still conducted mainly with plant resources. A mix of operational staff and contractors seems ideal in many cases.
Retention of key staff for decommissioning

According to the survey, retention is helped by training and money...there's no mention of chaining staff to their desks.
Public opinion

• generally favours early dismantling
• an important stakeholder in many countries
R&D much reduced against the 1990s: underground monitor, Czech R. D&D tools generally available off-shelf – with some adaptations.
Knowledge management. Don’t wait too long !!!
Availability of operational staff as key factor militating against deferred D&D
Regulations dictating strategy

- prescriptive regulations (Japan, USA) or
- evaluation of alternatives required; or
- case by case approach
Ethical factors

• “moral suasion” for early dismantling in some countries (based on international principles against placing the burden on future generations)
Selection of a decommissioning strategy

- Cost-benefit analysis (man-Sv for money?)
- Multi-attribute analysis
- Overwhelming factors more likely to decide
- Transparency
Strategy trends

• technologies generally available. The “decommissioning market “.
• early dismantling or shorter periods of safe enclosure prevail in some countries
• trends often based on country-specific factors (e.g. waste disposal costs)
• funding as major factor against early dismantling in less developed countries
Funds appear to be sufficient. The Zion NPP case.

Incremental decommissioning being pursued in some countries when funds are allocated piecemeal. Not ideal for staff and money optimization. Inevitable in some circumstances (Vinca; UK)
Strategy trends (cont’d)

- fewer NPPs will be decommissioned in the near future due to life extension policies. A number of research reactors and NFC facilities to be decommissioned or extensively refurbished soon.

- no clear global trend in decommissioning strategies (50:50 immediate vs. deferred D&D). However, a trend towards accelerated decommissioning (France, Italy) or shorter periods of safe enclosure (UK) seems clear.
Nuclear Power Reactors having completed their decommissioning process

- (1) HDR Grosswelzheim, Germany
- (2) Niederaichbach (KKN), Germany
- (3) VAK, Kahl, Germany
- (4) JPDR, Japan
- (5) Big Rock Point, USA
- (6) Elk River, USA
- (7) Fort St Vrain, USA
- (8) Haddam Neck, USA
- (9) Maine Yankee, USA
- (10) Pathfinder, USA
- (11) Rancho Seco, USA
- (12) Saxton, USA
- (13) Shippingport, USA
- (14) Shoreham, USA
- (15) Trojan, USA
- (16) Yankee Rowe, USA
- (17) Windscale AGR, UK
- (18) Lucens, Switzerland
At the end of 2014, 150 power reactors had been shut down. In total, 18 reactors had been fully dismantled, 50 were in the process of being dismantled, 60 were being kept in a safe enclosure mode or are awaiting commencement of final dismantling, 3 were entombed, and, for all others decommissioning strategies had not yet been specified.
IAEA and NEA references

- IAEA, Selection of decommissioning strategies: issues and factors, TECDOC-1478, 2005
THE PERFECT DECOMMISSIONING !!!!

Many thanks for your attention !!!!

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