NRC's research program comes under fire

The research program of the Nuclear Regulatory Commission (NRC) is inefficient, riddled with management problems and largely ignoring some important unanswered questions about the safety of commercial reactors, according to a new National Academy of Sciences report. The report offers unusually sharp criticism and pointed recommendations to NRC, the agency that commissioned it. However, says Steven Blush, a senior staff officer for the panel of experts that directed this assessment, the problems the panel identified were so egregious that his committee decided "nothing short of candor would have an impact" on those responsible.

The panel had been asked to recommend how the content of NRC's research program might be improved. That request was largely ignored, however. Says John Ahearne, a former NRC chairman and now vice-president of the Washington, D.C.-based Resources for the Future, "When we started looking at the research program, the consensus of our committee was that the management of it was so poor that it didn't make much sense to try and address its content." Instead the panel focused on management, attitudinal and institutional problems.

"We weren't really in a position to analyze the relationship between the existing safety research program and the safety of reactors," Blush says. He does note, however, that the panel identified several technical areas that can affect safety and are still largely unstudied.

For example, the panel says, "one of the most significant lessons" of the accidents at Chernobyl and Three Mile Island is an appreciation for the role of human error in causing or exacerbating accidents. However, the panel found, NRC is conducting virtually no research into these "human factors" – how people interact with or limit reactor controls and technology. This indicates, the report says, "that something is seriously wrong with the way the agency goes about structuring its [research] program and setting its budget priorities."

The panel also found NRC's research program hobbled by:

• no "research philosophy" to guide the agency in setting priorities.

• no long-term planning.

• a small and shrinking budget over the last five years.

• isolation of the agency's top officers. "In theory the five commissioners manage the agency and the agency staff," the report says, "yet in practice they do little policy formulation, program planning or staff guidance and do not appear to understand [its research] program."

• "the total absence of peer review," as Ahearne describes it. Though peer review "is the standard way to test whether your work is any good," he says, NRC has apparently discouraged publication of its research for fear of providing outsiders with ammunition against the agency. Ahearne says NRC seems equally concerned about having its research data used by critics to question the safety of existing plants as it is about having those data used by the industry to challenge the toughness of its regulations.

• a merger of two offices – the one that ran NRC's research and the one that wrote safety regulations – that ultimately compromised the quality of the research. As Ahearne explains, those from the regulations office were driven more by form, such as how standards should be written, than by the data that would or should serve as the basis for those standards. The result of this merger, he says, "seems to be that the people who were far more interested in form won out over the people who were interested in substance."

• "little interest in or understanding of the existing research program outside of the Office of Research," in the words of report. For example, Blush points out, the committee discovered that NRC's director of research had not been asked to discuss the research program with the commissioners in roughly two years. "That seems to be a pretty strong indication," he says, "that the commission doesn't have control of the program, and lacks both understanding and interest in it."

To counter these problems and strengthen NRC's research program, the panel recommends that the agency be reorganized – from the top down. For example, the report hints that a five-member commission (as opposed to the more common, single administrator) may not be the best way to run this agency. Ahearne is less tentative. "I think the commission's structure is inappropriate for an agency that tries to run a research program or an operations program with inspectors." He says it ends up being "a debating forum, not a deciding forum."

The report also recommends that NRC fund more research outside of the national laboratories, where 80 percent of its research is now conducted, and focus more attention on safety questions involving large unknowns. The latter recommendation has not gone unnoticed by Sen. Daniel Patrick Moynihan (D-N.Y.). "You would think the commission would spend its time and its money studying what it did not know much about. Instead," he says, "the commission has been plowing old ground and learning not very much at all." If Moynihan has his way, this will change. As a member of the Senate's subcommittee on nuclear regulation, he plans to use the report as the basis of an effort to redirect NRC's research.

Although NRC is not bound to adopt any of the panel's recommendations, Clare Miles, an NRC spokesperson, told SCIENCE NEWS that the agency is "reviewing the report to see what lessons might be learned." She adds that not only is the administration proposing a 7.2 percent increase in the agency's research budget (to $119 million) in fiscal year 1988, but NRC is also planning a "major reorganization." *–J. Raloff*

Lipid takes a stand against alcohol

Chronic alcohol consumption does unpleasant things to the body. But there is an interesting twist to the story of alcohol's effects: Scientists have known for several years that frequent ingestion of ethanol also alters cells in an apparently positive way. Normally, when cell membranes come into contact with ethanol, their lipid molecules begin moving more freely, a change that may affect normal enzyme function. Chronic consumption of ethanol, however, results in some cellular membranes that are unaffected by ethanol.

This resistance has been cited as a possible mechanism of tolerance in alcoholics. But exactly why it occurs has remained a mystery. Now, a study from Philadelphia's Thomas Jefferson University School of Medicine offers the 2.5 percent solution.

Researchers isolated different phospholipids, a major kind of membrane lipid, from cell structures in the livers of rats fed ethanol for 35 days (ethanol accounted for 36 percent of total calories), and from rats fed an ethanol-free diet. By suspending varying mixtures of those phospholipids in saline solution, the researchers made liposomes – spherical compartments surrounded by a lipid bilayer – and later used them to assess membrane damage.

They found not only that phospholipids from the ethanol-fed rats protected the liposomes from ethanol, but also that only 30 to 40 percent of the phospholipids in the membrane needed to be from those rats. After further refining the system, the researchers concluded that a single phospholipid is responsible: phosphatidylinositol (PtdIns), which in purified form can protect in concentrations as low as 2.5 percent of the total phospholipid content of membranes.

The ethanol tolerance can develop in membranes from other organs as well, according to a report in the December PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES (Vol. 83, No. 24). Theodore F. Taraschi, a member of the research team, told SCIENCE NEWS that they currently are studying the structure of PtdIns to explain its protective role, and that similar experiments using human blood are under way. He says unpublished work by the Philadelphia group also suggests that a different phospholipid from another cellular structure works in the same way. Studying ethanol's effects at the membrane level should increase the understanding of alcoholism in general, as well as suggest new approaches to treatment. Last month, a report from the National Institute of Mental Health described a new drug that may prove useful in stopping the intoxicating effects of alcohol by affecting the movement of chloride across membranes (SN: 12/6/86, p.358).

– D.D. Edwards

A more complex solar cycle

The sun is astrophysicists' exemplary star. It is the only one they can study at close range, and what they know of its behavior they extrapolate to other stars. The sun's activity also determines many things that happen on earth, from atmospheric physics and geophysics through paleontology to ecology. Solar physicists used to believe that the sun's physical activities varied over a cycle that takes approximately 11 years. Now it seems that the solar cycle is not so simple as scientists had believed.

According to results reported at last week's meeting in Pasadena, Calif., of the American Astronomical Society, the 11-year sunspot cycle seems rather to be part of a larger 19- or 22-year cycle that involves other aspects of the sun's behavior. Furthermore, the beginning of each new cycle overlaps the last phases of the previous one.

It is this overlapping feature, particularly, that will make serious problems for solar theorists as they try to explain the sun's behavior, according to the three astronomers involved in the observations now reported. Those astronomers are Herschel B. Snodgrass of Lewis and Clark College in Portland, Ore., Richard C. Altrock of the National Solar Observatory in Sunspot, N.M., and Peter Wilson of Caltech in Pasadena and the University of Sydney in Australia.

The classic sunspot cycle begins with the appearance of spots in the middle latitudes of the sun. Individual sunspots last only a short while, but as the cycle continues, the range of latitudes where new spots appear gradually narrows and at the same time approaches closer to the equator. When the latitudes at which new spots appear are graphed over time as the cycle proceeds, the graph shows a "butterfly pattern," that is, the appearance of a butterfly's wings, starting out fairly broad and away from the equator and narrowing and moving closer to the equator as time goes on.

The new evidence has been found from studies of small variations in the sun's rotation, along with other evidence from changes in the brightness of the solar corona and yet other evidence from variations in the magnetic polarity of sunspots. These data indicate that this sunspot cycle is part of a larger one that takes between 19 and 22 years to run and begins not in the middle latitudes but near the poles. Thus every 11 years or so, a new cycle begins near the poles, while the previous one still has 11 years to run near the equator.

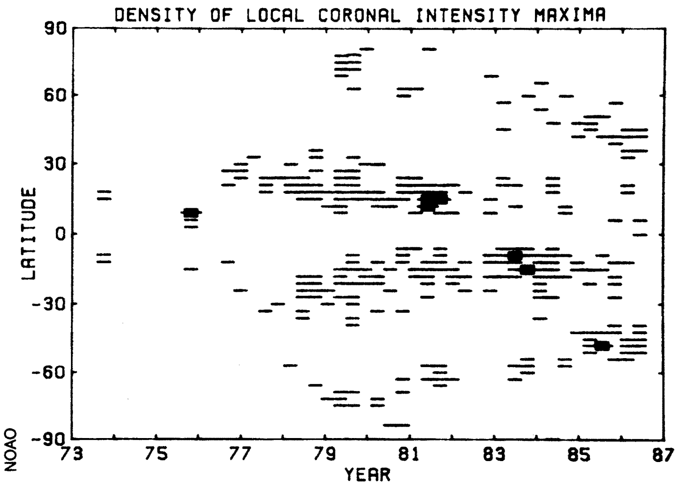
The sun's surface does not rotate rigidly, uniformly at the same speed; latitudes nearer the equator rotate faster than the polar ones. However, observations a few years ago showed that, contrary to expectations, the rotation rate does not increase smoothly from poles to equator. Instead, there is a small wiggle superimposed on the smooth change, so that alternately a slice of the surface will be going slightly faster and the slice next to it slightly slower than they might if the change in rotation speed were smooth.

Work done by Snodgrass at the Mt. Wilson Observatory in Pasadena shows that these zonal variations in rotation speed are cyclic. The zones appear near the poles and gradually migrate toward the equator on a cycle that is at least 18 or 19 years and may be 22. (The numbers are not sharply established; in any case, the sun's variations have never been very precisely timed. The classic sunspot cycle of 11 years has to be qualified with the words "more or less.")

Between the zones of fast and slow rotation is a great deal of torsional shear, producing an effect that some scientists describe as analogous to winds in the atmosphere of the sun. The material that undergoes the shear is an electrically conducting fluid, an ionized gas, and so it drags the sun's magnetic field, concentrating it in the zones where the torsion is greatest. As these torsional zones drift down to the middle latitudes, they begin to produce sunspots, which are magnetic phenomena. The spots are dark because they are cooler than their surroundings, and they are cooler because they represent local concentrations of magnetic field.

The magnetic polarity of the spots also varies cyclically. Spots come in pairs, and if the leader of a pair (as they are carried along with the sun's rotation) has a magnetic field polarized one way, the trailer's field will have the opposite polarity. Wilson reports that to come back to a given polarity relation between the leaders and trailers takes two 11-year cycles, providing further evidence for an overall 22-year cycle.

Finally, the cycle appears in variations in the brightness of the corona, the sun's hot, tenuous outer atmosphere, as Altrock reports. He used the classic technique of studying coronal variations, observing the green radiation from iron that has been ionized 14 times (that is, iron that has lost 14 electrons). He found that these variations, too, come in a cycle of 22 years that begins near the poles and drifts toward the equator.



Horizontal bars indicate solar latitudes having numerous coronal active regions. One cycle starts at ±30° latitude in 1977 and approaches the sun's equator. The newly discovered, overlapping solar cycle begins in 1979 at ±70° to 80° latitude and proceeds toward ±40° latitude.

As Wilson expresses it, the zones of variation in the rotation rate, which seem to drive the other phenomena in the cycle, seem to be caused by convective rolls in the sun's convection zone. Below the sun's outermost surface layers is the convection zone, where heat generated deep in the interior rises to the surface by convection. The matter carrying the heat rises to the surface, cools and then rolls over and descends to be heated again. These rolls maintain their shape in the manner of hair that has been rolled on curlers.

Under this hypothesis, the convective rolls would first appear near the poles and drift toward the equator. The zones where rotation speed differs would be the surface manifestations of the convection rolls, but why the rolls should migrate from poles to equator, the present observers cannot say. They opine that theorists will have a complicated time trying to explain these findings. *– D.E. Thomsen*

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