Decommissioning Nuclear Plants : Future Big Business

by M R Venkatesh

DECOMMISSIONING nuclear power stations (NPS) will take longer than building reactors, but is poised to become a big business for the nuclear industry in the years to come.

With over a score nuclear power reactors in different countries now under various stages of decommissioning that can span over five decades, there is a proliferation of in-depth studies on decommissioning NPS, with respect to safety, modes of disassembly, waste disposal methods and, above all, costs.

According to Mr LV Krishnan, who heads the safety research and health physics programme at the Indira Gandhi Centre for Atomic Research (IGCAR), Kalpakkam, about 60 km south of Madras, given current levels of technological tooling and innovation, dismantling a reactor that has been operating normally poses little problems.

Decommissioning becomes problematic only in reactors that have been affected by accidents, such as those at Chernobyl in the USSR, and at the Three Mile Island (TMI) in the United States.

While at Chernobyl, the affected reactor has been completely entombed, at TMI, the authorities cleared up those parts of the NPS zone outside the 'Biological Shield' (comprising the concrete structure within which the reactor vessel is housed) recently.

Already enormous volumes of literature on various models of decommissioning reactors have been generated from experience with regard to various reactors world-wide.

For purposes of decommissioning, the NPS is classified into three zones. Zone I refers to the inside 'concrete biological shield' of the reactor, Zone II to the plant and structures outside the 'biological shield' but containing radioactive material as in the pumps, pipework, control system parts, and fuel storage pool, and Zone III comprises the non-radioactive parts like the sea-water system, and transformers.

The decommissioning of an NPS is itself phased out in three stages with varying time spans, Mr Krishnan said. In stage I of decommissioning, which could go upto five years, the fuel, in which the bulk of the radioactive material in any NPS is contained, is taken out of the reactor core entirely, and sent away to the reprocessing plant.

Likewise, in the first stage, the coolant heavy water (in the case of heavy water reactors such as at Kalpakkam), is also drained for purification and reuse. The inventory of the radioactive material in the station is thus drastically reduced. While Zone I is kept under surveillance, all accessible radioactive materials in an around the reactor building are removed and the non-radioactive parts in Zone III are also cleared, he said.

In the second stage of decommissioning, which could run to another five years, the components and equipment in Zone II, such as steam generators, pipework, valves and pumps, which are likely to have some radioactive deposits settle on them, are removed using well-tested chemical treatment means, Mr Krishnan said.

The stage is then set for the third and final phase of decommissioning, namely disassembling the reactor vessel itself. Most of the radioactivity in the reactor vessel is due to Cobalt-60, which has a half-life of about five years. Hence, most of the radioactivity in the reactor vessel would come down a thousand to a million fold in 50 or 100 years respectively.

Thus, if the removal of the reactor vessel and concrete block around it is deferred for about 50 years, during which time there is very little possibility of this radioactive material appearing in the environment, it would be possible to take advantage of a substantial reduction in radiation levels, Mr Krishnan said.

Under-water plasma cutting devices could be used to break up the larger vessel into smaller parts to facilitate handling and disposal, he said. The concrete wall of the biological shield could be cut through with 'water jets' and the water prevents any dust from getting air-borne.

The water used in the dismantling operation could be collected, purified and disposed off safely. The technology for all this is already available today and "there is nothing to be developed ab-initio", Mr Krishnan emphasised.

At present, the Shippingport plant (pressurised water reactor of 90 mwe capacity) in the United States, is the first commercial-size nuclear power plants to be safely and cost-effectively dismantled completely down to the third stage. Another reactor in the US at Elk River site and one in Germany at Niederaichbach have reached the third stage of decommissioning.

Giving details of other nuclear power reactors in different stages of decommissioning, Mr Krishnan said that in the category of less than 100 mwe capacity reactors, two French, two German and one American and Swedish reactors are in the first stage of decommissioning. In the second stage of decommissioning in this category are two reactors in the US, and one each in Switzerland and Germany.

In the 100-500 mwe capacity range, three reactors in France, and one each in Germany and the US are in the first stage of decommissioning, while two other reactors are in stage II of dismantling, he said.

Tree reactors, with over 500 mwe capacity in Canada, Italy and Germany are through the first stage decommissioning.

A recent study shows that by the year 2000, the United Kingdom will have 25 power reactors which will be 30 years old and at the end of their working lives. This represents some billions of pounds worth of work for companies with the expertise and experience to undertake decommissioning projects.

In India, not even the first NPS at Tarapur in Bombay is anywhere near the decommissioning stage, normally reached after 25 to 30 years of operation, Mr Krishnan said.

World experience in decommissioning shows that the cost is not prohibitive and "is well within control."

Decommissioning cost estimates in many countries work out to about 15 per cent of the initial construction cost of the reactors.

Studies in Germany have demonstrated that there is no need "either to dismantle a plant immediately after it has been shut down or to decide in greater detail at the present time upon the steps to be taken when decommissioning becomes necessary."

Such decisions, according to the German studies, must not be made until plants are about to be decommissioned and techniques which well be available at that time could be used. The decision at the decommissioning time will have to be based on economic and energy policy aspects and will be influenced chiefly by "the intended further use of the site, namely, whether immediate demolition is necessary because a new power plant is to be built, or whether radiation protection reasons allow demolition at a later date to be chosen as the preferred alternative."

— PTI Science Service

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Car Makers Unveil New Models

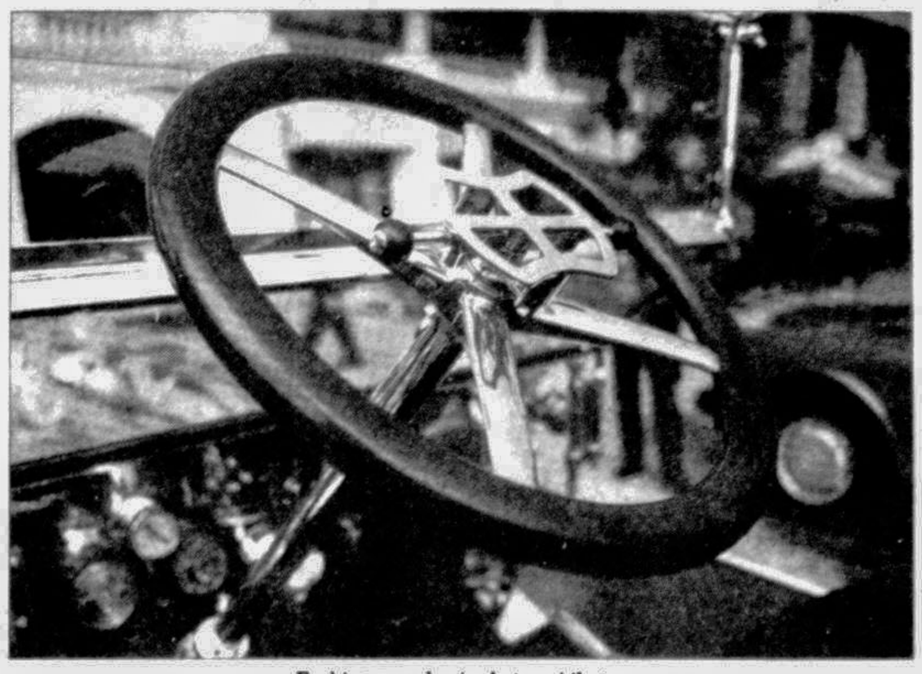
OPTIMISM prevails among management in the automobile industry, the Gulf crisis notwithstanding. Demand worldwide is booming, and most car plants report incoming orders in autumn 1990 to be higher than the levels of the previous year, according to the influential economic-affairs weekly "Wirtschaftswoche". Both the plants of Adam Opel AG in Russelsheim (near Frankfurt/Main) and of Volkswagen report rising sales figures. Volkswagen is even running overtime shifts as the German auto industry basks in the strong demand coming from the former GDR.

In Munich, BMW unveiled the new 850i, a luxury-class sports car. The vehicle boasts a 12-cylinder motor with piston displacement of 5,000 ccm and an electronically limited top speed of 250 kilometers per hour (155 mph). BMW is now investing an initial 100 million German Marks in the construction of a new assembly plant in Eisenach (Thuringia), where the firm once (prior to 1945) had the company division "Eisenach".

In October, Volkswagen will present new versions of the Polo: the Fox, CL, and GT will reveal a two-door vehicle in the coupe and hatchback versions (suitable for small transports).

Ford will then follow with the new Escort and Orion, featuring the latest motor and transmission technology in addition to new chassis. They will also go through an exceptionally stringent "quality-control procedure", the Ford management in Cologne under-scored. It all makes for a very exciting motoring autumn in Germany.

(IN-Press)



Fashion recycles in Automobile too

Taiwan's Advancement in Aerospace

by Alan Chalkley

THE world's aerospace industry was shaken up recently by the unexpected entry of a new contender in the high-tech firmament — Taiwan.

A company formed only last October in an industry of which the country has hitherto little experience is taking a 40 per cent stake in the civil aircraft operations of McDonnell Douglas of the United States.

The company is called Taiwan Aerospace and is headed by David Huang Hsiao-tsung, who was a senior engineer for 22 years with Rockwell International, America's military systems maker.

A first, Taiwan will manufacture fuselages and wings for McDonnell Douglas's new MD-12 jetliner model. But in view of the huge investment, amounting to as much as US$2 billion, it is obvious that Taiwan plans eventually to play a much larger role in world aircraft (and perhaps even satellite) development.

Some doubts have arisen among observers as to the viability of the project. But there are also reasons for viewing it optimistically — for instance:

Taiwan has the world's largest foreign reserves (about US$75 billion) and the investment is more than amply covered by those overwhelming exchange holdings.

The component sales to the US parent company alone could generate nearly US$200 million a year (a 10 per cent gross return).

The country's people are already highly experienced in large manufacturing operations, in electronics, plastics, shipbreaking and building steel and metalware, machinery, textiles, leatherware and toys.

Most interesting is this : the three big US satellite-throwing rocket-makers are Martin Marietta, General Dynamics and — McDonnell Douglas. It makes one wonder exactly what may be going on in Taiwan's science city very soon

The 8.5 million labour forces is based on a literacy rate of 92 per cent. Life expectancy is a healthy 70-plus years while Taiwan has a low population growth.

A "science city" and industrial park, equipped with state-of-the-art gadgetry, was founded in 1980. Over 125 high-tech companies are located there, partly based on government-assisted venture funds.

Why, therefore, do doubts persist? This is what the pessimists say: McDonnell Douglas (MD) comes a bad third in the world's makers of large civil aircraft (Boeing leads by a mile, then comes the European Airbus Industries consortium, then MD, and a fourth company, Lockheed, has now given up competing). Boeing complains bitterly that Airbus is heavily subsidised by its owner-governments, and the consortium has in fact piled up massive losses over the years.

Britain's own Aerospace company has rarely prospered: it had to offer a distress issue of capital fights recently. Giant aircraft can lose money fast.

MD itself is financially troubled, with a debt load estimated at US$2.7 billion. But perhaps the infusion of Taiwan capital will give the company some breathing space. MD keeps all of its military aerospace operations separate from the Taiwan deal — but even there, as the US cuts back on defence spending, there may well be some shrinkage in those orders.

The Douglas name goes back into the earliest days of aviation, and one of its models made civil and military history. For four decades the DC3 (or "Dakota") was flown in thousands all over the skies of the globe.

Many post-1945 airlines began with a second-hand DC3 or two (Cathay Pacific among them). You will still find these rugged old machines being used as small commuter and cargo carriers in the less-developed regions of the world.

The last wide-body DC was the DC10, and a new series of freshly designed machines is now being developed under the MD prefix, such as the wide-body MD11.

You have to give McDonnell Douglas credit for adventurous ideas — in 1985 it entered a joint venture with the Chinese government aircraft corporation to build MD82's in Shanghai.

The last 25 of these rolled out recently. But the scheme is being extended, to make MD82's for China's airlines, MD83's for the US, and a 150-machine batch of smaller MD95's for global sale.

Thus a giant battle for a whole range of jetliners is arising. Boeing's latest offer is its 375-seat 777, for which it already has 140 orders and options, and which is set to fly in 1994-95. Boeing says the world's airlines will need nearly 9,000 new aircraft by the turn of the century.

The interesting thing is that about 60 per cent of these machines will be sold in Asia. Long-haul routes between Europe and Asia alone will grow at over 12 per cent a year for some time, says Boeing.

Here in Asia things are very different. Korean Air is expanding its fleet from 67 aircraft to 114 by the end of the century. Singapore Airlines has 50 "Megatops" (biggest of the Boeing jumbos) on order or option. Eight Asian lines have orders for Airbus long-range 340's.

This, however, is a bright spot in an otherwise dark picture elsewhere. The world's airlines together are facing massive losses on operations for two years in a row. Some US lines have disappeared (Eastern, Pan Am, TWA) and others are bankrupt or cutting costs sharply. Europe's airlines, mostly government-run, are running scared and seeking mergers.

This is what scientists call a "quantum jump" in technology, as Asian nations leap from fragmented primitive communications in much of its rural areas straight to the electronic pulse and digital networks. Indonesia, the world's largest and most scattered archipelago, could see that satellite was the only answer.

But most interesting is this fact: the three big US satellite-throwing rocket makers are Martin Marietta, General Dynamics — and McDonnell Douglas. It makes one wonder exactly what may be going on in Taiwan's science city very soon.

— (Depthnews Asia)

Delving Deep into Mysteries of Outer Space

by Dietrich Zimmermann

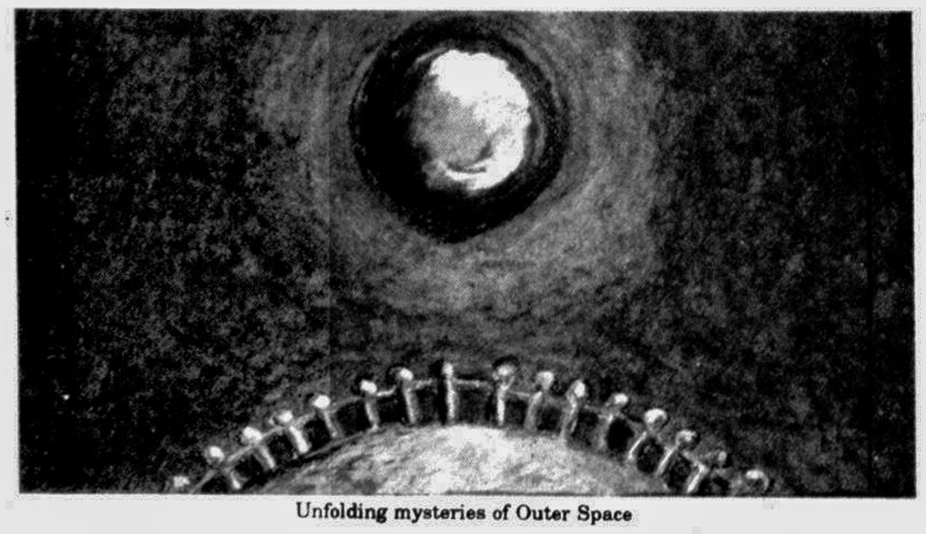
GERMAN Aerospace contributed significantly to the construction of the US space agency NASA's Gamma Ray Observatory GRO, which was carried into a 450 kilometer-high orbit by the space shuttle Atlantis to scan the universe. The two companies behind this name, Messerschmitt-Bolkow-Blohm Ltd (MBB) in Ottobrunn near Munich and Dornier Ltd in Friedrichshafen, are among the world's most productive manufacturers of satellites and space experiments.

Under the scientific supervision of the Max-Planck-Institut fur Extraterrestrische Physik (Max Planck Institute for Extraterrestrial Physics) in Garching near Munich, MBB developed and built the COMTEL experiment, weighing 1.5 tonnes, as well as the superstructure for the EGRET experiment, costing more than 60 million DM; Dornier's contribution to EGRET consisted of the electronics designed to detect interferences in radiation.

Gamma rays posses the shortest wavelength and, therefore, the highest energy in the electromagnetic spectrum. They range from just under one million electron volts (eV) up to several sextillion eV. Such high energies are only liberated when matter is disintegrated into radiation by nuclear forces. Indeed, gamma rays provide an insight into phenomena involving the release of huge amounts of energy, including quasars, pulsars, neutron stars, black holes and general processes which have played and still play a significant role in the origin and extinction of the universe.

High-energy gamma rays were first detected by EXPLORER XI in 1961. Subsequent missions like VELA, OSO 3 and OSO 7 revealed the existence of interesting gamma ray phenomena like the mysterious gamma bursts. In 1972 SAS-2 located about 30 gamma sources in the Milky Way, and in 1975 COS-B mapped the entire universe for the first time, registering more than 200,000 "events". The four experiments on the GRO will allow a unique, virtually complete survey of the extensive gamma ray spectrum.

High-energy gamma rays can neither be deflected nor bundled. Detecting and measuring them requires methods otherwise only common in elementary particle physics, where they are used to observe particles in large accelerators. Three of these modular experiments, each weighing a tonne or more, will be carried on board the raft-shaped GRO.



Unfolding mysteries of Outer Space

The fourth experiment BATSE comprises eight detectors which will be mounted at the eight corners of the satellite in order to scan the universe in all directions.

BATSE is responsible for low-energy gamma rays and also serves as a type of trigger. Upon registering an interesting gamma event like a burst, it will, if possible, also divert the attention of the other experiments to it. OSSE covers the spectrum between 100,000 and 10 million eV, which includes radioactive radiation. COMTEL is intended for the region between one and 30 million eV, while EGRET is designed to detect radiation energy ranging from 20 million to 30 billion eV.

The Imaging Compton Telescope, COMTEL in short, was built by MBB and is based on the Compton Effect: that is, interaction of gamma rays of a certain energy with electrons. When an electron is struck by a ray, it is deflected off its path. The energy transferred to it is radiated further in the form of a photon, while the attenuated gamma ray is deflected slightly off course. COMTEL is made up of two detection levels. The upper level consists of seven aluminium vessels filled with a hydrocarbon which serves as the detecting fluid. It is here that the Compton interaction takes place.

Each vessel is surrounded by eight photomultipliers which intercept and measure the energy of the photon resulting from the deflection of the electron. After travelling, about 1.5 metres, the slightly deflected gamma ray impinges on the second detection layer consisting of 14 cylindrical sodium iodide crystals and is absorbed by it. The light produced durfng this process is then intercepted and measured by the photomultipliers.

The energy of the gamma ray can be calculated from the sum of the energies captured at both levels. If there are sufficient events, the combination of the two levels at which interaction and absorption take place also allows a reasonably accurate determination of the location of the gamma source, with a highest possible accuracy of less than one degree. However, gamma rays are outnumbered by high and extremely high-energy "cosmic" particles.

In order to prevent these from distorting the results, the experiments are shielded by special plastic scintillators which indicate the motion of such particles past the detector, in which case the measurement in not registered. Such an anticoincidence system is of particular importance for EGRET.

The device has a height of 2.25 meters and a diameter of 1.6 meters. It is enclosed in a superstructure made of high-tensile aluminium which serves as a pressure vessel for the gas-filled spark chambers and also has a plastic coating which, by emitting flashes of light, is to indicate the presence of particle radiation which causes interference and leads to false measurements.

A prime example of forming technology, this seamless superstructure was manufactured at MBB; the specialists at Dornier supplied the electronics for registering and processing the flashes of light; a technological masterpiece, this system can carry out the above task in little more than a hundred millionth of a second.

Science Briefs

Thermoplastics from Wheat

Japanese researchers have developed a method for producing highly biodecomposable thermoplastics from the proteins in wheat (gluten), reports the journal *Techno Japan*.

The new method jointly developed by the Hyogo Prefectural Industrial Technology Center Nagata Sangyo and Dr Y Yamashita of Kyoto Institute of Technology adds glycerin and emulsified silicone oil to gluten, to impart thermoplastic nature and strenght to it.

The researchers are planning to commrcialise the process, considering that it can produce biodecomposable thermoplastics at a much lower cost than the microorganism-aided process.

The process is simple: powdered gluten, after being mixed with glycerin, glycol, emulsified silicone oil and urea, is dried and then pressed under heat. Gliadin and glutenin, the major components of gluten having bonded hydrogen and sulfur are solidified while dry.

These bonds, however, are weakened when exposed to water to form gaps, into which hydrophilic groups and hydrophobic molecules are introduced to impart thermoplasticity and strength to the gluten.

The treated gluten, after being dried, is pressed under a pressure of 150 kg per square metre into approximately 300 micrometres thick, semi-transparent sheets. It has been confirmed that these sheets are decomposed in four weeks when buried in soil.

The sulfur-free sheet is more resistant to decomposition, lasting an additional one to two weeks. The sheet containing glycerin and sulfur has a tensile strenght of 250 kg per square centimetre, sufficient for use in shopping bags. However, increasing the quantity of urea working as the pasticizer, decreases the tensile strength, the journal said.

New Rock Cracking Technique without Dynamite

A new rock cracking technique which does not require explosives has been invented in Sweden by Karl Gustaf Derman. The method is based on hydraulic pressure, reports the *Swedish International Press (SIP)*.

Oil is pumped into a specially designed expanding cartride, placed in a bore hole in the rock. Up to 80 per cent of all rocks crack before or at a pressure of 700 bar, but particularly solid or stubborn boulders may require additional cartridges, the company says.

The patented method, dubbed Dermanite, is marketed by Wstboenergi in Anderstorp in south Sweden. The company recommends the technique for farmers wanting to remove boulders from their land, for house owners wanting to remove a rock too close to house or for road workers who have to eliminate a roadside rock while traffic continues to flow.

The expanding cartridge is available in three sizes, the standard 30 cm unit, the short 20 cm cartridge and an extension cartridge of 30 cm. The standard cartridge develops an "cracking power" of 60 tons with the lowest pump-power force and up to 125 tons with the highest pump force.

The bore holes, measuring 32 mm in diameter, must not be deeper than 40 cm in order to obtain maximum pressure on the rock's outer layers. If the intended crack should exceed 70 cm or run in a specific direction the company recommends an additional bore hole.

The main pump has a maximum force of 750 bar, the normal one 1,000 bar and the largest 1,500 bar. Pressure exceeding these limits results in automatic closing of the valve with the oil returning to the tank. The largest pump has two pistons to do the job.

When the rock cracks the pump pressure immediately drops and the oil flows back into the tank. All the equipment, including hoses, is available in a kit packed in a sturdy box of sheet metal. The cost of the standard unit with three expanders is estimated at $2,040.

Electrodeless Lighting System

A Japanese company, Matsushita Electric Works Ltd, has developed a new type of lighting system that generates light with an electric blb having no filament nor any other lectrode.

With this new electrodeless discharge system, a high frequency magnetic field is impressed from outside a luminous body filled with mercury vapour or any other vapour by which an ultraviolet beam is generated inside to illuminate the fluorescent body.

The principle of this lighting system has long been known, but commercialising was delayed due to its radiation noise and poor efficiency, reports the journal *Science and Technology* in Japan.

The company linked the light-emitting nit and lighting circuit and incorporated a special radiation noise inhibition technique in the lighting circuit and circuit husing part. It also devised a means to enchance system efficiency which led to commercialisation of the world's first electrodeless lighting system.

The new system can be used for street lighting, especially lamp replacement is difficult. It can also be used an an underwater lamp and beacon lamp. It will be marketed this month under the brand name Everlight, the journal said.

The system enables substantial power savings, and its service life is about 40,000 h as compared to the 1000-2000 h of a conventional white incandescent lamp or the 5000-10,000 h of a fluorescent lamp.