Fighting Fire Toxicity: Experts Hold Conflicting Views

At recent conference, some attendees say fire ignition should be prevented; others would ban specific plastics; some say issues are not clear

Rebecca L. Rawls, C&EN Washington

Like fires themselves, the recent National Conference on Fire Toxicity seems to have generated a lot more smoke than flame. Sponsored jointly by the Consumer Product Safety Commission and the National Aeronautics & Space Administration, the day-long conference in Arlington, Va., had three stated purposes: to provide an overview of the work already in progress, to define the problem itself more clearly, and to project a practical and productive course for the future. Not surprisingly, these were not accomplished in a day.

Positions are long established and strongly held on the question of what to do about the major killer in fires in the U.S.—namely, the toxic gases and particulate matter generated as the fire burns. Two thirds of the more than 5000 residential fire deaths that occur in the U.S. annually are caused by inhalation of smoke and toxic gases, many of the deaths occurring several rooms away from the fire itself.

Experts have become partisans aligned with one of several conflicting camps. Some say that since all fires produce toxic products, the way to fight this toxicity is to prevent fire ignition or flame spread. Others think they can zero in on specific plastics that are the worst culprits in toxic gas production, and that these materials should be banned. Some think the scientific issues are not well enough resolved to know how to act, others that it is irresponsible to delay action any longer.

Somewhere in the middle are many chemical companies that make synthetic materials or intermediates. On the one hand, they make the fire-retardant chemicals that are now available and that almost no one buys unless regulations force them to. On the other hand, they also make the plastics that are charged with burning hotter and faster and producing more deadly combustion products than conventional materials and thereby causing most of the increased hazard of modern fires.

Trying very hard to take the middle position, too, is CPSC, which is just beginning to concern itself specifically with this issue. According to chairman Nancy H. Steorts, CPSC wants to serve as a catalyst for eliminating the effects of the toxic products generated in fires. It is, she says, one of the commission's most important projects. It has been designated a priority project for 1984 and 1985. Some inkling of the importance CPSC placed on the conference may be seen from all four of the commissioners' presence there, each making brief statements and moderating a session.

Smoke and toxic gases, as produced here in an NBS test, are responsible for most residential fire deaths

CPSC is hoping that by being a relative newcomer to the fire toxicity question, and therefore, essentially nonaligned in the controversies, it will be able to serve the catalyst function. "The truth of the matter lies somewhere between the two oft-quoted extremes, both of which oversimplify the toxicity problem," Steorts says. "On the one hand, there is the philosophy that everything that burns is toxic and to eliminate toxicity one must eliminate fire. On the other hand, it is the belief that toxicity is caused by a few particular products or substances and if these elements are simply identified, toxicity can be eliminated. The truth of the fire toxicity problem lies somewhere between these extremes but has yet to be determined."

The conference itself might be judged an indication of the commission's possibilities for success. It was literally packed—enough to cause some concern among the many fire marshals in attendance. And it represented, both in speakers and audience, a very broad spectrum of the participants in the issue. Federal, state, and local government officials were represented, as were industry, consumer groups, university scientists, private research laboratories, and private fire consultants. Possi-

bly because of the very broad range of viewpoints, about the only consensus the conference managed to achieve was that fire deaths are a bad thing and everyone would like to see them reduced.

Among the controversies aired, but by no means resolved, is the question of whether present knowledge is adequate for government bodies to restrict responsibly the use in buildings of materials whose combustion products are particularly toxic. New York state is moving rapidly toward trying to do this, the conference was told by New York Secretary of State Gail S. Shaffer. After an 18-month study, Shaffer recommended to the building code council last May that certain building materials and furnishings be subjected to performance testing to determine "the hazards they might pose to health and life in a fire situation." The animal test method developed by researchers at the University of Pittsburgh is the appropriate way to make this determination, Shaffer says. This is a bioassay test that uses rodents to measure the effects of combustion toxicity of materials that are burned in a separate chamber.

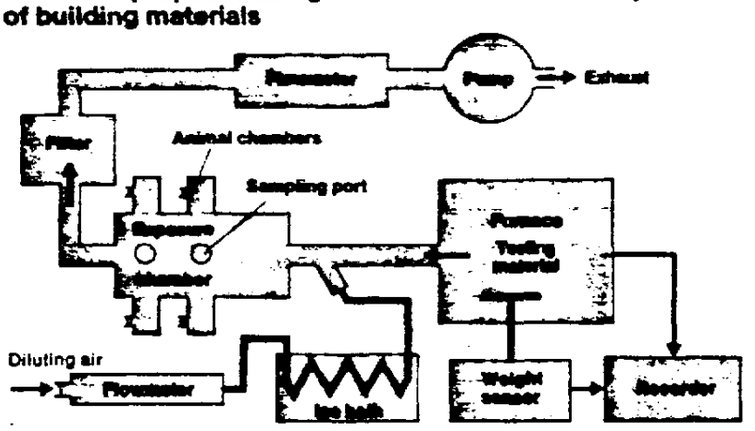
If Shaffer's recommendations are approved—and she hopes they will be within a year—mattresses; bed pads; furniture upholstery; interior wall, floor, and ceiling finishes; electrical wire insulation and conduits; and water distribution pipes installed in buildings will be tested. Test results will be filed with the Secretary of State's office, and materials not tested by a certain date would not be allowed in building construction and furnishings.

However, different animal toxicity test methods give different ratings of a material's hazards, and several of the scientists at the conference expressed reservations about whether data from such small-scale, one-component tests reflect the hazards present in a real fire. Many of the scientific reviewers of the report on which Shaffer's recommendations were based expressed these doubts, the conference was told, and the recommendations appear to ignore these reservations.

Proposed regulations were not the only topic to meet a critical reception at the conference. New scientific findings also found both skepticism and support. William T. Lowry, a toxicologist who heads a research section of Southwestern Institute of Forensic Sciences in Dallas, proposed that an as-yet-unidentified free radical produced when hydrocarbons burn may be responsible for a large portion of fire deaths.

Lowry, like many others, questions whether carbon monoxide, a lethal gas produced in essentially all fires, can alone account for the

New York proposes using this test of smoke toxicity of building materials



In this test, developed by the University of Pittsburgh, the toxicity of combustion gases is measured by exposing up to four mice to gases flowing past them from a furnace where the sample material is burned

toxic gas deaths caused by fires. He sampled the combustion products of a large number of organic compounds, looking for common products that might account for their lethality. Although he found no common stable product, he did find a relatively long-lived free radical that is present in concentrations that rise to more than 1000 ppm in fires. Its concentration was highest, he found, during the period when incapacitation generally occurs—from three to 15 minutes after the fire begins. He proposes that inhalation of free radicals at this concentration could cause peroxidation of lipids within lung tissue, cutting back the lung's ability to absorb gases, and leading to unconsciousness. Since the free radicals are not indefinitely stable, they would not be detected in autopsies of fire victims.

Although Lowry has not yet specifically identified his free radical, he does know some things about it. For instance, it is a fairly simple triplet, and it is carbon-based. Further work should pin down its identity, he says.

Lowry's hypothesis intrigued some researchers at the conference. John A. Parker, chief of the chemical research projects office at NASA, for instance, said that free radical processes play a large role in fire kinetics, and that many current toxicity testing methods, which measure the effects of pure gases rather than the products of real fires, would overlook their possible toxic effects. "I think this is probably one of the most threatening pieces of chemistry presented here today," Parker said. Other researchers, however, pointed out that carbon monoxide absorption through the lungs of test animals is just as efficient when the pure gas is used as when the gas comes from combustion products. Thus the lung's capacity to absorb at least this gas does not seem to be decreased by free radicals in combustion gases. □

New software aims at science applications

An integrated, interactive software package for data acquisition, analysis, and graphics will be marketed by Macmillan Software Co., New York City, for International Business Machines' PC computer. Adaptable Laboratory Software, Rochester, which developed the package for Macmillan, designed it to match the speeds, precision, and flexibility of mainframe and minicomputers for science, engineering, and mathematics applications.

The package, costing about $1800, is the first product to come from Macmillan Software, which was formed as a division of Macmillan Publishing in late 1983. The aim of the division is to develop and market microcomputer software for enhancing productivity of scientific, engineering, and research work.

Besides running on the IBM PC, the new package will run on such IBM-compatible computers as Compaq and Columbia, although Adaptable has had trouble with some other so-called IBM PC compatibles.

The first module, containing graphics and statistics programs, will appear in September. The second module, for data analysis, and the third, for data acquisition, will appear in October.

Programs in modules use all 640 kilobytes (actually 655,360 bytes) of random-access memory to which the IBM PC is expandable. Programs also use the Intel 8087 math coprocessor chip to do calculations at minicomputer speeds and with greater than microcomputer precision to avoid round-off errors.

The data acquisition module works through widely used interface circuit boards of such companies as Data Translation, Keithly, and Tecmar. Analog and digital input and output are available over 16 channels to take data from or to control instruments. The module either sends triggering signals to instruments or acts on receiving a trigger signal. The graphics program can divide the monitor screen into windows of text or graphics so that the user can manipulate several parts of the package at once. □

STATE OF NEW YORK
DEPARTMENT OF STATE
ALBANY, N.Y. 12231

GAIL S. SHAFFER
SECRETARY OF STATE

May 4, 1984

Honorable Yvonne Scruggs-Leftwich
Chairwoman
Uniform Fire Prevention and
Building Code Council
Two World Trade Center
New York, NY 10047

Dear Commissioner Scruggs-Leftwich:

Chapter 552 of the Laws of 1982, directed the Secretary of State to conduct a study of the toxicity of smoke and gases in fires. The legislation further required the Secretary to make recommendations to the Uniform Fire Prevention and Building Code Council based upon this study. The study report and my preliminary recommendations were previously transmitted to you and the Code Council. The attached recommendations fulfill the legislative mandate and follow-up on my previous transmittal.

I will be pleased to continue to work with you to promote the implementation of these recommendations.

Sincerely,

Gail S. Shaffer

INTRODUCTION

It is estimated that 80% of the people who die in fires die not as a result of flames but from inhaling toxic smoke and gases.

The reality of this statistic and the toll it represents in terms of human life were made particularly clear in a fire at the Stouffer's Inn in Westchester County in 1980 in which 26 people died.

This tragedy prompted then-Governor Hugh L. Carey to establish the Special Fire Safety Task Force to review fire safety conditions in New York State with a special emphasis on the adequacy of existing fire codes and recommendations for their improvement. In 1981, the Task Force, working with the Department of State's Office of Fire Prevention and Control, issued its report to the Governor. Among its conclusions: most fire deaths are caused by smoke inhalation and further, the apparent increase in such fatalities has occurred as a result of the toxic gases and smoke produced when certain materials, now commonly contained in buildings and furnishings, burn.

Accordingly, the Task Force recommended that the State undertake an intensive study of "combustion toxicity" -- an increasing threat to human life and safety. The Legislature in recognition of the Department of State's lead role in fire prevention and control, authorized the Secretary of State to conduct a study of the toxicity of smoke and gases given off under various temperatures by materials used in building construction and furnishings.

In undertaking this study, New York State has assumed a leadership role in developing public policy to address the causes and effects of combustion toxicity. Our work in the field of fire safety will serve as a model for other states and for the federal government to

follow. While the study of combustion toxicity is in its early stages of development, the Department of State is committed to learning more about the problems of toxic emissions of burning materials.

Contained on the following pages is a summary of the findings issued by Arthur D. Little Inc., which conducted the Department's study, and the resultant recommendations of the Secretary of State to the Uniform Fire Prevention and Building Code Council.

LEGISLATIVE HISTORY

Chapter 552, Laws of 1982, recognized the growing concern of the people of the State of New York about injuries and deaths resulting from the toxic behavior of building materials and furnishings when exposed to fire or high temperatures. At the time Chapter 552 was enacted, the Legislature acknowledged that while model test methods exist for rating the toxicity of combustion products, no adequate program exists to improve upon and integrate such tests into the Uniform Fire Prevention and Building Code. In light of this, the Legislature directed the Secretary of State to conduct a study of the toxicity of smoke and gases given off under various temperatures by materials used in building construction and furnishings.

The specific tasks to be performed by the study were as follows:

- *to assess the hazards from smoke and gases produced by the combustion of materials used in building construction and furnishings.*
- *to assess the feasibility of developing or adopting a system of rating the toxicity of materials used in building construction and furnishings.*

The study was to result in the development of a set of recommendations to the New York State Uniform Fire Prevention and Building Code Council. Considering the appropriate tests and standards that currently exist in the field of combustion toxicology, the Legislature anticipated that the Secretary's recommendations might take the form of performance standards for various materials at various temperature conditions.

Assessing the Feasibility of Incorporating Combustion Toxicity Requirements into the Uniform Fire Prevention and Building Code

The firm of Arthur D. Little of Cambridge, Massachusetts, was awarded a contract to undertake a study on the feasibility of incorporating combustion toxicity requirements into the Uniform Fire Prevention and Building Code. Arthur D. Little considered four possible regulatory options available to the State of New York as follows:

- *data filing, which would involve submission of data on combustion toxicity to a designated agency;*
- *product labeling, which would require test results or similar information to be affixed to building materials and furnishings;*
- *performance standards, which would require products to meet or exceed specified test result limits;*
- *material-specific regulation, which would ban materials based on regulatory agency determinations.*

Fourteen test methods for evaluating combustion toxicity were identified and reviewed. Two methods, the National Bureau of Standards Test Method and the University of Pittsburgh Test Method, were selected for more intensive scientific analysis. Both are bio-assay tests involving the exposure of rodents to the products of combustion.

The study concluded that:

- *The University of Pittsburgh Test Method is the most useful test currently available for assessing the hazards of the products of combustion; and*
- *A filing requirement for numerical test data (LC_{50}) is the appropriate performance testing standard at this time. (The*

LC_{50} is the lethal concentration which will cause the death of 50% of exposed animals within the test period.)

The Secretary of State submitted the findings of the Arthur D. Little study to scientific peer review prior to formulation of the following recommendations.

Recommendations of the Secretary of State to the Uniform Fire Prevention and Building Code Council

It is recommended that the Uniform Fire Prevention and Building Code Council require that certain building materials and furnishings be subjected to performance testing to provide information related to the hazard they pose to life safety in a fire scenario. The results of these performance tests should be filed with the Department of State in a Building Materials and Furnishings Data File and this information should be made readily available to the scientific community, the building and construction industry, the fire service and consumers of these products.

The tests and standards that currently exist in the field of combustion toxicology are sufficiently refined to support such performance testing and disclosure at this time. The information subject to public disclosure as a result of adoption of these recommendations will lead to a time when specific performance standards could be considered to minimize the hazards posed by building materials and furnishings in a fire scenario.

The specific recommendations regarding the creation of a Building Materials and Furnishings Data File follow:

- *It is recommended that the Uniform Fire Prevention and Building Code Council establish a Building Materials and Furnishings Data File in the Department of State, that will contain information on specific classifications of building materials and furnishings to be subject to performance testing, and that the file be available for public scrutiny.*

There is without question a need to increase the quality and quantity of information readily available to the public regarding the various properties of building materials and furnishings. The availability of this information will advance combustion toxicology

research and enable architects, builders, owners and occupants of buildings to make better informed decisions when selecting building materials and furnishings.

- *It is recommended that the Uniform Fire Prevention and Building Code Council require that the following classifications of building materials and furnishings be subjected to performance testing, the results of which shall be filed at the Department of State at the earliest practicable date as determined by the Uniform Fire Prevention and Building Code Council:*

  - *Furniture Upholstery*
  - *Mattresses*
  - *Bed Pads*
  - *Interior Wall Finish*
  - *Interior Ceiling Finish*
  - *Interior Floor Finish*
  - *Electrical Wire Insulation and Conduit*
  - *Water Distribution and Sanitary Pipes installed in buildings*

- *It is recommended that the Uniform Fire Prevention and Building Code Council prohibit the installation of any building materials or the use of newly acquired furnishings subject to the recommended performance testing and filing requirements, if the manufacturer of such product has not complied with the performance testing and filing requirements.*

This will help to ensure that the performance test and filing requirements are enforced.

- *It is recommended that the performance testing and data filing requirements imposed by the Uniform Fire Prevention and Building Code Council on these building materials and furnishings include the use of the University of Pittsburgh bio-assay protocol for measuring combustion toxicity.*

This test method was certified by Arthur D. Little as an appropriate performance test considering those currently available in the field of combustion toxicology.

- *It is recommended that the Uniform Fire Prevention and Building Code Council require manufacturers to disclose the percentage of halogens (chlorine, bromine, iodine, fluorine) contained in the products included in the categories of building materials and furnishings listed above. This information should be incorporated into the data filed with the Department of State and should be calculated to the nearest percent.*

Bio-assay tests alone do not fully account for the action of acid gases produced by products containing halogens or other chemical elements which are inclined to release acid gases. This limitation is attributable to the differences in the way rodents and humans breathe under stress: humans, unlike rodents, breathe through the mouth, exposing the lungs and trachea more directly to acid gases.

- *It is recommended that the Uniform Fire Prevention and Building Code Council require that information regarding the ignitibility and flame spread characteristics of the building materials and furnishings listed above be included in the Building Materials and Furnishings Data File.*

The following standard fire performance tests will provide the necessary information for those classifications of materials and furnishings to which these performance testing and filing requirements should apply:

- *Wall and ceiling materials - the Steiner Tunnel Test, also known as ASTM 84, NFPA 255 and UL 723.*

- *Interior Floor Finish - Critical radiant flux of floor covering systems using a radiant heat energy source, NFPA 253 and ASTM E 648.*
- *Upholstered furniture - NFPA 260A, Standard Methods of Test and Classification System for Cigarette Ignition Resistance of Components of Upholstered Furniture, 1983. This method is to be used for upholstered furniture, other than that used in facilities, such as hospitals, nursing homes, residential-custodial care, and supervisory facilities, such as (1) educational, (2) assembly, or (3) residential occupancies. NFPA 260B, Standard Method of Test for Determining Resistance of Mock-up Upholstered Furniture Material Assemblies to Ignition by Smoldering Cigarettes, 1983. This method is to be used for upholstered furniture used in facilities, such as hospitals, nursing homes, residential-custodial care and supervisory facilities or in public areas or facilities, such as (1) educational, (2) assembly, or (3) residential occupancies.*
- *Mattresses and Mattress Pads - Standard for Flammability of Mattresses and Mattress Pads (16 CFR Part 1632).*

The public interest in arriving at a meaningful approximation of the fire hazards posed by building materials and furnishings, is further served by requiring the disclosure of flame spread and ignitibility, in addition to combustion toxicity and chemical components.

CONCLUSION

The Uniform Fire Prevention and Building Code Council will review these recommendations and has indicated an intent to act upon them in six months. In its deliberations, the Council is urged to consider whether complying products should be labeled, tagged or otherwise identified.

Furthermore, It is recommended that the Code Council conduct a series of public hearings throughout the State prior to taking final action.

Adoption of these recommendations by the Code Council will raise a number of issues for consideration by the Governor and the Members of the Legislature as follows:

- *Possible restriction on sales of affected products which have not been tested or for which appropriate data have not been filed.*
- *Extension statewide of the applicability of the performance testing, filing and labeling requirements and the related use of sales restrictions. This would provide that building materials and furnishings used in New York City, as well as any other municipality in the State not covered by the Uniform Fire Prevention and Building Code, be subject to the requirements.*
- *Appropriation of adequate funding to the Department of State to support the recommended responsibilities related to data filing and analysis.*

Consumer Product Safety Commission
and
National Aeronautics and Space Administration
are pleased to sponsor a

NATIONAL CONFERENCE ON FIRE TOXICITY

Tuesday, June 26, 1984
Crystal Gateway Marriott
Jefferson Davis Highway
Arlington, Virginia

- MORNING PROGRAM -

7:30 - 8:45 Conference Registration and Coffee

9:00 Opening Remarks:
Nancy Harvey Steorts, Chairman
Consumer Product Safety Commission
Dr Hans Mark James M. Beggs, Administrator
National Aeronautics and Space Administration

9:30 - 10:30 Federal Activities: "The Leading Edge"
Moderator: Commissioner Stuart M. Statler
Speakers: Richard Gann, Chief, Fire Measurement and Research Division, Center for Fire Research, National Bureau of Standards
John Parker → Richard J. Tobiason, Manager of Aviation Safety Technology, National Aeronautics and Space Administration
Ed. McWall → Administrator, U.S. Fire Administration, Federal Emergency Management Agency
Peter W. Preuss, Associate Executive Director, Directorate for Health Sciences, U.S. Consumer Product Safety Commission
Question and Answer Period

10:30 - 11:00 Coffee Break

11:00 - 12:00 State and Local Activities: "Active Role Models"
Moderator: Commissioner Terrence Scanlon
Speakers: Gail Shaffer, Secretary of State of New York
William Lowry, Ph.D., Chief, Dallas Institute of Forensic Sciences
Edward V. Clougherty, Ph.D., Chemist Boston Fire Department
Question and Answer Period

URL U4239

12:15 - 2:00 LUNCH: Luncheon Speaker: Astronaut Robert L. Crippen, U.S.N., Commander, STS41C Space Shuttle Mission

- AFTERNOON PROGRAM -

2:00 - 3:00 "Science and Technology"
Moderator: Dr. Raymond S. Colloday, Deputy Associate Administrator, National Aeronautics and Space Administration
Speakers: Richard C. Brooke, Chairman, Coordinating Committee on Fire Safety, Society of the Plastics Industry
Gordon Vickery, President Foundation for Fire Safety
Arthur E. Cote, Assistant Vice President, Standards, National Fire Protection Association
Question and Answer Period

3:00 - 4:00 Private Sector "Innovation and Application"
Moderator: Commissioner Saundra Brown Armstrong
Speakers: Jack Kepley, Vice President Marketing Division, Weaver Products, Owens Corning Fiberglas
Aerospace Industry Representative
Sally P. Ginter, Research Leader, Flame Retardant Chemicals, Dow Chemical U.S.A.
Irwin A. Benjamin, Benjamin/Clarke Associates, Inc.
Question and Answer Period

4:00 - 4:15 Coffee Break

4:15 - 5:15 "Where From Here? Blueprint for the Future"
Moderator: Chairman Nancy Harvey Steorts
Speakers: Richard J. Tobiason, Manager of Aviation Safety Technology, National Aeronautics and Space Administration
Richard Gann, Chief, Fire Measurement and Research Division, Center for Fire Research, National Bureau of Standards
Steve Biegel, AIA, Vice President, National Institute of Building Science
R. Jerry Johnson, Chairman, Public Affairs Committee, Society of the Plastics Industry
Gail Shaffer, Secretary of State of New York
Peter W. Preuss, Associate Executive Director, Directorate for Health Sciences, U.S. Consumer Product Safety Commission
General Discussion Period

5:30 Reception

Registration Form - National Conference on Fire Toxicity

Name _____ **Title** _____

Affiliation _____ **Telephone** _____

Address _____

_____

Special Needs: _____
(special diet, handicapped assistance, etc.)

Registration Fee: $50.00

Make checks payable to: Consumer Product Safety Commission
Send checks for Conference registration and this completed form to:

National Conference on Fire Toxicity
U.S. Consumer Product Safety Commission
5401 Westbard Avenue, Room 700
Washington, D.C. 20207
(301) 492-6957

You may, if you wish, make your hotel reservations directly with the Shoreham Hotel, Calvert Street and Connecticut Avenue, N.W., Washington, D.C. (202) 234-0700, only until June 6, at the special rate of $55.00 for a single room and $70.00 for a double. A limited number of rooms are available at the Crystal Gateway Marriott (703) 920-3230, only until June 11, at $85.00 for a single room and $105.00 for a double.

NBSIR 84-2871

Fire Research Publications, 1983

U.S. DEPARTMENT OF COMMERCE
National Bureau of Standards
National Engineering Laboratory
Center for Fire Research
Washington, DC 20234

April 1984

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

NBSIR 84-2871

FIRE RESEARCH PUBLICATIONS, 1983

Nora H. Jason

U.S. DEPARTMENT OF COMMERCE
National Bureau of Standards
National Engineering Laboratory
Center for Fire Research
Washington, DC 20234

April 1984

U.S. DEPARTMENT OF COMMERCE, Malcolm Baldrige, *Secretary*
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"Fire Research Publications, 1983" is a supplement to the previous editions:

1969-72	NBSIR 73-246	NTIS Order No. COM-74-10989
1973	NBSIR 74-511	COM-74-11448
1974	NBSIR 75-736	COM-75-11018
1975	NBSIR 76-1120	PB-257837
1976	NBSIR 77-1277	PB-269965
1977	NBSIR 78-1504	PB-284462
1978	NBSIR 79-1745	PB-295395
1979	NBSIR 80-2114	PB80-103335
1980	NBSIR 81-2272	PB81-203317
1981	NBSIR 82-2499	PB82-220104
1982	NBSIR 83-2706	PB83-238915

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