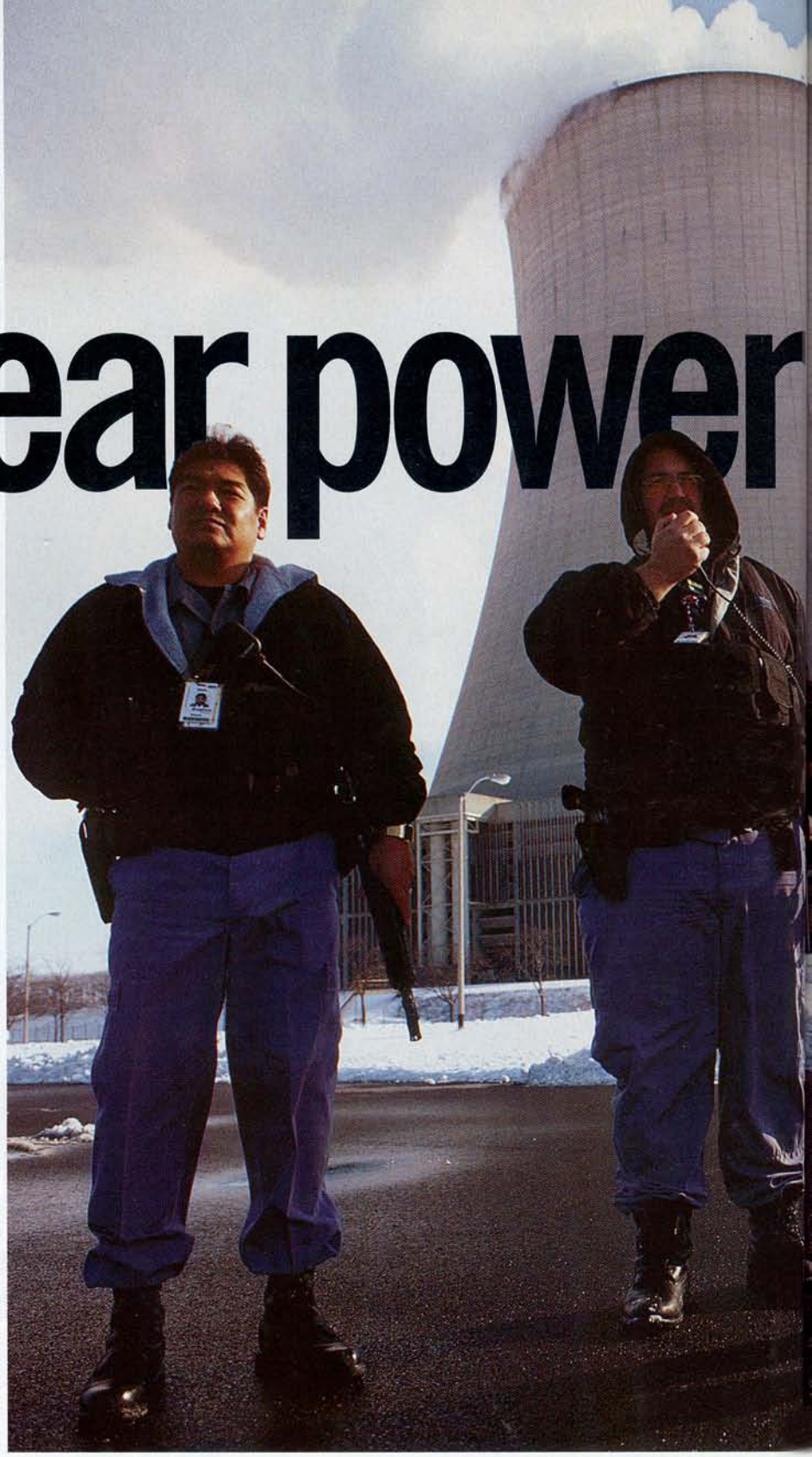
How do you feel about nuclear power

There are new reasons to build more plants—and new reasons to fear them.

BY STUART F. BROWN



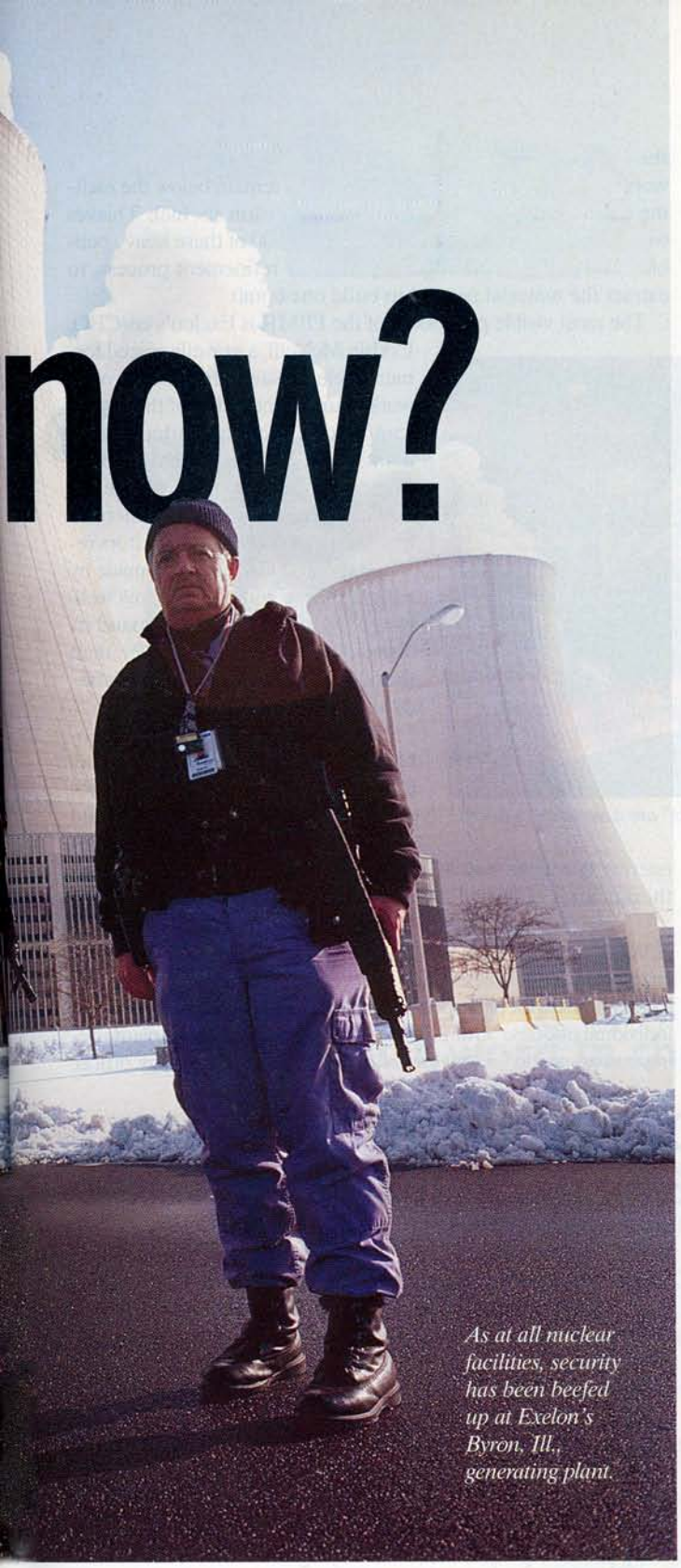
ON THE WESTERN EDGE OF THE VAST Nevada Test Site, where hundreds of nuclear weapons have been detonated, lies a dusty ridgeline known as Yucca Mountain. Located in a desert region of north-south mountain ranges, it is surrounded by alkaline dry lakebeds—dead-end watersheds that don't lead to the ocean. This hydrologic isolation, government scientists say, makes these lonely areas the safest places to store waste from nuclear reactors without endangering future generations.

For years, the Department of Energy has been taxing nuclear electricity at one-tenth of a cent per kilowatt-hour to pay for the construction of a permanent, high-level waste repository. So far this fund has swelled to $17 billion, and the DOE has spent several billion dollars over 20 years studying the Yucca Mountain site. Who knows how long the inquiry might have continued had not the Sept. 11 attacks left people freaked out by the thought of terrorists trying to blow up a reactor and unleash a Chernobyl on American soil?

Here's an even scarier thought: Terrorists who really did their homework might go after one of the concrete "swimming pools" where spent reactor fuel is currently stored underwater at nuclear power plants. The pools can contain many times more radioactive stuff than the reactor cores themselves, and they are located outside the stout, armored domes protecting the reactors. "There are fewer barriers between that material and the public," warns David Lochbaum, a nuclear safety engineer at the Union of Concerned Scientists in Washington.

The Nuclear Regulatory Commission is now in a huddle deciding what needs to be done to harden the nuclear complex

now?



As at all nuclear facilities, security has been beefed up at Exelon's Byron, Ill., generating plant.

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against the terrorist threat. "My life has been totally consumed since Sept. 11 in deliberating what our licensees should be doing in reaction to it," NRC Chairman Richard A. Meserve said in an interview three weeks after the attacks on New York and Washington. The power plants will probably not be assigned batteries of antiaircraft missiles, as has a major nuclear-fuel reprocessing complex in France. But at long last the Yucca Mountain plan is being put into motion. In January, Energy Secretary Spencer Abraham notified the governor and legislature of Nevada that he will recommend to President Bush that Yucca Mountain be developed, effectively triggering the final decision-making process.

Digging one big hole for hot waste in Nevada might soothe citizens concerned about scores of pools containing the stuff all over the country. Beyond that, by resolving the question of long-term nuclear-waste storage, it could profoundly change the prospects of the nuclear-power industry. That's because the storage problem has been a major barrier to the building of new nuclear plants—an idea that had been gathering momentum before Sept. 11. Recall that just months earlier, blackouts had rolled across California. Rising demand driven by the Internet's thirst for electricity, and even worries about global warming, were making utilities think some of their next generating plants might be fueled by uranium rather than coal or natural gas.

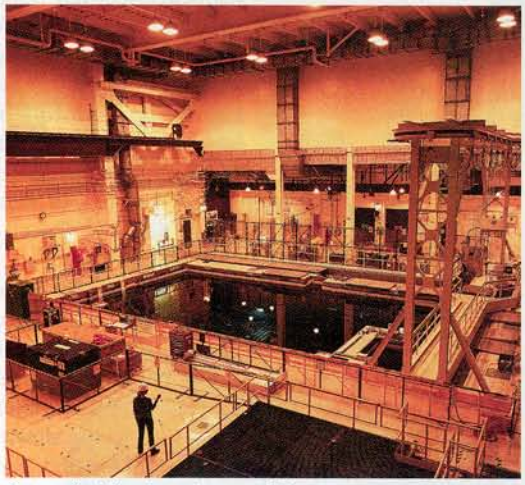
Those underlying issues aren't going away, and assuming that the current climate of fear gradually recedes, attention will once again turn to the slowly growing mismatch between electricity supply and demand. Some electric utilities are likely to begin pushing programs to build new-generation reactors that they say will be less vulnerable to accidents than the existing reactor fleet, which—Three Mile Island notwithstanding—has never killed anyone in the U.S.

The improving view of nuke plants as a business proposition is reflected in the acquisition deals of the past few years. Existing plants that were changing hands for just the price of their uranium fuel—or as little as one-twentieth their construction cost—have sharply rebounded in value as their improving uptime has made them look like bargain sources of megawatts. Industry data show that U.S. nuke plants ran at 89% of capacity in 1999, up from 70% in 1990 and just 59% in 1980. Average generation cost per kilowatt-hour in 1998 was 2.13 cents, down from 3.04 cents a decade earlier. The huge improvements have come from better management of procedures such as refueling, which occurs every 18 months and now involves about 35 days of downtime. Refueling ten years ago typically involved shutdowns lasting about 80 days. "There was a time just a few years ago when people were talking about retiring reactors prematurely. Now we anticipate that there may be some early-site permit applications filed soon," says Meserve, referring to the first step in getting NRC approval to build a new plant.

Having an administration in Washington that's friendly to nuclear energy doesn't hurt. The NRC has come up with a streamlined approval process that limits the amount of litigation anti-nuke groups can bring to bear on a construction program. Under the new rules, once any legal disputes are settled, a utility can embark on a building project without fear of the cost overruns brought by mid-course wrangles in court—the kind that caused nuke budgets to balloon in the 1980s. Moreover, the agency has preapproved three evolutionary, less complicated reactor designs the hardware makers have developed.

It isn't just federal regulators who are warming up to nukes. Depending on how the scientific inquiry into global warming unfolds, nuclear power may end up looking unexpectedly appealing to environmentally minded people because it emits no carbon dioxide, as do plants that burn fossil fuels. "Climate change will be a primary driver for energy policy, and for nuclear fission energy in the intermediate

future and fusion in the long run," says John Marburger, director of the White House's Office of Science and Technology Policy. Furthermore, the counterterror war has made Americans worry once again about reliance on foreign energy sources. Here the national logic could take an excursion that's understandable, if not entirely accurate. Even though North American–sourced coal and gas—not oil—are nuclear energy's competitors, shifting emotions about imported oil could end up making nukes seem like a more reasonable ingredient in the power-plant mix. And uranium comes not from the explosive Middle East but from friendly places like Canada and Australia. Places where they speak English and drink beer.



Spent-fuel "swimming pools" are a security concern.

OF THE POWER PLANTS THAT burn fuels (hydroelectric dams would be the main exception), nukes are the heavy lifters. A typical reactor produces 1,000 megawatts, enough juice to power a city the size of Boston. Nuke plants have operating costs that are generally lower than those of fossil-fuel plants, chiefly because uranium is in abundant supply and available under long-term contracts that lock in prices, a certainty the operators of natural-gas-fired plants can only dream of.

In the good old days, the electricity industry was a great place to work. All you had to do was convince the local public-utility commission that a new generating plant was a "prudent" investment, and it would grant you a rate increase to cover construction costs. Today's rough-and-tumble deregulated market makes managers skittish about investing in more generating capacity than the market can absorb, for fear of depressing prices and profits. Here's where the most unusual of the new nuke designs stands alone. Now in the advanced-development stage, it's called the pebble-bed modular reactor, or PBMR.

Unlike a conventional "light water" reactor, the pebble bed has no fuel rods and no cooling water. Instead, the fuel consists of about 15,000 tiny carbon- and ceramic-coated specks of uranium that are pressed into a tennis-ball-sized "pebble" with a graphite outer jacket. The fissioning uranium inside the pebbles releases heat, while the graphite traps radioactivity inside. About 300,000 of these pebbles are placed in a reactor vessel cooled by a flow of helium gas, which expands from the heat, spinning an electricity-generating turbine. Helium is chemically and radiologically inert, so the gas doesn't become radioactive as it circulates through the pebble bed.

A big part of the pebble bed's appeal is that relatively small units producing 110 to 140 megawatts of power could be built, allowing a utility to add capacity as needed, in modest increments. The project's backers envision making the modular reactors on a low-volume production line that would bring some economies of scale to an industry that's never had them. The other big selling feature is the claim that a PBMR can't have a core meltdown, as the reactor at Three Mile Island did, because even under the worst conditions, operating temperatures remain below the melting point of the ceramic pebbles that contain its fuel. Thieves would have to make off with perhaps 200,000 of these heavy pebbles, and put them through an elaborate refinement process, to extract the material needed to build one bomb.

The most visible proponent of the PBMR is Exelon's co-CEO, Corbin McNeill, a gravelly voiced former nuclear Navy officer who once worked under the father of the American reactor program, Admiral Hyman Rickover. Exelon built up its fleet of 17 operating reactors, the nation's largest, through acquisitions at fire-sale prices before competitors realized there was money to be made by running these complex systems well. Now Exelon would like to expand its capacity in increments smaller than the 600- to 1,200- megawatt sizes traditional reactors come in.

The NRC hasn't approved the pebble-bed concept, but officials say they'll develop an assessment protocol if Exelon decides it wants to build some. "We are resolving some engineering questions and will make the investment decision in the third quarter of 2002," says McNeill.

"LIKE SNOWFLAKES, NO TWO ARE alike," is how one nuclear engineer describes the existing fleet of American nuclear plants. It's a crazy patchwork of bespoke designs tailored to the preferences of individual utilities. "Our industry was hurt by each of the plants being custom-made," says Howard Bruschi, chief technology officer at Westinghouse Electric Co., the largest maker of power plants. When utility executives say they want to achieve capital-cost and operating efficiencies by building fleets of identical new reactors, they have a proven model in mind: France. Unnerved by the oil-price shocks of the 1970s, the French embarked on a sweeping nuclear-power program that now generates 77% of the country's electricity using just three models of reactors, built under license from Westinghouse. The plants employing each reactor type are identical, so skilled workers can move from one to another without needing retraining, and operational wisdom gained through experience can be shared across the fleet.

A power company interested in buying new reactors that are already NRC certified can choose from three advanced designs offered by Westinghouse (now a unit of British Nuclear Fuel Ltd.) and by General Electric. These are all light-water reactors that use either pressurized or boiling water to cool the core, where rods of fissioning uranium-235 produce heat that's used downstream to make steam, spin turbines, and turn big electric generators. All of the 103 existing reactors in the U.S., which generate 20% of the nation's electricity, are light-water designs. The main difference between the old ones and the proposed new ones is that the

Fear of terrorism may lead to a solution of the storage problem—opening a new era for the industry.

evolved designs use "passive" safety systems that make less use of fallible components such as pumps and valves, instead placing greater reliance on immutable natural forces like gravity and convection to supply emergency cooling water and air.

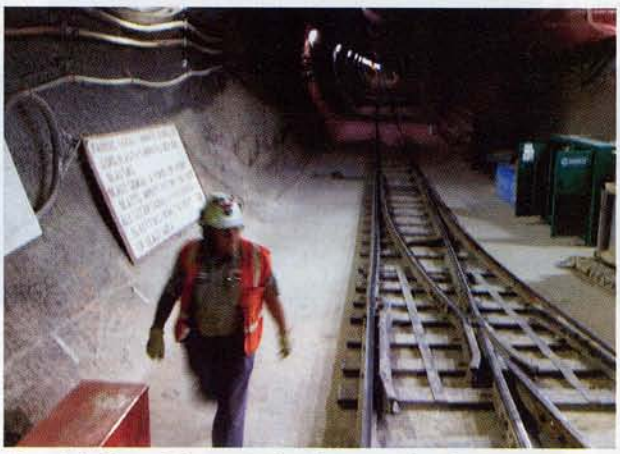
Charles Pryor, Westinghouse's CEO, says he's talking to several utilities that are interested in commissioning new plants. Pryor hopes he can be the first since 1978 to launch a new nuke-plant construction program and make it an economical one, by talking perhaps four utilities into buying a pair of 1,000-megawatt plants apiece. "It would be the worst thing for someone to come along and say, I just want one," says Pryor. "There would be no economy of scale."

Although cost estimates vary depending on whom you ask, the capital investment required to build a new "clean coal" generating plant equipped with soot-scrubbing equipment is $1,000 to $1,200 per kilowatt of capacity. Gas-fired turbine plants are the cheapest, costing some $500 to $600 per kilowatt. Pryor says he would like to be able to build plants for $1,000 per kilowatt, which would make them competitive with a natural-gas plant burning gas priced at $3.50 per million BTUs. By comparison, some of the last nuclear plants completed in the 1980s and 1990s, when the first wave of construction was drawing to a close, cost $4,000 to $5,000 per kilowatt.

"What I would like to see is a group of four or five utilities, vendors, and financial institutions coming together and building perhaps eight plants, and charging everybody the average cost, so nobody has to bear the risk of the first plant alone," says George Hairston, CEO of Southern Nuclear, Southern Co.'s nuclear unit, which operates a fleet of six reactors with a combined power output of 6,000 megawatts. "Our preliminary analysis of a 1,000-megawatt advanced light-water plant looks very competitive with clean-coal technology. The most efficient plants in our system today are nuclear, and that's followed by coal, and then gas. That's not too different from the rest of the nation."

Edward Tirello, senior power strategist at the New York investment banking firm Berenson Minella & Co., thinks utilities will be able to attract financing to build new nukes, although interest rates will at first be slightly higher than for the more familiar fossil-fuel projects. "If they use advanced designs, and get all the litigating done up front before construction starts, and the companies have assured Wall Street that they have markets for the power output, these plants are bankable," he says. "Nuclear plants are the best assets you have in the power business, because the power outflow, costwise, is steady."

Enduring value is also being squeezed out of the existing reactor fleet through operating-license extensions and "uprating" that increases power output. So far the NRC has reviewed the operations and safety records of six plants and granted 20-year extensions to their original 40-year licenses. "These extensions create the cheapest generating capacity you can imagine," observes Westinghouse's Pryor.



AP/WIDEWORLD PHOTOS

Nevada's Yucca Mountain: final resting place for hot waste?

WITH THE MANUFACTURING SECTOR RUNNING AT HALF-throttle and natural-gas prices now at a bargain-basement level, nobody expects a new nuke project to be launched right away. Some observers even predict that nuclear power will just fade away on its own under economic pressures. Among these observers is the Union of Concerned Scientists, which takes the position that the nation should retire its fossil-fuel and nuke plants as they time out, and gradually switch to a mix of renewable energy sources such as wind, solar energy, and biomass fuels. In the meantime, says the UCS's David Lochbaum, "We think the main reason for the recent attraction to new nuclear power was the runup in natural gas prices, which happened because gas plants have been the technology of choice for new generating capacity in the past three to five years." In the long term, he argues, plants using renewables should be able to replace both nuclear and fossil-fuel plants.

Power strategist Tirello counters that construction of new natural-gas-fired power plants won't be feasible after about 2004, because demand by then will have outstripped the capacity of the existing pipelines to deliver the fuel. He warns that future terrorist attacks on the fossil-fuel infrastructure would shake the nation's confidence and make nuclear power more appealing. "What happens when the first tanker ship gets blown up by somebody?" he asks. "All of a sudden the country says we could really have a problem."

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Countering global warming could end up being another big thrust behind a second wave of nuke-plant construction. Harold Feiveson, a senior research policy scientist at Princeton University's program on science and global security, calculates that the world's current nuclear electricity output would need to increase at least tenfold to significantly reduce carbon emissions over the next century. Just recently California moved to limit carbon dioxide emissions from vehicles, a trend that could be extended to cover power plants.

Whether nuclear power makes more or less of tomorrow's electricity will, in the end, be decided by public opinion. There will never be a shortage of people who deeply mistrust both the nuclear industry and the agencies that regulate it. Many feel in their guts that nuclear power is a cousin—however distant—of the nuclear bomb, with all the death and destruction and contamination that weapon brings to mind. But if the national conversation about nuclear power resumes with its old intensity, as seems likely, it will be with a new and different set of arguments. F

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