

Operations and Power Division

Fall 2003



You are invited...

To New Orleans, Louisiana "Cajun Country"

UWC 2004 Planning

Sunday, November 16, 2003
10:00 - 11:30 AM, Girod

OPD Program Committee

Sunday, November 16, 2003
1:00 - 3:00 PM, Loyola B

OPD Executive Committee

Sunday, November 16, 2003
3:00-6:00 PM, Loyola B

Everyone is welcome!

Check the final program
for any location or time change.

Don't miss the
Atoms for Peace Speech
50th Anniversary
December 8, 2003
Follow the Links at
OPD.ANS.ORG

Table of Contents...

From Your Chair.....	1
Program Committee	2
ANS Board Liaison.....	3
Membership.....	3
Homeland Security.....	4
Students Corner	4
Utility Working Conf	5
Walter Simon.....	7
Officers	8
Executive Committee	8

Edited by Mark Reinhart

From Your Chair

Sophie Gutner

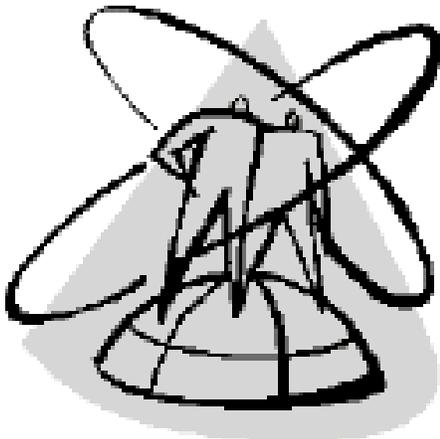
Can you believe it? It is again time for our Fall newsletter. I am delighted to be writing to you as Chair of OPD. It has been an amazing journey for me to get here. It all started in 1996 when I attended my first ANS conference as a student. I did not know anyone, except for a few professors from my University. Kyle Turner took it upon himself to become my mentor and introduce me to a few people at the President's Reception; I am very grateful for his welcome and guidance. Then, I decided to do the opposite of "NAVY" ("Never Again Volunteer Yourself"), and I started to volunteer to work on many different projects, sessions, committees, etc. I met more and more fascinating people who became my peers and colleagues, and I volunteered for more and more new projects. As they say, the rest is history. This points out the importance for mentors to welcome and guide new members into the Society.

ANS is a fascinating grouping of people from so many diverse backgrounds, experience and knowledge levels, interests, and degrees of enthusiasm. However, we all have one thing in common: we believe in the "N" word and we want the whole world to know that, understand what we understand, and believe as we do that Nuclear is here to stay and grow. So, we have a huge challenge in front of us, to ensure that nuclear science and technology have their place in our long-term future. As OPD is the largest technical division within ANS, we have a big responsibility towards the well being and success of the Society and what it represents.

Over the past 3-5 years, the nuclear industry has been on the edge of a renaissance. We oscillate between optimism and gloom as we follow the events of the day (political, social, technological, and economical). If we use all of our POWER, we can achieve great things for the "N"

industry. We are continuing some big projects such as the Petition for building the next generation of nuclear power plants, the new OPD Plant Resident Network and the launch of the "Young Utility Worker" program at each nuclear power plant site, the continued improvement and successful organization of the Utility Working Conference in August 2004, and the OPD Membership Drive through December 31, 2003. We are continuing our efforts to organize interesting and informative technical sessions for the New Orleans ANS Winter Meeting, the Pittsburgh ANS Annual Meeting, and the Washington, DC Winter Meeting next year. For these projects, we need you to be as actively involved as you possibly can. To succeed, we need all the help we can muster, we need all of you.

So, it is crucial that we hear from you as often as possible. Our challenge is to bring value to your membership and move OPD, ANS, and the "N" industry forward. What do you like about what we are currently doing? What do you need? What do you want? What do you dislike? How can we improve the value of your membership (given the constraints under which we must operate)? Look for our email addresses at the end of this newsletter.



Program Committee

By Donna Skay

The goal of the program committee is to develop topics for technical sessions that generate lively discussion and provide thought-provoking ideas to the meeting attendees. Based on informal feedback from ANS and non-ANS members, the committee is striving to provide more timely sessions that address issues of current concern. To further this effort, the program committee welcomes recommendations on session topics, and feedback on how well the sessions meet your needs for information. Please contact the chair or vice-chair with any comments: Chair, Donna Skay, NRC, Vice-Chair, Don Eggett, Automated Engineering Services

A new sign-up form for the OPD Program Committee is available on-line. OPD members interested in helping out with national meetings or topical meetings can sign up at <http://opd.ans.org/cprog-signup.cgi>. To those who have already signed up, thank you. We will be contacting you soon with areas in which you can help.

The Program Committee is exploring ways in which to make the technical sessions at national meetings more useful to ANS members. Some of the ideas that the committee is evaluating are: providing certificates to session attendees to document their participation and compiling the PowerPoint presentations from panel sessions on a CD-Rom.

Winter 2003 Meeting - New Orleans

The theme of the winter 2003 meeting is "Nuclear Science and Technology: Meeting the Global Industrial and R&D Challenges of the 21st Century." OPD will be sponsoring 10 sessions on topics such as: financial performance enhancements, the risk-informed environment, quality assurance, radiological terrorism, and digital upgrades. In addition, to affirm its support of younger members of the nuclear profession, OPD is sponsoring a series of panel discussions on the status of the International Young Generation in Nuclear.

2004 Annual Meeting -Pittsburgh

OPD has proposed 10 sessions for the 2004 annual meeting. Please contact the organizers listed if you would like to get involved in planning and/or making presentations.

1. Hot Topics and Emergent Issues - Don Eggett (dreggett@aesengineering.com)
2. Nuclear Asset Management - Bob Holzworth
3. Advanced Nuclear Energy Systems - Buzz Savage (buzz_savage@hq.doe.gov)
4. Control of Next Generation Reactor Systems - Belle R. Upadhyaya (bupadhya@utk.edu)
5. Containment Sumps - Steve Stamm (steve.stamm@shawgrp.com)
6. New Opportunities for Cost Savings at Nuclear Power Plants – Bill Burchill
7. Is Safety Improved by Licensee Burden Reduction? - Prasad Kadambi (npk@nrc.gov)
8. Integrated Risk Informed Decision Making - Mark Reinhart (fmr@nrc.gov)
9. Advanced Nuclear Energy Systems: Policy Issues - Jean Marie LeCorr
10. Current Challenges - Jean Marie LeCorr (LeCorrJM@westinghouse.com)

2004 Winter Meeting - Washington DC

Planning for the 2004 winter meeting will begin at the November 2003 meeting in New Orleans. The theme for this meeting is "Leadership Towards a Progressive,

Integrated Nuclear Community -- Going Forward Together." This theme gives us an opportunity to recognize that there are technical issues that impact other areas of the nuclear community, beyond the commercial nuclear power industry, and to work more closely with other divisions in developing sessions and topics.

ANS Board Liaison

By Eric Loewen

Just elected to the ANS Board of Directors, one of my responsibilities is liaison between a professional division and the Board. I was fortunate to have been assigned to OPD.

Though I have never operated or been involved with a commercial reactor, I do have six years experience as an officer in the Navy Nuclear Power Program, and I held a SRO license at the University of Wisconsin TRIGA reactor. Currently employed at the Idaho National Engineering and Environmental Laboratory, I am performing corrosion research in support of two Generation IV Reactor concepts: the Lead Cooled Reactor and the Fast Gas Reactor cooled by CO₂. INEEL also assigned me temporary duty to Washington, DC to support the President's Climate Change Technology Program.

Our technology is relatively new in the course of human history. It's a technology that is misunderstood, misrepresented, feared, and over-regulated – yet needed. We recognize these characteristics in our daily course of life with Homer Simpson jokes and reference to glowing in the dark. My external focus for the Society is to see us recognized as the premier source of unbiased information about nuclear technology. The Society is gaining that recognition with www.aboutnuclear.org, the Washington, DC Office, the Congressional Fellow, teacher workshops, public outreach, etc.

My principal internal concern for the ANS is membership. As Membership Committee Chair for the past three years, I saw us gain ~1,000 new members a year, then watched us lose ~1,100. We must reverse that trend. I believe that the OPD can be a strong player, as evidenced by the work that Rich St. Onge, Sophie Gutner, and others are leading in this area.

Some personal anecdotal information shows again the membership challenge. When I encourage fellow INEEL employees to become ANS members, their response is, "ANS is about nuclear utilities; there is nothing for us

scientists." When I talk with friends in the utility sector about joining, their response is "ANS is just for the lab-rats and professors; it has no utility focus." What is the truth?

I hope that we can get members to view the ANS as a large university, with our 19 technical divisions serving as the specialized departments on campus. Our members can hone in on the information and benefits in their technical divisions, while recognizing our alma mater - ANS.

I encourage your OPD members to share their ideas and pass along their inputs, suggestions, or comments. You can contact me at any time at ejzhloewen@aol.com or (208) 526-9404.

Would you also spread the word that I am available to visit your members' company or utility with a presentation about the INEEL involvement with Generation IV reactor concepts. I'll also overview the ANS to encourage signing up new members or starting a new branch section. All contacts welcome.

I look forward to working with you and the OPD for the next three years and representing your interests to the Board.

Membership

By Sophie Gutner

The members who do not renew their ANS membership by June are dropped from the database in July. Between January and June, many attempts are made by ANS staffers and OPD members to contact these non-renewing members to encourage them to renew. In July, we "give up," and we turn our energy towards recruiting new members. However, the net effect (number of new members minus number of members who drop out) remains negative and OPD membership keeps decreasing year after year. In August 2003, we have 4100 members, down from 4209 members in August 2002. We have to reverse this trend.

Approximately half of our members work for utility or consulting companies, 11% are retired, 13% work for government agencies or national laboratories, 19% work for AE firms, manufacturing firms, service companies, and other industries, 3% are students, and 2% are professors at universities (the rest are "not identified").

What will it take to reverse the negative membership trend? As a minimum, it will take all of us lending a helping hand. How? By participating in our very own OPD Membership Drive. It's simple: as an OPD member,

you can help recruit new OPD members by talking to your colleagues, peers, and friends. Joining online is easy; show them how to access it on the ANS website. You can also send a pre-written email (or you can customize it) to prospective new members directly from the "Invite a Member to Join" section of the ANS Member website. Our Membership Drive runs through the end of the year, just a few weeks away! Early in 2004, we will identify the three best recruiters for prizes. Of course, when you recruit a new ANS member, you are also automatically entered in the continuous ANS membership drive (a recruiter is randomly selected each year to win a laptop).

Ready? Set! Recruit!



ANS Completes Report For Department Of Homeland Security

By Ted Quinn

On August 11, 2003, a white paper was delivered to the Department of Homeland Security Under Secretary McQuery and management in the Science and Technology Directorate, as a product of the ANS.

This white paper provides a scientific basis for a communications action plan by the DHS on the subject of radiological dispersion device (RDD) events, sometimes called dirty bombs. The actual physical health consequences from most RDD events would be relatively low. But, public fear of a terrorist attack involving radiological materials is likely to be high and could produce psychological and behavioral consequences that endanger physical and mental health and the economic well being of a community. Thus, there is a real opportunity, by preparing effective communications that reduce these psychological and behavioral consequences, to significantly reduce the radiological terrorist threat.

This white paper builds on previous studies and takes those studies one step farther by making recommendations directly to DHS. The white paper makes recommendations for three time periods—before an event (preparation), immediately after an event (response), and in the days that

follow (change and recovery). The recommendations are for 1) DHS national communications and 2) DHS support for system communications.

An RDD terrorist event is distinct from other terrorist events because of the unique technical challenges and psychosocial issues related to radiation. Yet, we believe that many of the recommendations in this white paper are applicable to an all-hazards approach. Also, a terrorist event is distinct from an accidental radiological dispersion because of the added response challenges and psychosocial issues related to a terrorist attack and the unknowns about what might happen next. Valuable knowledge, experience, and resources have been developed in preparing for accidental radiological events and should be used to the extent possible.

This white paper was produced by a team of ANS members, including Ted Quinn as Project Manager, Ann Bisconti, Brian Grimes, Karen Seeland, Andrea Pepper and Chuck Vincent from ANS Staff. The report is available thru www.ans.org/goto/nad.cgi for \$30 for the CD version or \$50 for the hard copy version.

Students' Corner



By Sophie Gutner

OPD is continuing its support of Student activities in 2003-2004. The next ANS Student Conference will take place at the University of Wisconsin-Madison, April 1-4, 2004. The theme is going to be "*Out of the Ashes: Revival of the Nuclear Era*" and the co-chairs are Ross Radel (rfradel@wisc.edu) and Lola Neisius (lkneisius@wisc.edu). More information is available at their website <http://www.cae.wisc.edu/~ans/conf/>.

We would like to congratulate our three 2003-2004 scholarship winners: Brian Douglas Hehr, North Carolina State University (2003), cunobelinus@hotmail.com [Lacy Scholarship]; Paige Leigh Nitsch, Texas A&M University (2003), plnitsch@hotmail.com [Bisesti Scholarship]; and David William Barbara, Purdue University (2003), db@purdue.edu [OPD Scholarship, in honor of Peter L. Reagan].

We encourage your involvement with students, to help them bridge the gap between school and career in the nuclear industry. If you are planning to attend the November ANS Winter Conference in New Orleans, consider signing up as a mentor to assist students or newcomers with their first experience at an ANS Conference.

Utility Working Conference By Tom Snow

This year marked the tenth anniversary of the Utility Working Conference, held at Amelia Island, Florida during August 3-6. Progress Energy Senior Vice President & Chief Nuclear Officer, Scotty Hinnant, chaired the 2003 Conference, and Tom Snow, from Dominion, was the technical program chair. The honorary general chair was Tom Crimmins, and Ron Bayer was the honorary technical program chair. Tom and Ron had filled the two chair positions at the inaugural Utility Working Conference in 1994.

The theme of this year's meeting was "TEN YEARS OF PROGRESS; Assessing The Past, Projecting The Future". Nearly 300 registrants attended the plenary session, and then, during the following two days, participated in sessions within six tracks: Business, Engineering, Maintenance, Operations, Regulatory Relations, and Supply Chain.

The speakers at the opening plenary included William Magwood, Director of DOE Office of Nuclear Energy, Science and Technology; Marvin Fertel, NEI Senior Vice President and Chief Nuclear Officer; William Kane, NRC Deputy Executive Director for Homeland Protection and Preparedness; and Jim Asselstine, Lehman Brothers Managing Director.

Marvin Fertel reviewed the impact of today's successes and failures on tomorrow's nuclear generation. He noted the improved performance of the existing plants over the past 10 years and equated the increased generation to 22 new 1000 MW plants. The trend in public opinion has been increasingly favorable, with a current 2-to-1 ratio in those favoring the use of nuclear energy. Marvin also noted the necessity of having a credible regulator and of exercising proper authority within a predictable regulatory environment. He admonished the industry to focus on continuing safe, reliable and economic operation of the existing plants, while pursuing proactive programs to address materials, aging, and equipment reliability issues.

Bill Kane presented insights from a decade of change in nuclear regulations. He identified some of the promises and challenges of risk-informed initiatives. Improved

maintenance effectiveness and a better understanding of the relationship to safety were attributed to the advent of the maintenance rule. Changes to the Reactor Oversight Program have allowed greater stakeholder involvement and more focused regulatory response, but the significance determination process needs to be refined.

Jim Asselstine brought the nuclear future into focus for Wall Street. He noted improved nuclear economics and little impact from industry restructuring. The changes in nuclear regulations were also viewed favorably. Requirements for future nuclear generation were identified as cost competitiveness with higher initial capital investment, predictable licensing process and construction schedule, low cost fuel supply and enrichment services, public acceptance of safety and spent fuel disposal, and protection under Price-Anderson.

Bill Magwood described the role of nuclear energy in meeting national objectives. DOE is funding research to support the National Energy Policy which calls for the deployment of a new advanced light water reactor by 2010. To address a growing vulnerability in the transportation sector, DOE has proposed a significant role for nuclear in meeting President Bush's National Hydrogen Fuel Initiative. The DOE plan through 2050 includes international collaboration on reactors with advanced fuel cycles.

In support of the conference theme, the Operations Track provided four sessions: "Operational Learning in a Success Environment", "Operations Lessons to be Learned from a Near Miss", "Operational Impact of Organizational Streamlining", and "Human Performance and Root Cause in Operations." The track was co-organized by Sophie Gutner (Dominion) and Bill Corcoran (Nuclear Safety Review Concepts).

The first session included non-traditional speakers. Some walk-away thoughts included the effectiveness of the Golden Rule in organizational culture and the importance of never surprising an employee with unannounced changes. It also included a report of knowledge management successes as well as successes in the application of performance models and in a plant cultural upgrade.

The second session focused on the Davis-Besse episode. It included alternative views of safety culture assessment and the importance of thoughtful compliance. Discussions of new insights on precursor recognition were followed by a report of relevant international activities.

The third session focused on the effects of "doing more with less" in Operations. It included discussion of teamwork by design and fleet-wide safety culture assessment. It also provided actual measurements of the

effects of reduced workforces as well as a discussion of the need for plants to make themselves “employers of choice.”

The wrap-up session got into the details of how we got where we are with respect to root cause analysis, as well as a description of operational success by focusing on the fundamentals. It also included a tutorial on the basics of human performance technology.

The four sessions for the Regulatory Relations track included “Progress Toward a Risk-Informed Environment”, “Reactor Oversight Program”, “Challenges of Applying Probabilistic Risk Assessment in the Regulatory Arena”, and “Future Nuclear Power Plants”. The co-organizers were Mark Reinhart (US NRC) and Alan Hackerott (OPPD).

The Risk-Informed Regulation session included discussions of the need to understand the strengths and weaknesses of probabilistic risk assessments (PRA), the need to maintain the quality of PRA’s, and the need for a solid transition plan for functioning in a risk-informed environment. Integration of PRA into the regulatory arena will involve the NRC and industry working together.

Implementation of the Reactor Oversight Program has encouraged nuclear plant staffs to view equipment and structures from a risk-informed perspective. The effect of external events is an additional consideration to be included as part of the oversight program.

With respect to the future nuclear power plants, the focus is on safety and economics. The NRC is updating its regulatory infrastructure to address the evaluation and licensing of advanced reactors.

The Engineering track included sessions on “Configuration Management”, “Life Cycle Management”, the “Role of the Engineer in Equipment Reliability”, and “Engineering Aspects of Reactor Vessel Inspections and Evaluations”. The co-organizers were Donna Skay (US NRC) and Bob Hess (PGE).

Important aspects of effective configuration management involve oversight of both vendor and in-house engineering efforts to ensure thoroughness in evaluations being performed, assuring that design margins are being maintained, and verifying continued compliance with the licensing basis. The existence of a comprehensive listing of plant equipment is an integral part of configuration management.

A key aspect of life cycle management is the proactive evaluation of equipment reliability and cost/benefit analyses for the most effective use of maintenance efforts. A proactive approach should result in a noticeable reduction of unexpected maintenance activities and lost

production during the operating cycle. Similarly, equipment reliability is not achieved unless a focused effort is provided by engineering. A meaningful evaluation of system “health”, and a proper assessment of key areas for maintenance, requires dedicated engineering involvement.

Among the topics discussed during the Maintenance track were “Work Management Challenges of On-line and Outage Maintenance Activities”, “Overcoming Adversity in Plant Maintenance”, “Advancements in Maintenance Technology”, and “Maintenance Lessons Learned”. During these sessions, it was noted that craft ownership is a key element in effective station maintenance. Also, the existence of the INPO and NRC performance indicators for safety system unavailability, and their effect on focus areas for maintenance activities, were discussed. The co-organizers for the Maintenance track were John Jenco (JJenco, Inc), Phil Opsal (PSEG), and Bob Paley (PPL).

Within the Supply Chain track, topics included “Supply Chain Automation”, “Impact of Short Cycle Work Management”, “Inventory Opportunities and Challenges”, and “Reducing Costs through Contracting Strategies”. Co-organizers for this track were Jim Ripple (Southern Nuclear) and Mike Jurmain (FPL). Automation of the supply chain, and accommodating short-cycle work management to address emergent needs, have the advantages of reducing work order backlogs, improving equipment availability, and precluding potential longer term equipment degradation. And cost reduction can be achieved through inventory management and contracting strategies that allow various utilities to share resources and reduce overhead expenditures.

The Business track included sessions on “Nuclear Asset Management”, the “Business Value of Information Technology”, “Practical Innovations for Driving Down Costs”, and “Market-responsive Business Operation”. This track was co-organized by Vince Gilbert (NEI) and Harold Stiles (Progress Energy). In these sessions, it was noted that plant improvements such as equipment replacements to improve efficiency, and plant uprates probably will be more valuable to facilities that function in a de-regulated environment than for facilities that remain regulated. With respect to technology utilization for Business, Supply Chain, and Work Management, continuing advances will provide ongoing performance improvements and reduced costs for plant operation.

Mark your calendars and plan to join us for the next Utility Working Conference, August 8-12, 2004.

Special thanks to Harold Stiles, Bill Corcoran, and Mark Reinhart for their contributions to this article.

Walter H. Zinn Award, Acceptance Speech By Walter Simon

I want to thank all those who have been involved and gave me the honor to select me this year for this prestigious Walter H. Zinn Award.

To put things into perspective, I thought I would give you some highlights of my career which to a very large fraction was focused on gas cooled reactors, their design, development, and operation.

In 1961 I got my Diploma in Mechanical and Nuclear Engineering at the Technical University in Aachen Germany, following five years of studying. Only a small amount of technical material was available in those years. If material was available at all, it was in English. Since I had grown up in the French occupation zone, I had a relatively small amount of English, but a lot, i.e. nine years, of French. I was quite elated when I met Milt Edlund at an ANS meeting. He and Sam Gladstone were my first nuclear teachers through their books on Nuclear Reactor Theory.

In those days, General Atomic had an office in Zürich, Switzerland. I applied for a job, successfully, and on November 1, 1961 I became a member of General Atomic. The work in those days was already focused on High Temperature Gas-Cooled reactors, guided by Peter Fortescue. A German utility had inquired about a Peach Bottom type HTGR. We spent a fair amount of effort to prepare a proposal for a 40 Mwe gas-cooled reactor, when the requirements prescribed the proposal to be submitted both in German and in English. This was a significant learning process. The technical terms were in English; the German language had not adopted or developed yet "Germanized" gas-cooled reactor and reactor physics terminology.

There are two additional highlights that are worth mentioning. There was no large computer available in the Zurich area. And we made an arrangement with the Italian computer center that was operated in Bologna, Italy. The nice part of this was the opportunity to take the train across the Alps to Bologna, a beautiful trip with excellent food. And upon arrival, of course, good computer equipment was available.

At the same time, Euratom was building a Research Center at the Lago Maggiore which was closer to Zürich, had a large computer center, and a beautiful environment. As soon as possible, we negotiated with the Zentrum management and soon we made our computing at Ispra.

Then came a large change in our family's life in the Spring of 1964. I was asked to go to San Diego for six months for training. We accepted and flew to San Diego in June 1964. When the six months were over, nobody asked us to return. Rather, GA made me an offer for a job at GA in San Diego. I assure you, it took some time to realize we were not on vacation, in the climate that we rarely experienced in Germany.

My wife, who was pregnant when we traveled to the US four months later, gave life to the first US citizen in the family.

But back to the gas-cooled reactors. I did not spend a lot of time on the GCFR, which was started in the Zürich office while we were there. In the US, I worked on HTGRs. First there was the Peach Bottom HTGR in Pennsylvania, the first HTGR GA built.

After I went back to San Diego, I took over the Reactor Physics Branch. This was the time when we designed the first block type fuel, validated fuel loadings, and HEU and thorium loadings, with 1492 fuel elements, the first of this type. The reactor reached criticality in January 1974.

I could tell a lot of stories and events about Fort St. Vrain, but it would take a lot of time, which I will skip.

From a professional standpoint, the time I was involved in the development and design of Fort St. Vrain was challenging and quite satisfying. From computer code development to fuel specifications and fuel manufacturing, as well as design of graphite fuel elements, it was quite a challenge. But our team really rose to the challenge. The results, indeed, were quite satisfying.

The first criticality was reached with $.002 \cdot K$ and with $2''$ of the predicted control rod position. For a first of a kind reactor, all of us that had been involved deserve recognition for these excellent results.

Interestingly enough, Ed Teller was in Denver to give a talk at the local ANS section the night when Fort St. Vrain went critical. We stopped the rise to the first criticality to listen to Ed's talk. After the meeting, we decided to go back to the site and continued the steps to first criticality. Fort St. Vrain actually went critical at 4:30 that morning.

Yes, there were some problems on the conventional parts of the plant. The reactor core, however, was pretty close to what had been expected, with one exception. During rise to power, the fuel columns actually started to move. Of course, the NRC was quite upset. We had many meetings with the Commission and were successful in convincing the involved personnel that there were no reactivity effects. Driven by the coolant, fuel columns

behaved like bimetallic strips moving every ten minutes. Connecting the fuel columns at the top of the reactor eliminated the movements up to full power. While Fort St. Vrain had some more items to be modified, the reactor actually ran quite well.

In the late 60's to mid 70's, our owners – Gulf Oil and Royal Dutch/Shell – pushed for moving into the commercial market. At that time, GA had sold five large two-reactor stations, 2000 or 3000 MWth units each. These were, of course, significantly larger units than Fort St. Vrain. The business was going well. GA had about 3000 people on the site in San Diego. Then came the oil crisis of the 70's. Utilities cancelled their orders when customers in the US started to save electricity. As a result, one utility actually cancelled their two units on the same day the NRC issued a construction permit.

In 1984, Congress sent us a letter asking us to look at smaller and inherently safe reactors. That impulse moved us to Modular reactors. Starting with 350 MWth, we finally designed for 600 MWth. But there was more. In 1986, Neal and Linden Blue acquired GA. Both liked the gas-cooled reactor, and still do. In the later 80's, General Atomic got a reactor contract to produce tritium. Ultimately this project was cancelled when the USSR collapsed and there was no more need for additional tritium. However, in the late 80's, we started to look at gas-cooled reactors that would utilize a Brayton cycle for electricity production. It was 1992 when we adopted the Brayton cycle as the reference design.

In 1993, following discussions with the Minister of MINATOM and some of his staff, we reached an agreement to work together in the development of the GT-MHR, the Gas Turbine-Modular Helium Reactor. A couple of years later, we were encouraged to design this machine with focus on WPU fuel destruction, i.e., to convert the WPU energy to electricity. This cooperation is going on with support by MINATOM in Russia and US government providing support for Russia and GA.

This covers about 42 years of gas reactor development, design, cooperation, ups and downs. However, we did our best to keep this technology alive. Yes, we had good and bad times, but we continued to develop an inherently safe reactor, which will reach about 48% efficiency and allows operation at temperatures significantly higher than LWRs. The GT-MHR will be completed with a prototype and the characteristic that I can only say: The direct cycle, efficiency, safety characteristic and many fitting characteristics leads to a simple statement – That's what gas-cooled reactors were invented for.

One final comment. Looking around, there are not many young people. Clearly, hiring and training the next generation is absolutely necessary if we want to keep the

technology alive and make it available to provide electricity or hydrogen. The GT-MHR will provide clean energy sources for the future, and will provide many challenging tasks for the next generation, particularly young new talents. It's this new generation that will get more and more attention, and I am sure that gas-cooled reactors will find their way.

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