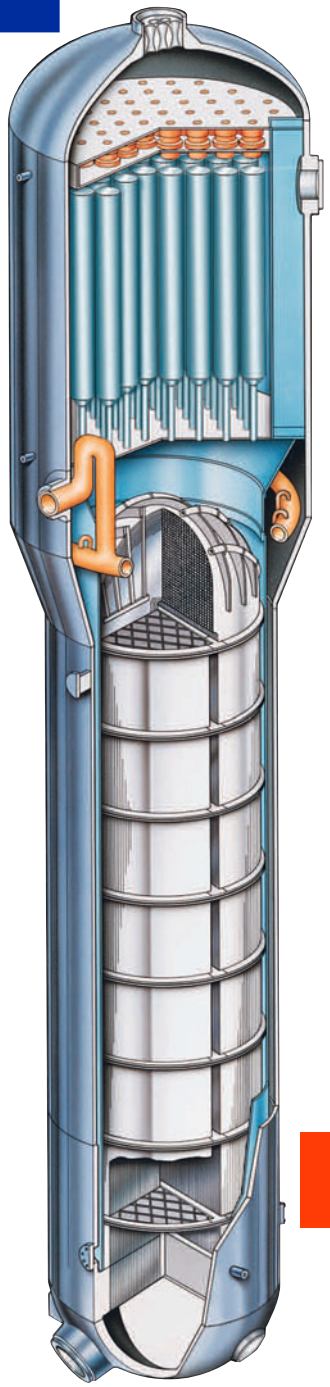
Powering Up

Nickel and the Nuclear Future

Nuclear power and stainless steel continue to go hand-in-hand



STEAM GENERATORS AT THE HEART OF THE REACTOR

WESTINGHOUSE AND BABCOCK & WILCOX

Concern over global warming and ballooning oil prices has driven interest in nuclear-generated power to its highest level since the 1970s. It isn't surprising, then, that demand for nickel-containing alloys, valued for their corrosion resistance and high-temperature performance, is expected to rise as well.

Greenpeace co-founder Patrick Moore and scientist/environmentalist James Lovelock have thrown their weight behind nuclear power as a low-polluting source of energy which will see us through to the time when fusion energy becomes viable. "I do not see nuclear energy as a panacea but as an essential part of a portfolio of energy sources," Lovelock writes in his best-selling *The Revenge of Gaia: Why the Earth is Fighting Back – and How We Can Still Save Humanity* (Allen Lane, U.K., 2006). He adds that "new nuclear building should be started immediately."

Moore, who is co-chair of the recently launched Clean and Safe Energy Coalition, says nuclear power just might be the energy source that can save our planet from catastrophic climate change.

The world's uranium producers are already poised to meet the demand. "We're seeing a rebirth of nuclear power, driven by the environmental argument to reduce emissions," says Alice Wong, vice-president, investor relations and corporate communications, for Canadian-based Cameco, the world's largest producer of uranium oxide or 'yellow cake'.

In China, five plants are under construction, six are planned, and 19 are proposed, according to the World Nuclear Association. By 2020, that country's National Leading Group for Nuclear Power Self-Reliance Development wants installed capacity in operation to reach 40 gigawatts (GW) and installed capacity under construction to be at 18 GW. That translates to 30 new nuclear power stations over the next 15 years, which would render China the world leader in nuclear power growth.

Westinghouse Electric Company, which designs reactors and manufactures stainless steel and nickel alloy components for them, submitted competitive bids for four new plants in China, according to Scott Shaw, the company's communications consultant, nuclear power plants.

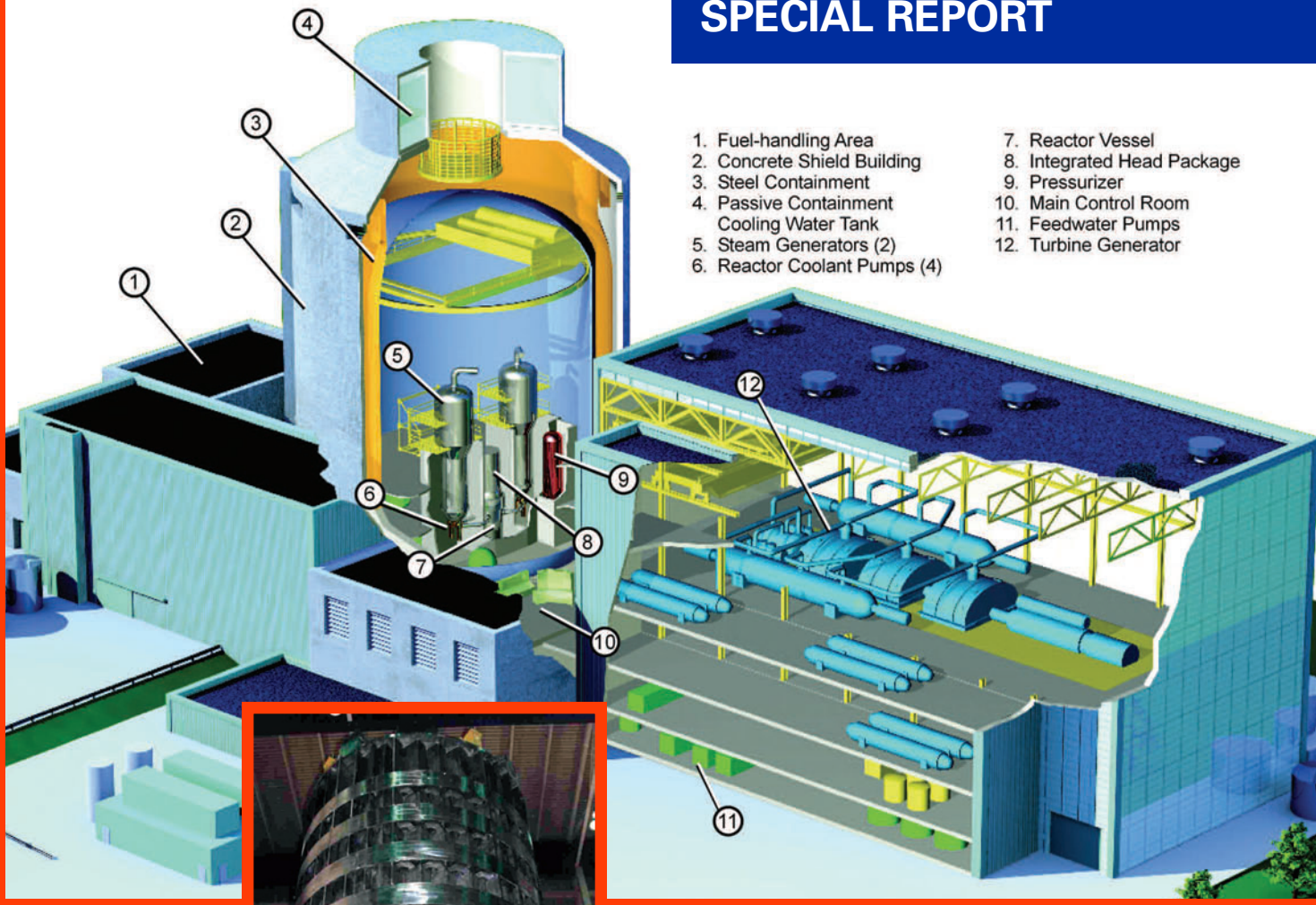
South Korea has had the largest nuclear energy build program of any country. Says Chris Hoffman, fellow engineer, metallurgy, with Westinghouse: "Since about 1998, our primary customer has been South Korea, for which we have manufactured reactor vessels, internals, control element drive mechanisms, reactor coolant pumps, and associated supply hardware."

In Europe, the attitude toward nuclear power is increasingly

NUCLEAR POWER FACTOIDS

Plants Worldwide:	441
Power Production:	368,496 Megawatts Net
Under Construction:	27 in 11 Countries
In Planning Phase:	38 in 11 Countries
Proposed:	113 in 17 Countries
Countries with the Most Plants:	United States (103)
Country with the Highest Contribution to the Power Grid:	France (75% of the Nation's Power)

Source: World Nuclear Association (Figures Valid as of March 31, 2006)



INSIDE GENERATOR

STAINLESS STEEL CONTAINMENT

NICKEL ALLOYS ARE ESSENTIAL

favourable. Among the many countries boosting their nuclear generating capacity is Finland, which has a fifth reactor under construction, due to begin operation in 2009.

North America is likewise poised to boost its nuclear output. Yong Kim, nuclear sales manager with Canadian-based Babcock & Wilcox, which makes equipment for the nuclear industry, says things haven't looked this bright in twenty-five years. "We are quite optimistic about new builds in North America. . . . For the United States it is a matter of 'when', not 'if'."

For producers of nickel-containing alloys, perhaps the biggest cause for optimism is licence renewals. "Most likely every plant in operation in the U.S. will apply for licence renewal," says Shaw, and with licence renewals come repairs and refurbishing, which often require large contracts for plant equipment that contains nickel.

With the nuclear renaissance comes increased demand for stainless steel and specialized nickel alloys. Decades of operational experience have proved that, for many applications, there is no viable substitute for nickel-containing alloys. In refurbishing projects, replacement stainless steel offers considerably lower maintenance than original carbon-steel components.

Westinghouse manufactures nuclear power plant components of stainless and high-alloy steels at its Newington Operations facil-

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ity in New Hampshire. The facility uses 15 to 20 different nickel-containing base metals and 8 to 10 different filler metals. Applications range from high-tonnage applications in reactor vessel internals, in which one might find up to 200 tonnes of S30400, to nickel alloys, such as N06625 and N07750, in control element drive mechanisms. Another application of S30400, and of S31600, is in piping that's in contact with the primary coolant, and the piping that delivers the reactor-heated water to the steam generators. In all these applications, the alloys are chosen for their resistance to corrosion.

"Most original nuclear plant service water piping consisted of lined or coated carbon steel, but a lot of plants have replaced parts of their systems with stainless," says Dr. James Fritz of the consulting service TMR Stainless in Pittsburgh, Pennsylvania. However, maintenance problems, including corrosion of S30400 and S31600 stainless steels (due to the "aggressiveness" of the water, as caused by the presence of bacteria and high chloride levels), have forced utilities to take another look at their materials selection.

For example, the Salem Nuclear Generating Station in New Jersey began replacing S30400, S31600 and polyethylene-lined carbon steel service water piping with 6% molybdenum stainless steel on a large scale in 1988. The replacement program has comprised 2,290 metres of 254 SMO ™ (S31254), AL6XN ™ and 25-6MO ™ (both N08925) pipe ranging from 19 to 508 millimetres (mm) in diameter.

This year saw the publication of the Code Case for S32205 (N-741) for class III construction in the seventh supplement of the American Society of Mechanical Engineers (ASME). The code case opens the door for material that sits midway in corrosion resistance between 316 and 6% Mo. Recently, Duke Energy of Charlotte, North Carolina, received approval from the ASME to use S32205 duplex stainless steel for safety-related service water piping systems.

There is also a materials change in the area of steam generators, where 315° C water from the reactor heats water on the secondary side to 277° C to make steam to run the turbines.

A steam generator might weigh 500 tonnes or more; about 10% of that weight consists of 4,000 to 15,000 alloy tubes ranging from 12.4 to 21.3 metres long with an outside diameter of 19.1-22.2 mm and a wall thickness of 1.02-1.27 mm.

In the U.S., early steam generator tubing was made of N06600, which has suffered from stress corrosion cracking. "(The cracking) is caused by residual stresses and an aggressive water chemistry," explains Richard Klarner, manager, engineering technology and proposal engineering, with Babcock & Wilcox. "It is a very harsh localized chemical environment within the heated crevices."

Over the past 15 years, B&W has replaced tubes in 42 steam generators in the U.S. with tubes made of N06690. Another alloy, Alloy 800, continues to prove beneficial in other plants. B&W has a contract to replace twenty-four 120-tonne steam generators at Bruce Power's Bruce A nuclear power plant in Ontario, Canada, using Alloy 800.

Whether for refurbishing existing plants or building new ones, nickel stainless steels and nickel alloys continue to play an irreplaceable role in the nuclear power industry.

MORE INFORMATION:
www.nickelmagazine.org/nuclear

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STEAM GENERATORS HAVE UP TO 15,000 NICKEL ALLOY TUBES ▸
NEW TECHNOLOGY HAS BROUGHT NEW ALLOYS TO NUCLEAR POWER ▾