SESSION 1

OPENING OF THE CONFERENCE

MONDAY: August 18, 1986
CHAIRMAN: D.M. Moeller
Harvard School of Public Health

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WELCOME AND OBJECTIVES OF THE CONFERENCE

Melvin W. First

Harvard School of Public Health
Department of Environmental Science and Physiology
665 Huntington Avenue
Boston, MA 02115

It is my special duty and honor to open the 19th DOE/NRC Nuclear Air Cleaning Conference by welcoming each of you on behalf of the Conference sponsors (who are the Harvard Air Cleaning Laboratory of the School of Public Health, the U.S. Department of Energy, and The U.S. Nuclear Regulatory Commission) and the Program Committee of the Conference. I especially want to acknowledge the dedicated service of the Program Committee over the past two years for planning the Conference in detail, for seeking out appropriate speakers, for presenting papers of their own and arranging panel sessions, and finally, for chairing the many sessions and panels that will take place this week.

Chernobyl was surely on the mind of each of us as we gathered for this Conference. Although much of what occurred is still ill defined, and the nature of the protective arrangements, if any, that were in place to avert emissions of radioactive materials to the environment remains largely a matter of speculation, it is inevitable at a Conference such as this one, that we reflect soberly and at length on the efficacy, adequacy, and pertinency of nuclear air and gas cleaning systems to the full armamentarium of protective measures intended to avert such disasters.

Some years ago I was taken to task by a nuclear engineer for stating that air and gas cleaning systems are important because they represent the ultimate protective barrier to atmospheric emissions. The contrary explanation offered was that the containment structure is the final barrier and, therefore, that air cleaning equipment does not count for much. Still, not all operations involving nuclear materials are conducted inside containment vessels and even when they are, TMI-II has surely shown that air cleaning systems are an effective barrier to emissions under unusual circumstances. Current interest in vented containment concepts in a number of countries are scarcely thinkable without the use of ultrahigh efficiency air and gas cleaning systems.

It will come as no surprise to this audience that public fears of nuclear energy have been enormously stimulated by the news from Chernobyl and relentlessly reinforced by the professional anti-nuclear establishment. They are expressing concerns about the reliability of existing containment structures of U.S. nuclear power plants. In my own home state, the Pilgrim Nuclear Plant has recently announced a multi-million dollar program to strengthen their structure to help allay the publicly-expressed fears of nearby community groups. The Governor of my state has found it convenient to respond to identical public fears to abet those opposing the development of an evacuation plan as a stratagem to halt the startup of the Seabrook Nuclear Plant. I am sure most of you can cite similar events in your own community.

One of the effective remedies to counter fears of failed containment is rigorous application of air and gas cleaning technology that is installed for the purpose of rapidly returning the internal environment of the containment structure, in the remote event of an accident, to a safe pressure and to a greatly reduced amount of airborne radionuclides capable of affecting human health should they be released.

The Program Committee has structured the topics that will be addressed at this Conference and has selected the papers that are most pertinent to 1) describing innovative improvements in nuclear air and gas cleaning systems and components and 2) explaining how greater on-line reliability and effectiveness of existing systems may be obtained. The program is liberally sprinkled with panel and open end sessions that permit free exchange of practical operating experiences among all those in attendance.

It is an excellent program and a timely one. On behalf of the entire Program Committee, our DOE and NRC sponsors, and myself, I extend a sincere welcome to all, and especially to those of you who have come from other countries to enrich our knowledge and to study, with us, ways to make nuclear activities - not safer, but safe.

HISTORY OF RADIATION MONITORING

by

MICHAEL J. LAWRENCE

Manager
U.S. Department of Energy
Richland Operations Office

Hanford has a long and well-publicized history of involvement with air emissions control. As the nation's first plutonium production facility, we were pioneers in environmental engineering. Because we were dealing with a new and unknown capability in those early years, air cleaning technology, as we know it today, did not exist--nor did the knowledge that must precede it.

When the Hanford Site was acquired in 1943, the sparsely populated desert area was covered with sagebrush, inhabited by deer and blessed with pristine air and water. From the very beginning, there has been a real concern for maintaining the clean air and water of that natural environment. This is emphasized by the ongoing development of engineering techniques to minimize production hazards.

Before the first two nuclear production reactors were completed at Hanford, both onsite and offsite air sampling stations were installed. Sampling of air within the facilities and for stack effluents began shortly after initial start-up of Hanford's reactors.

The tolerable levels of pollutants in air and water were first calculated in early 1944. The radiation standard from 1943 through 1949 war 0.1 R per day to the total body. No distinction was made between workers and the public, and the dose limit was based on the exposure that would not produce an observable effect. Hanford complied with these standards and began monitoring worker radiation exposure at the time of production startup.

Routine sampling and analysis of environmental substances--including air, water, and soil--were initiated in 1945, after the war ended. Prior to that time, operations documents reflect an urgent emphasis on plutonium production for the war effort. During the rush to produce the needed plutonium, extremely large quantities of Iodine-131 were released to the atmosphere.

In 1945, there were 345,000 curies of Iodine-131 released; however in December 1949 the approximate release level was measured at 5,000 curies of Iodine-131. It is believed that the reduction was related to our increased detection capability and that part of the curies released were from the Soviet Union's emerging nuclear weapons program.

By today's standards, those early iodine release levels were very high; but the early standards were different. A tolerance level for Iodine-131 in edible plants was established by the Hanford Medical Department in early 1946. This level was set at 200 pico-curies of Iodine-131 per gram of vegetation.

By 1948, the tolerance concentration level for Iodine-131 on vegetation was lowered to 10 pico-curies per gram. And in 1950, the NCRP changed the radiation protection standards to 0.3 R per week and 3.9 R per 13 weeks to the total body. In 1954, the radiation protection standards were changed again--this time to 0.3 rem per week, or 3 rem per 13 weeks and 15 rem per year.

Between 1958 and 1963, a number of new radiation protection standards were established. Many of these standards have remained in effect since that time.

Estimates of radiation doses to members of the public were first identified by Hanford scientists in 1957. Hanford scientists were also the individuals who sat on the international boards that established radiation limits and were otherwise leaders of the nuclear movement. It is difficult to separate Hanford's history from that of nuclear development.

Hanford has played a key role in the evolution of radiaton monitoring, which will continue to be an ongoing process. And of course, as with any new technology, miscalculations were made along the way, resulting in corrective changes in monitoring procedures. Iodine releases like those that occurred in the early years would never be allowed today because we know a great deal more than we did in the beginning.

All of our early records, including those 1945 sampling analyses, were maintained in environmental reports that form a portion of Hanford's historical documents, which were released in February 1986, to the public by the Department of Energy. Those historical documents are part of our "report card" at DOE. That report card shows how our operations affect both people and the environment.

If you look at the records, you will see a dramatic decrease in radiation releases over the years. In 1957, the maximum dose received by an individual from all sources in the Hanford area, including fallout doses, ranged between 10 to 20 mrem per year. In 1963, the dose peaked at 110 mrem, due to significantly increased international nuclear testing and world-wide fallout.

By 1973, the maximum dose had dropped markedly to 2 mrem. Since 1973, the maximum dose has been in the range of a few mrem per year from Hanford operations.

When you compare these totals with coal- and oil-fired plant operations, you will see that the release rates for those fossil fuel plants is ten times higher than Hanford's. The annual does rate to the average population from coal- and oil-fueled plants ranged from 0.25 to 4 mrem per year, according to the Bier III Report. And those figures represent only air readings, while Hanford's 0.03 mrem per year dose rate for the average individual includes all pathways.

I am proud of the role Hanford has played in the evolution of nuclear energy. Of course, I wish we had the knowledge we have today back in our embryonic era. That knowledge would have prevented mistakes that were made due to a lack of necessary technology.

However, looking back at the limits we have used over the years, we can compare them to the speed limit. In the 1940's, the speed limit was anywhere from 70 mph to unlimited speed. If we were to compare operating standards of that time with the national speed limit, Hanford was operating at 69 mph. Today, the speed limit is set at a much safer limit of 55 mph; however, Hanford now operates at approximately 1 mph, far more efficiently than standards require. We are that committed to comply with environmental regualtions and operate in a manner that keeps releases as low as reasonably achievable.

What were the effects of those early years? Based upon workers, people who both work and live in the area, we see no observable health effects. However, we do not stop here. The DOE is funding a review by both the States of Washington and Oregon inconjunction with the Center for Disease Control to analyze the significance of our vast amount of present data to determine if any further health studies could be of significant benefits.

Hanford has been among the most visible entities in the environmental spotlight, and will probably remain there for some time. And while this hasn't always been easy from a public image standpoint, it has pushed us to improve, to innovate and to ensure that the public and the environment are protected at all costs. Our dedication and commitment to a clean environment has never changed . . . fortunately, our technology has.

BUILDING CONFIDENCE IN ENVIRONMENT, HEALTH AND SAFETY PROGRAMS

Mary L. Walker
Assistant Secretary
Environment, Safety and Health
U.S. Department of Energy
Washington, D.C.

I am very honored for the invitation to speak at this conference. Nuclear Air Cleaning has always been extremely important to the Department of Energy and its predecessor agencies, the Energy Research and Development Administration, and the Atomic Energy Commission. Our sponsorship of these 19 conferences, beginning in 1951, demonstrates our active interest in this subject and the protection that nuclear air cleaning systems provide to the public and the environment.

As you are aware, the nuclear industry in the past several years has been criticized extensively for not having adequate nuclear safety and environmental protection programs in place. Although most of this criticism may have been unfair and based upon perception, some of the criticism was, perhaps, deserved. The 1979 incident at Three Mile Island and, on a different scale, the recent nuclear disaster at Chernobyl, have also heightened public concern about the possibility of accidents in nuclear power plants. This has left us with a severe credibility problem. According to the latest Gallup polls, seventy-three percent of Americans today say they would oppose construction of a nuclear power plant within five miles of where they live. Sixty-six percent of the public favored a cutback in nuclear power operations until stricter safety regulations could be effected. A separate CBS poll found that fifty-five percent of Americans thought an accident similar to that at Chernobyl was likely to occur here. The message is clear. The public lacks confidence in the safety of nuclear power.

Restoring confidence, whether because of real or perceived past actions, requires time and a demonstrated commitment to making safety and environmental considerations the highest priority. I would like to discuss with you today how the Department of Energy is enhancing public confidence in its nuclear safety and environmental protection programs. Two topics that I would like to discuss in relation to this theme are the Secretary of Energy's new initiatives strengthening the environment, safety and health functions within the Department of Energy and the reviews of the safety of DOE reactors we are performing out of an abundance of caution in light of the Chernobyl incident. Clearly related are the public's perception, technical reality and the importance of air cleaning systems as critical protection.

Secretary Herrington's Personal Commitment To Safety

Secretary Herrington has made a personal commitment to operate DOE facilities in an environmentally sound and safe manner. In January of this year, the Secretary issued the Department's Environmental Policy Statement which sets forth the framework for the Department to meet its environmental obligations. The policy states that "... protection of the environment and the public are responsibilities of paramount concern and importance ....", and this extends to workers and their families at each of our sites. The policy firmly commits DOE to assuring incorporation of national environmental protection goals in the formulation and implementation of DOE programs. The policy statement contains four major points:

(1) First, as a matter of public trust, the Department considers it an obligation to conduct its operations in a safe and environmentally sound manner;

(2) Secondly, it is the policy of DOE "to conduct its operations in compliance with the letter and spirit of applicable environmental statutes, regulations, and standards;"

(3) Thirdly, the Department pledges itself to exercise good environmental management by seeking to minimize risks to the environment or public health; and

(4) Fourth, DOE expects its operating contractors to share its commitment to good environmental management and to conduct their operations in an environmentally sound manner. DOE will actively oversee contractors' activities to assure compliance with this policy.

Air quality and the effect of DOE activities on air quality, both in operation and in accident mitigation, are important factors in meeting the Secretary's commitment.

The Secretary's formal policy statement followed equally significant actions he took in 1985. In September of that year, the Secretary announced a set of new initiatives to strengthen the environment, safety and health functions of the Department. These new initiatives are the result of a thorough independent review of those functions conducted at Secretary Herrington's request. As I describe these initiatives, keep in mind they were pre-Chernobyl, and pre-Challenger accidents. The key elements of the initiatives are:

(1) A new Assistant Secretary for Environment, Safety and Health and consolidation of all Departmental environment, safety, and health functions under this official, whose responsibilities are independent from and do not include any programmatic functions;

(2) Technical Safety Appraisals of DOE's major nuclear facilities to determine not only compliance with safety requirements, but also industry lessons learned, and licensed facility requirements;

(3) A baseline Environmental Survey of DOE facilities in order to catalog and prioritize all existing environmental problems and areas of concern; and

(4) A computer assisted tracking system that will allow us to monitor compliance and assist us in identifying and reducing areas of potential risk.

In addition to the environmental policy statement, the Secretary will soon release a safety policy statement. The policy statement re-enforces the responsibilities of line managers to conduct their activities in a manner that assures the safety of our workers and the public. The policy further stresses the Secretary's commitment to a strong, centralized safety over-sight organization, to develop health and safety policy, and to assure the implementation of that policy.

A major objective of this safety policy is to have program personnel at all levels in the organization become knowledgeable and sensitive to health and safety requirements and concerns. Headquarters program managers, whose responsibilities include program development, planning and implementation, are expected to integrate safety and health concerns into their basic requirements and have safety and health considerations be a part of their management responsibilities.

Thus, in order to meet our responsibility to assure safety and the protection of the environment, we have embarked on a multi-faceted plan under my direction with the solid support of all of the Department's senior management. Air cleaning plays an important, technical role in meeting this responsibility.

Centralized Responsibilities for Policy and Oversight

The first of the three elements of the initiatives was to consolidate and upgrade the environment, safety and health organization. That has been accomplished. Environment, Safety and Health Department-wide policy is now set by this new office. Also, my office provides DOE line management with more detailed information about the nature of potential safety and environmental problems, and oversees more directly the corrective action to be taken.

Air cleaning concepts have been factored into our policy development and are an important element in our supported programs. We have reviewed the Department's policies in areas such as design criteria and safety analyses. We have updated industrial ventilation design criteria in the Department's General Design Criteria Manual. We have revised the plutonium glove box design criteria, which included many filter and ventilation High Efficiency Particulate (HEPA) System design and operating considerations. (We plan to incorporate the HEPA filter test standards into the Department's directives when the standards are finalized.)

Other projects in which my office is involved include the update of two documents, the "Nuclear Air Cleaning Handbook" and the "Nonreactor Nuclear Facilities: Standards and Criteria Guide." Both contain important confinement and ventilation design criteria. We are also supporting analytical and experimental work examining the effects of explosions on ventilation systems. And finally, there is our sponsorship of conferences such as this one.

Technical Safety Appraisals

The second component of the Secretary's initiatives was to conduct thorough Technical Safety Appraisals of DOE's high and moderate hazard nuclear facilities by teams of experts led and directed by my senior technical staff. In the course of these safety reviews, we will review more than 50 nuclear facilities in over 11 states. The onsite activity for each appraisal lasts about 2 weeks, preceded by weeks of preparatory work. These comprehensive reviews are in addition to, and are significantly different from our other ongoing safety appraisals. First, the Technical Safety Appraisals are detailed, multi-disciplined reviews of a facility's design and operations. Secondly, the Technical Safety Appraisals will not only determine compliance with DOE requirements and policy; but will also review implementation of industry requirements, standards and guides, industry lessons learned, and good engineering practices. In this manner, these appraisals strive to reach a new standard of safety excellence at our facilities. Lastly, the appraisal teams consist of technical experts from DOE, private industry, universities, and private consultants.

The appraisals began at the Fast Flux Test Facility in February of this year. To date, six appraisals have been conducted. The most publicized has been the Technical Safety Appraisal conducted of the N Reactor in Hanford, Washington, because of the similarity to the Chernobyl reactor in the use of a graphite core. For the Technical Safety Appraisal of the N Reactor, a total of 105 PERFORMANCE OBJECTIVES were addressed in 14 subject areas. (These included examining the ventilation system's ability to prevent the spread of radioactivity into clean areas and checking if the gaseous effluents from the plant were being properly monitored.)

The Environmental Survey of DOE Facilities

Nuclear safety appraisals alone are not sufficient to rebuild public confidence. The public wants to know how we are going to fix our environmental problems and be assured that we have addressed environmental risks. This led to the third element of the Secretary's plan -- the Environmental Survey. We have just begun the baseline Survey of six DOE operating facilities and programs. In the area of airborne emissions, DOE's diverse facilities contain about 1800 air emission stacks, not all, of course, related to nuclear activities. But this gives you an idea of the scope of our task!

The Survey will cover all media: air, water, soil, and all areas of environmental regulation. The purpose is to identify problems and areas of risk, and to prioritize Department-wide, in a single effort, necessary corrective actions. The Survey will be a management tool that will enable effective and wise long-range planning to correct problems, to ensure compliance and to reduce identified areas of risk.

Public Confidence - Chernobyl vs. N Reactor

As I stated earlier, the Soviet Union's nuclear accident at Chernobyl has heightened public concern about the possibility of accidents in nuclear power plants. We are still trying to determine the causes to understand the accident at Chernobyl. As with other events, nuclear and non-nuclear, we will be determining whether any new phenomena occurred that may have been overlooked in prior reviews. Our preliminary analysis shows that U.S. reactors are better designed to prevent a Chernobyl-like event. One of these key design differences is in the systems used to prevent uncontrolled release of fission products. A case in point is the N Reactor at Hanford, Washington.

At Secretary Herrington's request, before the fire was even out at Chernobyl, a series of safety reviews were ordered to be conducted by my office of the N Reactor at the Hanford site. The first, a "Special Safety Review," looked specifically at the fire protection safety of the N Reactor's graphite moderator and the safety of the reactor's confinement system. The second was the "Technical Safety Appraisal" which closely examined all operating aspects of the reactor with regard to safety. (The schedule for this review, already planned, was accelerated seven months.) The third review, recently completed, was a "Design Review" which considered the safety of all design features, the safety analysis on which the operation of the reactor is based. Based on the limited knowledge we have of the Chernobyl incident and the reviews we have conducted at N Reactor, we believe that a Chernobyl-type accident could not occur at N Reactor.

A comparison between the N Reactor and the Chernobyl Reactor shows that the N Reactor confinement completely envelopes the entire reactor primary coolant system and reactor core. This is in direct contrast to the relatively small-volume steam suppression confinement system used in the Chernobyl RBMK design, which surrounds only the part of the coolant system below the top core region.

Our preliminary analysis indicates that at Chernobyl the release path of the radioactive debris was through the top core region, completely by-passing the Soviet-designed confinement system which only partially encloses the core. In contrast, N Reactor's confinement system completely surrounds the core, and the air cleaning system provides the public and the environment protection from a significant radiological release should a severe reactor accident occur.

These are the facts. Yet public confidence is lacking. One of my duties at the Department of Energy is the task of enhancing our credibility with the American public and to make the facts known. Your work plays a vital role in this since the effectiveness and reliability of nuclear air cleaning systems is a strategic element in the assurance of safety and environmental protection. Public confidence in these systems is important. The N Reactor case demonstrates the importance of your role.

Closing Remarks

In closing, I want to leave you with a couple of thoughts. First, to improve public confidence in the safety of nuclear power, the Department of Energy is actively enhancing its programs in the areas of nuclear safety and environmental protection. President Reagan and Secretary Herrington have made this a high priority at the Department of Energy. This has been mirrored, too, by private industry's actions that we fully support. Finally, your work, your exchanging of ideas on the international level, and your active participation in conferences such as this, help strengthen the safety and environmental programs that assure a continued good, sound operation and will, ultimately, lead to a strengthening of the public's confidence in nuclear power.

I appreciate and commend your personal and corporate commitment to assuring the integrity of our systems and to improving the nuclear industry worldwide. As bold, new and exciting technologies carry us into the future, we must move ahead, but always maintain our first commitment to the environment, safety and health of our programs and, most importantly, to the public.

DISCUSSION

BELLAMY: Ms. Walker, I tried very hard to get an upbeat, positive philosophy from your talk, but I wonder how much optimism you really have in light of the expected February mandated cuts in our budget due to the Gramm-Rudman-Hollings bill?

WALKER: I have to say that I am optimistic. I think that what the Department of Energy has done was wanted by the nuclear industry. Our focus on a standard of excellence goes well for us. While we are in a time when the American public does not necessarily feel the need for energy sources other than petroleum, I think the nuclear industry will survive. I think we can be upbeat about what we have to say about it in America because other countries feel the same way we do about safety and environmental concerns. Budgets are budgets. They force us to be more constrained about how we spend our dollars. I have to fight for my own budget up on the Hill and I share with you all the concerns you have about that. Both Mike Lawrence and I would like to spend more dollars than we currently have available for oversight, safety, and for correcting our problems. It may mean that it will take us longer to accomplish our objectives and as a result, it may takes us longer to restore public confidence. But, I am confident that ultimately we will.

HULL: Those of us who are here would, by and large, feel that these were responsible and satisfactory efforts. I am speaking more from what I read in the press. I wonder what you feel are the odds that the public will be satisfied short of somebody else, such as the NRC, looking over DOE's shoulder in applying an NRC-type approach to the safety and environmental problems DOE has?

WALKER: I will tell you first of all that self regulation is a big issue for me and for the agency. Every time I testify, which is often these days, I am hit with self regulation and whether or not it is meaningful; whether or not somebody else shouldn't be looking over our shoulders. The real accurate technical answer, and anyone from NRC may wish to debate me on this, is that NRC itself admits they wouldn't now be ready to oversee us. They don't have the expertise, it is at DOE. They would probably end up hiring one-half of my staff if they had to do it. Therefore, I don't know what purpose it would serve except, perhaps, as you suggest, the appearance of having it occur somewhere other than within the Department. However, I am not even sure that that is a public concern as much as it is a political concern. In terms of some of the rhetoric coming out of Congress, it is more of a social agenda than a concern for safety. These people are really opposed to the nuclear power option. They will use any mechanism that they can find to slow it down, impede it, or whatever. I really think the Department of Energy has a credibility problem born of its past actions. That may be true for the nuclear industry as a whole. It is certainly true of corporate America in the environmental area. We have a problem that we, in part, caused and we have to fix it. Assuming that we can do that in a timely enough manner, I believe that we can demonstrate our commitment in such a way that we won't end up with other oversight, which I think wouldn't necessarily be productive, wouldn't necessarily be very effective, and certainly would take a long time to put into place. In short, I really don't think it would be a good idea, but at the same time, we have a problem we have to overcome if we are going to avoid it.

HULL: I just want to say for the record, as a DOE person, we do go out and supply some of our expertise to NRC.

BASTIN: Shortly after the accident at Three Mile Island, Hugh Sidey (Time Magazine Washington Contributing Editor and Agronsky & Company panelist) made the comment at a seminar at the National Academy of Sciences that the news media don't really understand nuclear power and nuclear systems. No matter what we do to improve our safety, the public will see the 6:30 news, five minutes of irresponsible reporting which distorts everything we do and everything we say, and makes our systems appear unsafe. I watched you on TV a few nights ago, and you had good comments on nuclear safety. Then there followed five minutes of how terrible everything is, how radon is released all over the place and gets into the atmosphere. People are concerned. Is there anything being done, are there any programs to provide a bit of education for the news media? Is there any dialogue with the management of the news media?

WALKER: Let me attempt to answer that and then give Mike Lawrence a chance to comment because he is certainly out there on the firing line. You raised a very important point and it has been recognized both by our friends on the Hill as well as internally within DOE that no matter how good a job we are doing, no matter what we are doing in moving forward to the future to seek a standard of excellence, if we can't communicate that effectively it is lost on the public. You are right. The press and the stories that are on the news, whether they understand it or not, certainly are not designed to convey the other side of the story. I can't always tell whether that is by intent or by accident. I think in some cases we need to be more available to educate them on what is happening. In the case of the one news story you were alluding to, that was not a failure of ours to educate them, it was really a decision on their part to proceed in a certain manner to get an effect that they wanted. We are out there; we are available. I indicated that our reports are public. We usually have press releases on them. What I have seen in the private industry sector is an attempt to educate people through the newspapers regarding the safety systems that are already in place. I think it is hard for an industry that is very technical, and has operated for a lot of years with the public fairly content to allow them to be technical off on their own, to realize that all of a sudden we are in the public arena, and if we aren't, we should be. Maybe it is more evident in Europe than it is in America. Maybe we are more behind, I don't know, but certainly we have an educational task ahead of us and we are always looking for opportunities to do that in a meaningful way. You don't want to overwhelm people with so much technical information that they become lost, but at the same time you have to explain the safety systems, or at least explain that they are there, so they will have confidence in them.

LAWRENCE: I would just add that I think we would have to be both constant and candid. It is amazing, sometimes, to see how much they get right considering that they have so little knowledge coming into an issue. They are told a lot of things in a fifteen minute interview or press conference after something goes wrong and then they must report on it. Consequently, I think things like frequent briefings, press conferences, tours to try to educate are important over time. I think when you blow it you have to say you blew it and you are going to do better next time. You have to be candid that way. But, I think if we are going to rely on the public to get all of their information through television, everything they know about a certain topic through a one minute news blip, we are doomed to failure. It has got to come to them over time, it has got to be an educational process so that the public gets the basic information and develops a basic trust in what is going on. That can only happen, as Mary says, over a long period of time through our actions. That is the best hope we have. I am confident it can happen because I am confident that is the type of leadership people we have involved in the industry and in government right now. They recognize that outreach and candor are important to gaining credibility and, given time, that will work.

IODINE FILTRATION - DO WE HAVE A PROBLEM?

by

Robert M. Bernero*

Abstract

Filtration of radionuclides at nuclear power plants is important for normal operation as well as in the event of an accident. For normal operation, data have been collected which indicate that iodine filtration reduces offsite exposures significantly. For accidents, both during and following the event, the effectiveness of filtration depends on whether the filters are bypassed or overwhelmed.

First, I will summarize our present knowledge and use of accident fission product characteristics in Part I. Then, in Part II, I will review our understanding of iodine releases for normal operation. In Part III, I will discuss the filtration of iodine, including an overview of our understanding of the current technology. Finally, in Part IV, I will identify the kind of fission products we might expect for severe accidents, whether present capabilities may be adequate, and what could be done to improve existing capabilities.

I. Accident Source Terms

Accident source terms have been a consideration in the regulation of reactors since the 1950's. In 1962, 10 CFR Part 100 was published, referencing Technical Information Document TID 14844, "Calculation of Distance Factors for Power and Test Reactor Sites." In this document, a loss-of-coolant accident (LOCA) was assumed to release 100% of the noble gases, 50% of the halogens, and 1% of the solids in the core (equal to about 15% of the gross fission product activity). It was assumed that the event involved a substantial meltdown, and that the release was inside an intact containment. Some 50% of the iodines released inside the containment were assumed to be available for release to the environment. Regulatory Guides 1.3, "Assumptions Used for Evaluating The Potential Radiological Consequences of a Loss of Coolant Accident for Boiling Water Reactors," and 1.4, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Pressurized Water Reactors," assumed 91% of the iodine inside the containment to be elemental (I_2), 5% to be particulate, and 4% to be organic iodides. In reference to the particulates, the usual practice has been to assume that they are not released from the containment. The above assumed releases characterize the containment source terms that have been used in calculating the effectiveness of engineered safety features (e.g., containments and filters) as well as site suitability. Such calculations are used to perform design basis evaluations.

*Director, Division of Boiling Water Reactor Licensing, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, D.C., 20555

In October 1975, the Reactor Safety Study (WASH-1400) was published. This study indicated that the bulk of public risk, although low, could be attributed to accidents more severe than design basis events. A major part of that study was the assessment of fission product releases for typical PWRs and BWRs.

After the TMI accident of March 1979, several significant actions related to accident source terms were undertaken. Among these were efforts to reassess accident source terms as well as the existing design and operation of filter systems. The source term effort has resulted in a number of significant findings which are based upon detailed models, taking into account the physical and chemical processes associated with the release of fission products and their attenuation through the reactor vessel, coolant systems, containment and exterior compartments. Calculations using these models have led to source term estimates differing significantly from those in WASH-1400. Furthermore, because of differences in plant designs and accident sequences, the estimates themselves vary significantly. The analytical models have been supplemented and partially verified by a number of small and large-scale experiments. The verification efforts are continuing. As part of the same work, considerable attention has been given to the chemical forms of the various nuclides. For iodine, CsI, HOI and I_2 compounds have been identified, with CsI in aerosol form potentially dominating. These studies indicate significant uncertainty in the chemical forms, and point to potentially important differences between boiling water reactors (BWRs) and pressurized water reactors (PWRs). The differences are attributable to the dissimilar uses of boron at BWRs and PWRs.

The WASH-1400 report, as well as some more recent studies, have not credited the plant operators with the ability to arrest core melt, containment failure, or bypass sequences. Also, potential safety improvements have not been considered. In both cases, significant changes in source term estimates could result.

Table 1 illustrates the range of historical source term estimates that have been made for BWRs.

II. Results of Monitoring Plant Releases In Normal Operation

Now, let me review our understanding of iodine releases and filtration for normal operation.

During the past ten years or so, the Idaho National Engineering Laboratory has conducted an in-plant source term measurement program for the NRC. This program involved the assessment of normal plant releases of radioactive materials at five PWRs and one BWR. The primary objective of the program was to provide operational data that could be used for licensing reviews of liquid and gaseous radioactive waste management systems. EPRI has conducted a similar program at three other BWRs.

As expected, it was observed that airborne iodine releases during normal plant operation, including anticipated plant operational occurrences, are directly related to the reactor coolant iodine concentration. In terms of annual release rates, data for 1983 indicate that a total of approximately 10 curies of iodine were released from 66 operating LWRs

TABLE 1

FRACTION OF FULL POWER CORE RELEASED

SOURCE OF ESTIMATE	Xe-Kr 1	organic I 2	FISSION I 3	PRODUCT Cs Rb 4	GROUP Te Sb Se 5	Ba Sr 6	Sr 6.1	Ru,Rh,Co, Mo,Tc 7	La,Y,Zr, Nb,Ce,Pr, Nd,Pu,Am, Cm 8	La,Zr,Nd, Eu,Nb,Pm, Pr,Sm,Y 8.1	Ce,Pu,Np 8.2	Ba 8.3	ESTIMATE CIRCA	ACCIDENT TYPE
TID-14844 FOR RE-LEASE FR CONTAIN	1.0	--)))	.25	(.01 OF SOLIDS -----------))) IODINES & NOBLE GASES ONLY RELEASED FROM CONTAINMENT @ .001 OF VOLUME PER DAY									3/23/62	LARGE BREAK LOCA
REG GUIDES 1.3 & 1.4	1.0	.01	ELEMENTAL+ PARTICULAT .24	(.01 OF SOLIDS ----------)))SOLIDS NOT RELEASED IODINES & NOBLE GASES ONLY RELEASED FROM CONTAINMENT AT TECH SPEC LEAK RATE									6/74	LARGE BREAK LOCA
WASH 1400 (PEACH BOTTOM)													10/75	
BWR1	1.0	.007	.4	.4	.7	.05	(b)	.5	.005	(b)	(b)	b		STEAM EXPLOSION
BWR2	1.0	.007	.9	.5	.3	.1	(b)	.03	.004	(b)	(b)	b		LOSS OF DECAY HEAT REMOVAL
BWR3	1.0	.007	.1	.1	.3	.01	(b)	.02	.004	(b)	(b)	b		ATWS
BWR4	.6	.007	.0008	.005	.004	.0006	(b)	.0006	.0001	(b)	(b)	b		CORE MELT WITH ONLY CONTAINMENT LEAKAGE
BWR5	.0005	.0000000002	6 E-11(c)	.000000004	8 E-12(c)	8 E-14(c)	(b)	0	0	(b)	(b)	b		DBA/LOCA
NUREG0956 DRAFT FOR PEACH BOTTOM													7/85	
AE	1.0	(a)	.32	.31	.67	.5	(b)	.005	.021	(b)	(b)	b		LOCA WITH OVERPRESSURE FAILURE-BWR2
TW	1.0	(a)	.049	.052	.2	.19	(b)	.0018	.0053	(b)	(b)	b		LOSS OF DECAY HEAT REMOVAL-BWR2
TC3'	1.0	(a)	.16	.14	.48	.39	(b)	.0019	.018	(b)	(b)	b		ATWS-BWR3
BCL FOR GRAND GULF													2/26/86	
TB1	1.0	(a)	.00028	.00024	5.4 E-7(c)	(b)	.0034	.0033	(b)	.00018	.00031	.0023		STATION BLACKOUT W/LATE CONTAINMENT FAILURE
TB2	1.0	(a)	.016	.013	.11	(b)	.30	3.7 E-7(c)	(b)	.021	.034	.10		STATION BLACKOUT W/EARLY CONTAIN. FAILURE FROM IGNITER FAILU
TC2	1.0	(a)	.0032	.0036	.0025	(b)	.0015	5.2 E-9(c)	(b)	8.6 E-5(c)	.00014	.001		ATWS
BCL FOR PEACH BOTTOM													5/13/86	
TC1	1.0	a	.031	.033	.24	b	.49	.00000035	b	.012	.022	.39		ATWS WITH DEPRESSURIZATION/REPRESSURIZATION FAILURE
TC2	1.0	a	.013	.014	.007	b	.3	.000002	b	.0072	.015	.19		ATWS W/O DEPRESSURIZATION
TC3	1.0	a	.00062	.0096	.0045	b	.0072	.00000041	b	.00032	.00049	.0042		ATWS WITH VENTING THRU WETWELL @ 110 % OF DESIGN PRESSURE
TB1	1.0	a	.012	.014	.22	b	.37	.0000004	b	.031	.048	.28		STATION BLACKOUT WITH LATE CONTAINMENT FAILURE
TB2	1.0	a	.036	.041	.23	b	.44	.0000007	b	.035	.055	.34		STATION BLACKOUT WITH EARLY CONTAINMENT FAILURE
V	1.0	a	.44	.44	.26	b	.24	.0000014	b	.013	.023	.2		CONTAINMENT BYPASS THRU LOW PRESSURE ECCS PIPING

NOTES:
a. organic I combined with I in group 3
b. fission product elements regrouped in 1986
c. 6 E-11= 6 X 10-11 = .00000000006

(or 0.15 curies of iodine per reactor). The average annual iodine release per reactor has been somewhat constant for the past 15 years.

For BWRs, most of the iodine is released through the Turbine Building Ventilation System. Within the Turbine Building, more than 85% of the iodine is released from the ventilation system serving the main condenser area (steam line, feedwater heaters, reheaters, moisture separators, etc.) during normal power operation. The remaining iodine releases came from miscellaneous other areas, such as the steam jet air ejector room, the turbine operating floor, the feedwater pump room, and the mechanical vacuum pump room.

For PWRs, negligible amounts of iodine are released from the Turbine Building Ventilation System. On the average, approximately equal amounts of iodine are released from the Auxiliary Building, the Containment Purge and the Radwaste Building Ventilation System, although the relative contributions tend to vary widely depending on the specific plant and its conditions.

Under normal reactor operating conditions, the forms of radioiodine observed in plant atmospheres and plant gaseous effluents are: (1) particulate, (2) the elemental (I_2), (3) possibly hypoiodous acid (HOI) as a vapor or gas, and (4) organic (usually assumed to be CH_3I).

As shown in Table 2, the predominant iodine chemical forms appearing in BWR releases are elemental and HOI. The exception is in the case of releases from the Radwaste Building, where the principal form is organic iodine.

TABLE 2
BWR Releases In Normal Operation

Iodine Form	Fraction of Total Iodine Species			
	Containment	Auxiliary	Turbine	Radwaste
Particulate	0.11	0.2	0.2	0.002
Elemental	0.32	0.48	0.50	0.28
HOI	0.38	0.24	0.22	0.25
Organic	0.19	0.09	0.08	0.47
	1.00	1.00	1.00	1.00

For PWRs, the predominant iodine species released from the Containment and Auxiliary Buildings is organic, while elemental and HOI are the principal forms released from the Turbine and Fuel Handling Buildings respectively.

TABLE 3
PWR Releases In Normal Operation

Iodine Form	Fraction of Total Iodine Species			
	Containment	Auxiliary	Turbine	Fuel Handling
Particulate	0.09	0.04	*	0.01
Elemental	0.21	0.21	0.78	0.17
HOI	0.21	0.22	*	0.57
Organic	0.49	0.53	*	0.25
	1.00	1.00	*	1.00

*No data on breakdown of other species.

We observed that with time the chemical specie of airborne iodine changes from the reactive forms (elemental and HOI) to the relatively non-reactive organic form. We believe that this phenomenon is due to the reactive forms of iodine depositing on surfaces (walls, charcoal filters, etc.), reacting with organics, and then resuspending in the air.

For example, at Turkey Point and Rancho Seco, we observed that the iodine species distribution changes with time after the Containment Building has been isolated. The initial amount of reactive iodine decreased with time and after about six days after containment isolation, organic iodine exceeded 90%.

III. Filtration of Iodine

Now, let me turn to an overview of our understanding of the current iodine filtration technology and the associated difficulties that we face in reactor licensing.

Charcoal filters have been found to be effective in the removal of iodines in both particulate and gaseous forms from the building ventilation systems of nuclear power plants. Observed decontamination factors for various species of iodine are shown in Table 4.

TABLE 4

Iodine Form	Iodine Decontamination Factors	
	Average	Maximum
Particulate	10	600*
Elemental	200	300
HOI	200	1600
Organic	50	100

*included roughing and HEPA filters

The maximum decontamination factors occur for new charcoal, or when the influent iodine concentration increases significantly. This is relatively important during and following an accident, when the iodine concentration can increase significantly and the more reactive iodine species are expected to predominate. Under these circumstances, the efficiency of a charcoal filter for iodine removal is expected to be higher. Hence, charcoal filters are more important under accident conditions than under normal conditions.

It appears that high efficiency and long service life of charcoal filters is critically dependent on the process of charcoal impregnation. For example, commercially available activated charcoal with triethylene diamine (TEDA) and potassium iodide (KI) exhibits less penetration by methyl iodide than charcoal which is impregnated only with potassium iodide. Other important observed parameters are the degree of atmosphere contaminants (ozones, sulfur dioxide, nitric oxide etc.) and water vapor in the outdoor makeup air.

Now, I have two problem areas in charcoal filter operation, namely charcoal testing and iodine sampling. First, let us discuss charcoal testing.

The activated carbon in a charcoal adsorber bed degrades slowly due to atmospheric contaminants and moisture. Therefore, nuclear power plant technical specifications require a periodic laboratory analysis of a representative carbon sample. This permits periodic verification of the capability of charcoal filter systems to remove iodines.

In late 1982, the Committee on Nuclear Air and Gas Treatment (CONAGT) conducted a round/robin interlaboratory comparison test. The test involved measuring methyl iodide penetration of new and used nuclear grade charcoal. Some 15 laboratories participated in this effort. Seven of the participating laboratories were from the U.S., and one each were from West Germany, Italy, Japan, Canada, U.K., Finland, Netherlands, and France. The test results were disappointing. New charcoal exhibited penetration in the range from less than 0.01% to 9.3%. For used charcoal, however, the test results varied between 0.37% and 84% penetration.

Again, in late 1984, the second set of round/robin interlaboratory comparison tests were conducted. This time, some eight laboratories in this country, two laboratories from Canada, and one each from U.K., West Germany, and Korea participated. The test results were equally disappointing.

The new charcoal test results varied between 0.23% and 8.4% penetration, whereas used charcoal tests yielded penetrations between 17.4% and 60%. Nuclear power plant standard technical specifications typically require no greater than 1% penetration of methyl iodine for a 2-inch thick charcoal bed. The specifications also typically call for a penetration test to be performed at least once every 18 months.

The results of the round/robin tests clearly challenge the reasonableness of the existing charcoal testing requirements for all U.S. reactors.

Some participating laboratories recently received charcoal samples with specific test procedures provided by EG&G for the third round/robin interlaboratory comparison tests. These tests can have a significant impact on the technical specification requirements. Hence, I urge full cooperation with the test efforts, particularly with the test procedures specified by EG&G. Specifically, we are considering a relaxation of the acceptance criteria for methyl iodine penetration requirements for all operating reactors as long as they meet the guidelines of Appendix I to 10 CFR Part 50 for normal iodine releases, as well as for iodine releases during and following a DBA. However, if the results of this third test also fail to show reasonable agreement, then we will have to consider a laboratory accreditation program as a means of certification of qualified laboratories which can reproduce the EG&G test results.

The other problem area associated with the operation of iodine filtration systems has to do with representative iodine sampling. Specifically, I am talking about sampling systems installed to sample airborne iodines after an accident. In many of these systems, there is a potential for sample line loss of iodine. The loss can be so large that the iodine sampling process becomes meaningless, and one is left without a representative sample and analysis of the iodine content of gaseous effluents. Hence, in the event of a nuclear accident, the operator is faced with the alternative of calculating projected offsite doses to the population (which may be based on extremely conservative assumptions), or rapidly obtaining radiation measureements in the field.

The requirements of Item II.F.1, of NUREG-0737, were promulgated to assure that a plant operator would have the capability, under accident conditions, to obtain and analyze sufficiently representative iodine samples. This would permit a realistic assessment of the projected offsite doses on the basis of actual accident discharge conditions. Unfortunately, there are no current regulatory guidelines or acceptance criteria for an acceptable line-loss estimating method, or measurement program. Instead, the NRC has recommended that either the actual iodine sample delivery system, or a full-scale mockup, be tested experimentally to determine the extent of sample line-losses. At this time, we are not prepared to either recommend or endorse any specific test method as being acceptable. However, we are receptive to proposals for technically sound test procedures for determining iodine line losses for both particulates and in gaseous forms.

IV. Do We Have A Problem?

As I have indicated, fission product source terms are typically grouped by chemical and physical form. They are further characterized as those that are released in normal reactor operations, and those that can occur in accidents. Filtration can provide significant attenuation of many of them, but not all. For example, the noble gases cannot be attenuated with the types of filter systems that are presently used. However, a significant portion of the dose associated with normal effluents, as well as accidental releases, is comprised of iodine nuclides.

Hence, present nuclear plant filtration capabilities are aimed at attenuating iodine. The focus is on both particulate and gaseous forms through roughing, HEPA and charcoal beds, respectively. The HEPA designs, however, can be overwhelmed by high concentrations of particulates. Also, charcoal filter designs typically are predicted on the assumption that accidental iodine releases are predominately gaseous elemental iodine. Yet recent findings indicate that other forms of iodine can be released in significant quantities. Furthermore, the ability to predict with confidence the filtration capability of charcoal is in large measure dependent on a good testing standard. Currently, this does not exist.

Is there a match between existing filter system designs and what we know about normal and accidental fission product releases?

There is no doubt that the existing filtration systems will continue to be needed for attenuating normal releases as well as releases as well as releases from design basis accidents. However, as I noted earlier, it is increasingly apparent that the bulk of the risk is due to severe accident sequences. Hence, there may be a shift to a greater emphasis on roughing and HEPA filters to cope with potentially high concentrations of post-accident particulates of biologically more significant fission products, such as Cs, Te, and Sr.

We should not rule out charcoal. We should use it effectively in pursuing the ALARA goals, since experience shows that charcoal is effective in removing particulate and gaseous forms of iodine from plant ventilation systems. We should also continue to rely on charcoal for its potential to mitigate the consequences of accidents, where it would be effective in dealing with the more reactive iodine species. However, we must keep in mind that this potential may be limited under severe accident conditions, if the charcoal filters are overwhelmed. We must have rational test and inspection requirements. These should encompass severe accidents, where temperatures, humidity, and particulates are representative of containment venting or bypass accidents. These considerations should be reflected in our regulatory assessments.

Acknowledgements

I want to acknowledge the suggestions, comments and help of J. Hulman, K. Campe, J. Lee and L. Kriesel of my staff in the preparation of this paper.

DISCUSSION

KOVACH: While I agree with most of your comments, and appreciate the emphasis you laid on methyl iodide testing of adsorbents, I do not believe in the potential existence of HOI in the vapor phase. I feel that we should emphasize the identification of penetrating iodine forms instead of calling everything unknown HOI in vapor phase.

BERNERO: I agree there is uncertainty about HOI. It is a problem that has challenged us for years. I am not sure that it is so simple that merely confronting it will get us an answer in a short time because it changes, it is not stable.

WILHELM: Till today, nobody has verified airborne HOI. I have even heard that $10,000 has been offered by a participant here for confirmation of it's existence as an airborne compound. Previously, we never considered the possible iodine compounds which may result from reactions between organic radicals and iodine. In a core melt down accident, one will have high irradiation fields and lots of airborne organics, for example, from burning cable insulation, paint and oil, ignition by the heat of the molten core. Even during normal operations of a PWR, we found concentrations of airborne organics in the equipment compartment rooms (part of the inner containment) in the range of some mg/m^3, for example 6 mg/m^3. During refueling and repair operations, we found concentrations of up to 60 mg/m^3. In comparison, of the air in the equipment compartment of 10^{-9} to 10^{-11} Ci/m^3 of I-131 corresponds to 10^{-14} to 10^{-16} g/m^3 of I-131. Under the influenced of a high irradiation field, organic compounds will be partly converted into radicals which in turn will react with iodine. In organic chemistry, the reaction of iodine with radicals is a well known confirmation reaction for the presence of radicals. As a result of this reaction, airborne organic iodine compounds will be formed with a different sorption behavior than that of the methyl iodide. Mr. Kovach mentioned ethyl iodide, a simple organic iodine compound with two carbon atoms. Our measurements of the sorption behavior of this compound show clearly an ion exchange with the KI-impregnation of the charcoal, but a much lower reaction rate compared to methyl iodide. This results in a much lower removal efficiency. Considering the whole spectrum of all possible iodine compounds, it would be naive to assume that methyl iodide will be a conservative model substance for all cases. It is true that methyl iodide has a high vapor pressure, but the iodine atom in this compound is also extremely reactive. Over all, this results in a relatively good removal behavior. I may add that in one case during a relatively high iodine contamination of the coolant in a BWR, we have seen sometimes only airborne iodine which penetrated the iodine filter completely. Tests showed at the same time an excellent removal efficiency of the same iodine filter for methyl iodide and the absence of any leaks.

<u>BERNERO:</u> I agree that the use of methyl iodide is a shorthand method in that, in effect, it writes everything off as methyl iodide. I am interested in the result Mr. Wilhelm cites of 100% penetration. I hope the members of my staff are aware of it, because I am surprised to learn of 100% penetration through an acceptable tested bed. That is disconcerting.

<u>HULL:</u> First, a comment on long sampling line runs. If you are convinced that you get mostly penetrating, organic forms, than you have less of a problem with long sampling lines because there wouldn't be a deposition problem. Concerning the matter of sampling in the vent from the plant to establish what is going on, I am somewhat concerned with the NRC position that it isn't as important to get a representative sample from the containment itself as it is from the fraction going out the vent. I have the transcript of a conference, the synopsis of which said we just want a representative sample of the containment atmosphere. As an emergency planner, if you could demonstrate convincingly that whatever iodide had been released was in the water and not airborne, than I wouldn't be anywhere near as worried as I would be if it was in the containment and the containment pressure was building up. Why isn't it as important to get a representative sample of the airborne iodine in the containment, if any, as it is to sample what is going out the vent? The NRC position is that representative sampling is not important unless airborne iodine is used in the core damage assessment.

<u>BERNERO:</u> I am not sure whose conclusion it was that it is not important to get a containment sample. I think we do believe that it is important. There is a clear desire to have a large, dry containment because it is a passive device that can be deliberately vented during normal operations. Therefore, any release would be inadvertent and representative of what is in the containment, so it is quite important. Sampling is intended to provide a reasonable measure of what is in the containment atmosphere of a boiling water reactor. If there were to be a pressure buildup and then venting, the focus would be much more on what was going out the vent. It would vary dramatically with the plant design and I think vent sampling may be what was intended for that reason.

<u>HULL:</u> I don't know who talks to whom down at your shop, but I can say that the transcript that I got of the conference I just mentioned was that, unless you are using the information for core damage, it really isn't important to get a representative sample. We have been doing the reviews and that is what we have been told to use as guidance, i.e., that it is not important unless it is used in the core damage assessment procedure.

<u>BERNERO:</u> I am sorry I cannot explain it further. I am not familiar with it.

<u>SILL:</u> As a chemist, I am a bit horrified at all the talk about HOI being a mysterious material. HOI is a very simple hydrolysis product of elemental iodine. If you write the reaction you have: $I_2 + H_2O \rightleftarrows HI + HOI$. I don't know anything about the thermodynamics of the reaction but I will guarantee you that if you put chlorine into sodium hydroxide you will wind up with a solution of sodium hyperchloride. The same kind of a thing is going to happen if you dissolve iodine in sodium hydroxide. Now, even under the conditions of a reactor operation, all you would need to get HOI, for certain, would be to have elemental iodine in the presence of moisture. How far that reaction would go, thermodynamically, I don't know. But if you put a little bit of alkali in there, it certainly is going to kick it in the direction of more HOI, i.e., $I_2 + OH^- \rightarrow I^- + IO^-$.

<u>GUEST:</u> I would like to make a remark about deposition in sample lines that you talked about. We have seen a lot of speculation in the literature and a few laboratory studies. We have been quite concerned and have made measurements within the Bruce A. Nuclear Power Station on the deposition in the sample lines for elemental iodine and methyl iodide. This was a fairly major study and I will be presenting a paper later in the week on this. We found that there is no deposition of either methyl iodide or molecular iodine in the long sample lines at the Bruce A. Station. I would be very please to hear your thoughts on that paper when I present it.

<u>BERNERO:</u> I have staff here at this conference and we are hoping to get a good deal of information from papers such as yours.

<u>DEITZ:</u> In connection with the HOI topic under discussion, this species may not be present in the gas phase, but it is certainly present in the activated carbons. Large quantities of ozone in the air pass through a carbon adsorber in the months that it is in service and the ozone oxidizes the iodine ion introduced in the impregnation. A number of IO_x^- complexes are formed ranging from IO^- to IO_3^-. The reaction can be reversed by chemical reduction; we have used hydrazine. These hypoiodides are responsible for the irregularities encountered in testing used carbons for the penetration of methyl iodide-131.

<u>VIKIS:</u> One more statement about HOI. The reference to abundant quantities of HOI formed by the hydrolysis of iodine is, indeed, correct. There is no doubt that we do have HOI

formed in solution from the hydrolysis of I_2. The problem we are facing is identifying the gaseous form of HOI. This is where the question arises, whether there is HOI in the gas phase. At the Whiteshell Nuclear Research Establishment of Atomic Energy of Canada Ltd, we searched for gaseous HOI using definitive techniques (e.g., mass spectrometry). We were unable to detect gaseous HOI above iodine solutions, although we had no problem in identifying gaseous HOCl or HOBr above the corresponding halide solutions.

CLOSING COMMENTS OF SESSION CHAIRMAN MOELLER

We heard first this morning from Michael Lawrence who reviewed the history of environmental monitoring at the Hanford Works. We see there much of the history of radiation protection, in that we began in the early years with relatively high permissible dose and release rates, and these have gradually reduced down through the years.

At the same time, however, it must be recognized that nuclear operations at Hanford were initiated under wartime conditions during which there was an urgency to accomplish their goals on a priority basis. Today, those responsible for operations at Hanford are funding appropriate agencies within the States of Washington and Oregon, as well as within the Centers for Disease Control, to re-examine these releases and to evaluate any effects that they may have caused in terms of the nearby populations or the environment. Even though there are ready explanations for many of these early releases, they have, in some instances, led to a lack of confidence on the part of the public in the safety of nuclear operations, not only in terms of DOE's facilities but also in terms of the commercial nuclear power industry.

Following the initial presentation, Mary Walker reviewed a range of programs that DOE is pursuing to help restore the confidence of the public in DOE's operations. In particular, she reviewed three initiatives currently underway. The first of these is the preparation and issuance of an environmental policy statement confirming that DOE expects operators of its facilities to go beyond the rules and regulations in seeking to reduce environmental risks. Secondly, DOE is conducting technical safety appraisals of all its facilities, using a multi-disciplinary approach. The results of these appraisals will be used as a basis for the initiation of additional improvements. Lastly, her Office is conducting environmental surveys of all DOE facilities to identify problems in this area. The results of these surveys will subsequently be used to establish priorities for addressing these problems, including the establishment of a computerized tracking system to keep up with these problems, the status of each, and the progress being made in terms of corrective actions.

Lastly, we heard this morning from Bob Bernero on nuclear power plant accident sequences and their implications relative to nuclear air cleaning. Mr. Bernero called upon us not to neglect charcoal--it is still an effective material for retarding various radioactive materials that might be released from a nuclear plant not only under normal operating conditions but also, and most particularly, under accident conditions. Mr. Bernero cautioned, however, that we must keep in mind that our testing procedures for evaluating the effectiveness of charcoal leave much to be desired; the same situation applies to our ability to collect the proper samples for preparing estimates of radionulcide releases within a nuclear power plant under accident conditions. Obviously, there is much work to be done. These and related topics and questions will be addressed in later sessions of this Conference. I know that all of you look froward to hearing the papers to be presented and in taking part in the related discussions.

Finally, let me close this session by formally thanking each of the people who appeared on the program this morning. Their presentations have set a high standard for the speakers who follow.