nedy's version of events and the committee's may be unnecessary now that Kennedy has resigned, although a departmental committee charged with looking into the other matters raised by the episode plans to complete its report. In the absence of conclusive proof, the benefit of the doubt should presumably go to Kennedy; the biosafety committee seems to signal such a resolution, while standing on its own version of the facts, by saying in the conclusion of its report that Kennedy may have cloned Semliki forest virus either with knowledge or "due to poor record keeping or lapse of memory . . . by mistake without prior identification." But the committee goes on to note that Kennedy should not be allowed to resume cloning experiments because of the "absence of . . . mutual trust," a verdict that did not allow him much room for maneuver.

Having resigned earlier from the biosafety committee, of which he was a member, Kennedy has now resigned from the university. "My reason for resigning was in no way prompted by any feelings of guilt, and I have maintained from the outset of this matter that I am innocent of any wrong doing," Kennedy declares. But since there is no prospect, he maintains, of the university's biosafety committee allowing him in the near future to resume cloning, a procedure essential to his work, it seemed better to continue his work elsewhere. According to committee chairman Gill, however, the committee made plain that it would consider future cloning requests.

Kennedy is now preparing a report of his own at the request of the NIH. He is confident that the NIH's study will vindicate his position. His colleagues, even if they in his view misunderstood his actions, in any event paid tribute to his skills as an experimentalist. He plans to go to Europe for a scientific conference and then to look for another job.

If the incident at UCSD had been a simple matter of Kennedy having anticipated the change in the NIH rules by a few months, whether through accident or an excess of enthusiasm, he could have been rapped on the knuckles and everyone would have heaved a sigh of relief and gotten back to work. Unfortunately, the case was evidently much more complicated because Kennedy turned out to be a man with a special problem, the problem being that of a situation in which, for whatever reasons, he came in this matter to lose the trust of his colleagues.

Did such a situation merit special allowances? Within the constraints of its responsibilities to the NIH, did the biosafety committee go as far as possible in recognizing the particular nature of the situation it had to deal with? The biosafety committee may have felt it had little option but to render a cold rendition of the facts, and to let all other matters be addressed by the departmental committee. But after its declaration of a lack of mutual trust, Kennedy's resignation was presumably not a matter of surprise. Only the committee knows how hard it may have tried to find more gradual solutions to the issue it perceived, and maybe there were none.

—NICHOLAS WADE

Navy Considers Scuttling Old Nuclear Subs

Reactors on decommissioned vessels must be disposed of as radioactive waste; burial at sea is one alternative

The U.S. Navy is considering disposing of the dangerously radioactive power plants of decommissioned nuclear submarines by scuttling the submarines at sea over deep ocean bottom areas that would be chosen off the Atlantic and Pacific coasts. No radioactive waste has been dumped off U.S. coasts since 1970, and for the past 8 years the Environmental Protection Agency (EPA) has issued no permits for such dumping.

The Navy has only two practical options for ultimate disposal of defueled reactors of decommissioned submarines, either scuttle the subs or remove and bury the reactors on a government reservation. Both options are under review.

The ocean disposal option will of course be open to the Navy only if the EPA can be persuaded that the deep seabed is a suitable place for reactors that are thousands of times more radioactive than the kind of low level waste commonly dumped off the Atlantic, Pacific, and Gulf coasts between 1946 and 1970, when sea disposal of such radioactive material was allowed.

During that period 87,000 containers (mostly steel drums) and other items of waste were dumped under license from the old Atomic Energy Commission; altogether, the radioactivity thus disposed of came to 94,000 curies. But one submarine reactor could contain 50,000 curies, or better than half as much as all of the radioactivity disposed of offshore during more than two decades of active dumping.

Whether the dumping of such a reactor would be environmentally acceptable, neither the Navy nor EPA is prepared to say. The effects of past ocean dumping of radioactive waste have in general been poorly monitored. From existing information EPA cannot say either that such dumping is harmful or that it is innocuous.

The land disposal alternative that the Navy has under review would involve removing the entire reactor compartment from the submarine, putting this large structure (weighing several hundred tons) on a barge, and towing it to a government installation for shallow burial. The government has only two installations in mind: the Hanford reservation on the Columbia River in Washington, and the Savannah River Plant reservation in South Carolina.

Sea disposal of entire submarines might be much the easier and cheaper of the two options. But if this is the alternative proposed, the Navy may well provoke controversy in the United States and perhaps other nations, such as some of those around the Pacific basin where radioactive waste disposal has become an issue of extreme political sensitivity.

"My gut reaction is that it is not a smart idea," Thomas Cochran, staff physicist with the Natural Resources Defense Council, commented to this reporter.

Cochran observed that there are al-

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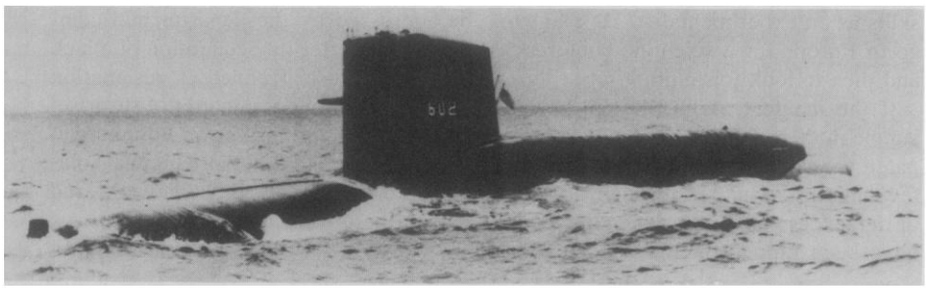
ready well over a hundred nuclear-powered naval vessels in the U.S. Navy, another sizable number in the navies of the Soviet Union, France, and the United Kingdom, plus several hundred research and commercial power reactors in service or under construction around the world. If, he added, sea disposal becomes the thing to do every time a reactor is decommissioned, "pretty soon you are talking about a thousand hulks down there."

Cochran said that he would not want definitely to oppose the sea disposal of reactors without reviewing the environmental analysis the Navy must prepare before deciding on the sea disposal ver-



Decommissioned Polaris submarines such as the Abraham Lincoln *ultimately may be scuttled; their defueled reactors will have high induced radioactivity. [U.S. Navy photo]*

sus land burial alternatives. "But my initial reaction is that land disposal would be better," he said.

The Navy has already disposed of one submarine reactor at sea. This happened in 1959 when, without any public announcement, a barge bearing the sodium-cooled reactor from the *Seawolf* was towed 120 miles off the coast of Delaware and scuttled over the so-called 2800-meter site commonly used during the postwar period for radioactive waste disposal.

Today, after 21 years of radioactive decay, the 33,000 curies present in the *Seawolf* reactor at the time of disposal are down to about 2,000; the predominant isotope is cobalt-60, which has a half-life of about 5.3 years. According to the Navy, the radioactivity—consisting of activation products created by the bombardment of the metal of the reactor by neutrons—was contained inside the reactor as an "integral part of the corrosion-resistant stainless steel reactor vessel structure."

The Navy says, further, that the products of corrosion of steel are "primarily solid, rust-like materials that are extremely insoluble in seawater and therefore tend to remain attached to the metal surfaces or absorbed locally on the bottom sediments." But the Navy is in no position yet to show that this has indeed been the fate of the corrosion products, because the effort made in recent years to find the *Seawolf* reactor has failed. The Navy did find debris from the nuclear submarines *Thresher* and *Scorpion* after they were lost in 1963 and 1968, however, and the only radioactivity detected in surveys made after the sinkings and in more recent years are low levels of cobalt-60 in bottom sediments.

As a consequence of U.S.-Soviet arms control agreements, the Navy is under immediate pressure to decommission some of its old Polaris submarines before seven Trident subs, which will each have 24 missile launchers, come into the fleet over the next 4 years. Compliance with the strategic arms agreements can be achieved by removing the submarines' missile-launching tubes, but, with this done, the Navy will still be left with the radiologically hot reactors and the question of what to do with them.

Nuclear submarines can be decommissioned, defueled, and laid up in Navy shipyards, and five times over the past 13 years this has in fact been done. This year the Polaris submarines *Abraham Lincoln* and *Theodore Roosevelt* were decommissioned and placed in protective storage in the Pudget Sound Naval Shipyard. But the laying up of more and more nuclear subs and surface ships as they reach the end of their useful lives of 20 to 30 years will, at some point, become clearly impractical.

According to the Navy, if ocean dumping of decommissioned submarines should be proposed and approved, the disposal operation would be carried out in a "deep part of the ocean where there is virtually no likelihood of its being disturbed by human activities, seismic action, or ocean movement." The defueled subs would be towed to the disposal site, flooded, and allowed to sink to the ocean floor. "Preliminary information indicates that the submarines would be intact after landing on the bottom and that the reactor plant and containment would remain intact," the Navy adds.

Also, the Navy observes that the total radioactivity of the cobalt-60 would be reduced by a factor of 1000 after 50 years, or probably before corrosion—which works slowly in the low temperatures of the deep ocean—eats away the submarine's hull. The hull is, the Navy contends, a far more durable waste container than the steel drums used by several European nations in their dumping of radioactive waste on a burial ground off Portugal.

In no case, says the Navy, would any of the reactors constitute high level waste, which cannot be disposed of at sea either under U.S. statutory law or under the London Convention of 1972 on the prevention of marine pollution. As defined by the International Atomic Energy Agency (IAEA) in 1978, high level waste is waste whose activity exceeds 1 curie of alpha radiation or 100 curies of beta-gamma radiation per metric ton, with the alpha and the beta-gamma radiation each to be averaged over no more than 1000 tons.

For the Navy to convince EPA to allow ocean dumping of subs, it will have to show, through research, that the dumping will do "less harm to man and the environment than other practical disposal alternatives." Charles D. Hollister, senior scientist in the Woods Hole Oceanographic Institution's department of geology and geophysics and dean of the graduate school, started the research program for the Navy several years ago. He thinks that sea disposal of nuclear vessels will be technically feasible. "Politically, it's exciting perhaps, but scientifically it's trivial," Hollister said in an interview with *Science*.

Ross Heath, dean of the School of Oceanography at Oregon State University and now one of the key participants in the Navy research program, is more reserved in his judgment as to how the research will come out. "I would suspect that he [Hollister] is right, but we have a ways to go before we can be convinced that seabed disposal is appropriate. One first actually has to do the oceanographic work, the radiation studies, and the corrosion studies."

Up to now, the studies have been directed at identifying ocean bottom areas in which suitable disposal sites might be designated. The area of principal interest to Heath is the broad abyssal plain between the Mendocino and Pioneer fracture zones, off northern California's Cape Mendocino and just within the 200-mile limit.

The area thus far appears to meet the criteria that the IAEA has prescribed for selecting sites for low level waste dumps; for example, besides the fact that the water is more than 4000 meters deep,

the area is remote from the continental margin and seems relatively tranquil, with no strong erosive currents to keep bottom sediments in suspension. The EPA itself has not yet issued site-selection criteria, but Heath suspects that when it does, the criteria will be similar to those of the IAEA.

Hollister and some of his Woods Hole associates last year prepared a report for the Navy which discussed two study areas in the Atlantic, one north of Puerto Rico, the other about 200 miles off Cape Hatteras. Referring to the latter area, the report says, "It is quite conceivable that there is within this ocean bottom region an area that is both flat . . . *and* tranquil *and* of a size large enough for disposal operations." Hollister thinks that any site selected should have smooth terrain and thus facilitate environmental monitoring.

The Navy says that, so far, about $1 million has been spent on the oceanographic research effort; it estimates that about a million more will be spent before the broad area studies are completed. But Heath believes that to do all the research needed to identify and propose actual dump sites will cost more like $5 million and perhaps twice that.

Because the research will require several more years, the Navy is still a long way from deciding either for or against the sea disposal option. EPA needs more time too; its assessment of the environmental effects of past dumping of radioactive waste is not expected to be completed until 1985, and the agency may not be ready until then to decide whether to allow dumping to begin again.

—LUTHER J. CARTER

Scientists and Congress Battle over NIH

Biomedical lobbyists resist tighter control, but to no avail

Paying little attention to heated opposition from the nation's biomedical community, the House and Senate have overwhelmingly passed separate bills that scientists say undermine the sovereignty of the National Institutes of Health and shake its preeminence in international research.

Although the bills are quite different, together they spell more federal oversight and periodic review of the $3.5 billion budget of NIH. Legislators will hash out the differences in House-Senate conference committee which is expected to meet within the next 2 weeks. Congress recesses 3 October for elections.

All in all, the two bills—particularly the House version—have left bad blood among the health institutes, biomedical lobbying groups, Capitol Hill, and the Secretary of Health and Human Services (HHS), Patricia Harris.

Scientists have been focusing primarily on the House bill because it would require each institute to have its budget authority renewed periodically. That would bring NIH in line with the funding processes of most other government agencies which must be reviewed by reauthorization and appropriations committees. All except two institutes at NIH have permanent budget authorities.

Legislators are surprised at the furor their bills have created. They believe that the bills protect NIH's budget at a time of general belt tightening in the federal budget.

Representative Henry Waxman (D-Calif.), sponsor of the House bill and chairman of the subcommittee on health and the environment defends his proposals by saying, "There's no reason why NIH should be different from other government agencies that are routinely reauthorized."

Opponents of the Waxman bill, which passed 292 to 48 on 28 August, disagree. They say that reauthorization allows legislators to tack on their pet projects or disease-of-the-month programs when they might not be in the best interest of research. Reauthorization places NIH in the business of "horse trading," says John Sherman, vice president of the Association of American Medical Colleges. The AAMC has been one of the most vocal groups opposing the legislation.

"What's so bad about NIH?" asks Thomas Kennedy, another AAMC official. "It's a terribly sound institution that's doing its job."

The Waxman bill sent biomedical lobbyists scrambling in confusion when it first came out. AAMC lobbyists thought the bill included a sunset provision that would automatically terminate the institutes if they were not reauthorized. In fact, there was no such provision.

But when the initial cloud of confusion passed, researchers were still vexed by two proposals in the bill—the requirement for reauthorization and ceilings on spending. Specifically, the bill says Congress will renew the budget authorities of all 11 institutes every 3 years with a fourth-year extension if Congress fails to approve authorizations in time. The two largest divisions at NIH—the National Cancer Institute and the National Heart, Lung and Blood Institute—have been periodically reviewed since the early 1970's when Congress pushed for more research in cancer and heart disease.

Waxman's bill limits NIH's annual spending increases to about 22 percent on the average for all the institutes, which at present do not have ceilings. Some critics balk at the idea of any ceiling when NIH has been accustomed to none. Others say the ceilings are so high they are meaningless. "NIH is not in a position of growth. It's just trying to keep up with inflation," says Burke Zimmerman, a special assistant to NIH Director Donald Fredrickson.

The bill also voids NIH's current power to obtain appropriations if Congress fails to approve them by the end of NIH's fiscal year. Without this power, which has bailed out NIH several times, the continuity of research would be disrupted, Zimmerman says.

Waxman says he wants to shield NIH from Carter's proposed 10 percent cut in its spending next year to help balance the budget. Waxman believes financial support of NIH should be higher, says a subcommittee aide. Presumably, the congressman would use his power of reauthorization to protect NIH from slashes in spending.

Waxman says scientists have been overreacting to his bill. In particular, "the AAMC has been leading a hysterical campaign. People worry about any change in the status quo," he says.

The bill is the first major piece of NIH legislation proposed by Waxman, a relative newcomer to biomedical affairs since he became subcommittee chairman

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