Three Mile Island 2 Accident Radiological Lessons Learned

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Department of Nuclear, Plasma, and Radiological Engineering

Purpose of Presentation

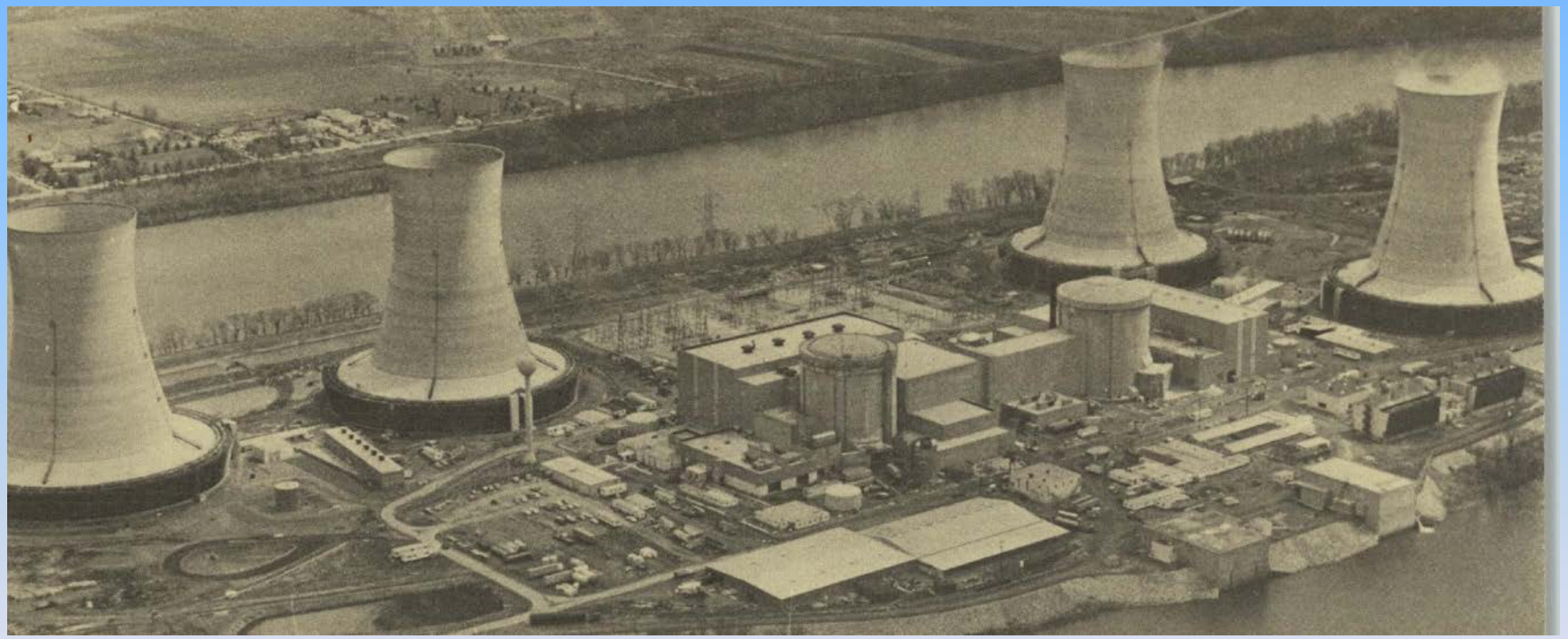
- To highlight key radiological lessons learned from the April 1979 TMI 2 Accident
- To provide text for Chapter 8.1 Lessons Learned Section for the ISOE Expert Group on Severe Accident Report
- To assist RP professionals globally in managing the radiological aspects of future severe nuclear plant accidents

Organization of Presentation

Lessons Learned on:

1. Personnel Monitoring e.g., beta dosimetry
2. RP Instrumentation Performance
3. Initial Decon of Vehicles
4. Winning the Trust Back of the Local Communities
5. Training Local Physicians on Rad Health

TMI Units 1 & 2 Site:
An Island in a River!



Utility Performance Excellence Organization Formed

- Post- TMI 2 Accident: US Industry established INPO- RP
- Post- Chernobyl Accident: Global Industry established WANO –RP
- Post-Fukushima Severe Accident: Global Industry established WANO expansion – (pending)

Industry Operating Event Communication System

- Developed with the establishment of INPO
- Promote rapid communication of industry events
- Provide lessons learned for each operating plant

New Requirements for Post-Accident Reactor Coolant Samples

- Six of the twelve TMI 2 accident over-exposures were due to handling highly radioactive coolant samples
- TMI lessons learned developed a regulatory required post- accident harden sampling panels to reduce the dose for accident coolant sampling
- Post-Accident worker access to post-accident sampling panel needs to be provided

Radiological Engineering Design Approach

- Regulatory agency provided the Post-Accident sample panel requirements with Design Basis source term, sample analysis and timeline
- Industry developed Post-accident sample panels to meet regulatory requirements
- Benchmarked petroleum and pharmaceutical plants to evaluate chemical analysis instrumentation operating on harsh environments i.e., conductivity, pH, radioactivity.

Beta Dosimetry Insight

- In the second year of clean up at TMI-2, plant health physicists discovered that beta dose had not been accurately measured in Auxiliary Building due to pure beta emitter: Sr-90
- Led to 1982 International Beta Dosimetry Conference
- Conference Proceedings & other TMI-2 related studies are archived for ISOE members on “My Box” (University of Illinois- faculty 50 GB ftp data files)
- University of Illinois joint project with University of Tokyo to develop & maintain severe accident lessons learned databases established in Spring 2013

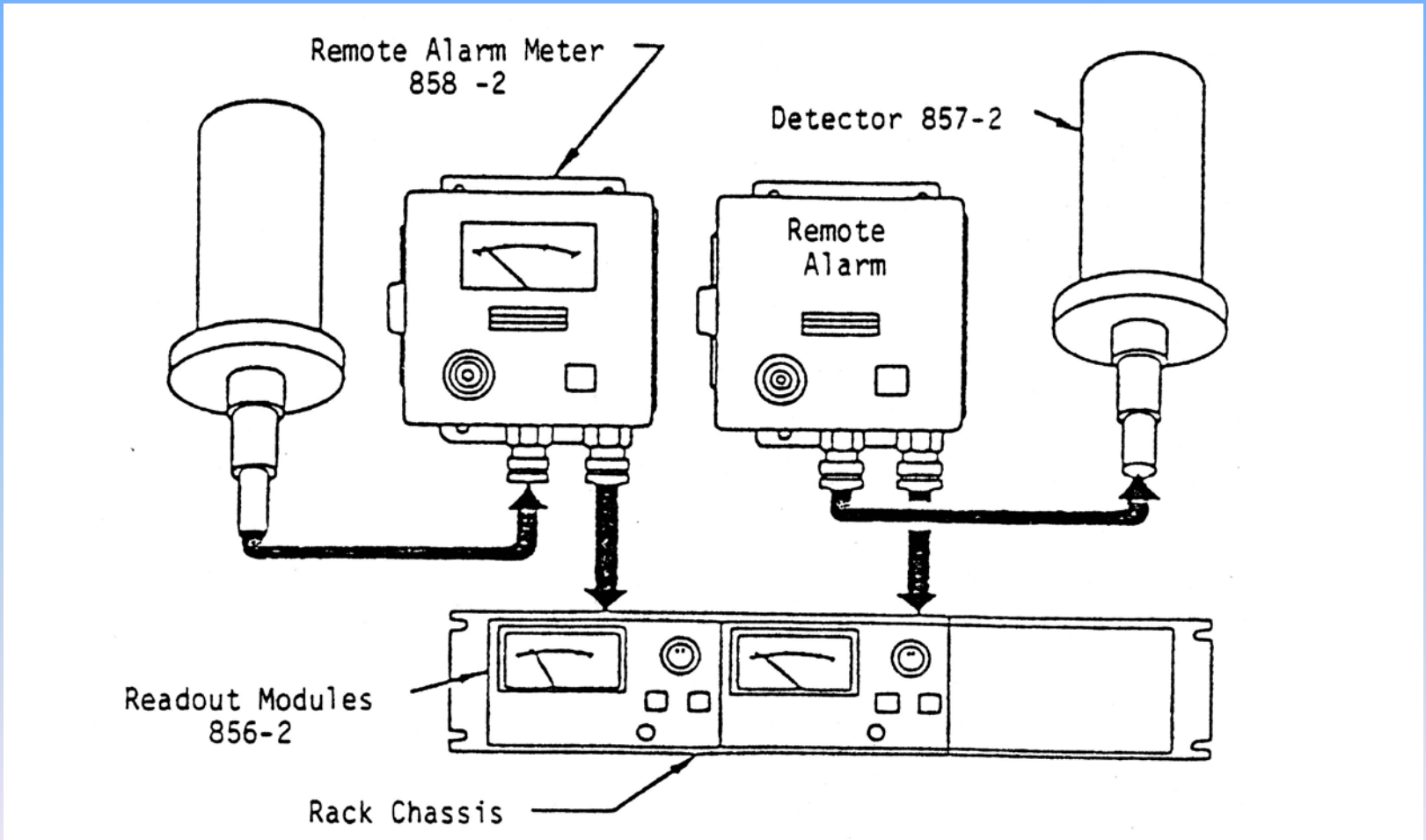
Revision of Iodine Source Term

- TMI-2 Accident provided evidence that the USNRC design basis source term assumption for halogen release from the core (25%) was too high
- An Alternate Iodine source term was approved by US NRC of 2% core halogen based on TMI-2 lessons learned
- Also, discovered that the TMI-2 stack monitor long sample lines released radioiodine for 30 days even though no new radioiodine was entering the sample line
- Due to radioiodine sample line plate-out

TMI-2 RP Instrumentation Lessons Learned: Containment Monitor

- Why the Contanment Area Monitor Failed to Provide Accurate Dose Rate Information during the TMI-2 Accident and Recovery Phases?
- Monitor continuously read 45 mR/hr
- No change when check source was inserted

TMI-2 Containment Area Monitor



Interpretation of Measurements

- upon the observation of a periodic 40 kHz output on the signal in line from the detector and the excessive loading on the 600 V power supply, it appeared that the Geiger-Mueller tube failed
- If the tube failed in an ionized condition (i.e., depletion of the quench gas), there would be an excessive current load on the 600 V power supply which could result in the observed drop in the supply voltage

Interpretation of Measurement, con't.

- The detector assembly contains an "anti-jam" circuit
- Designed to produce a periodic output upon saturation of the Geiger-Mueller tube.
- Designed to prevent loss of signal in the unlikely event of over-range radiation levels
- Would also be triggered by a "shorted" tube

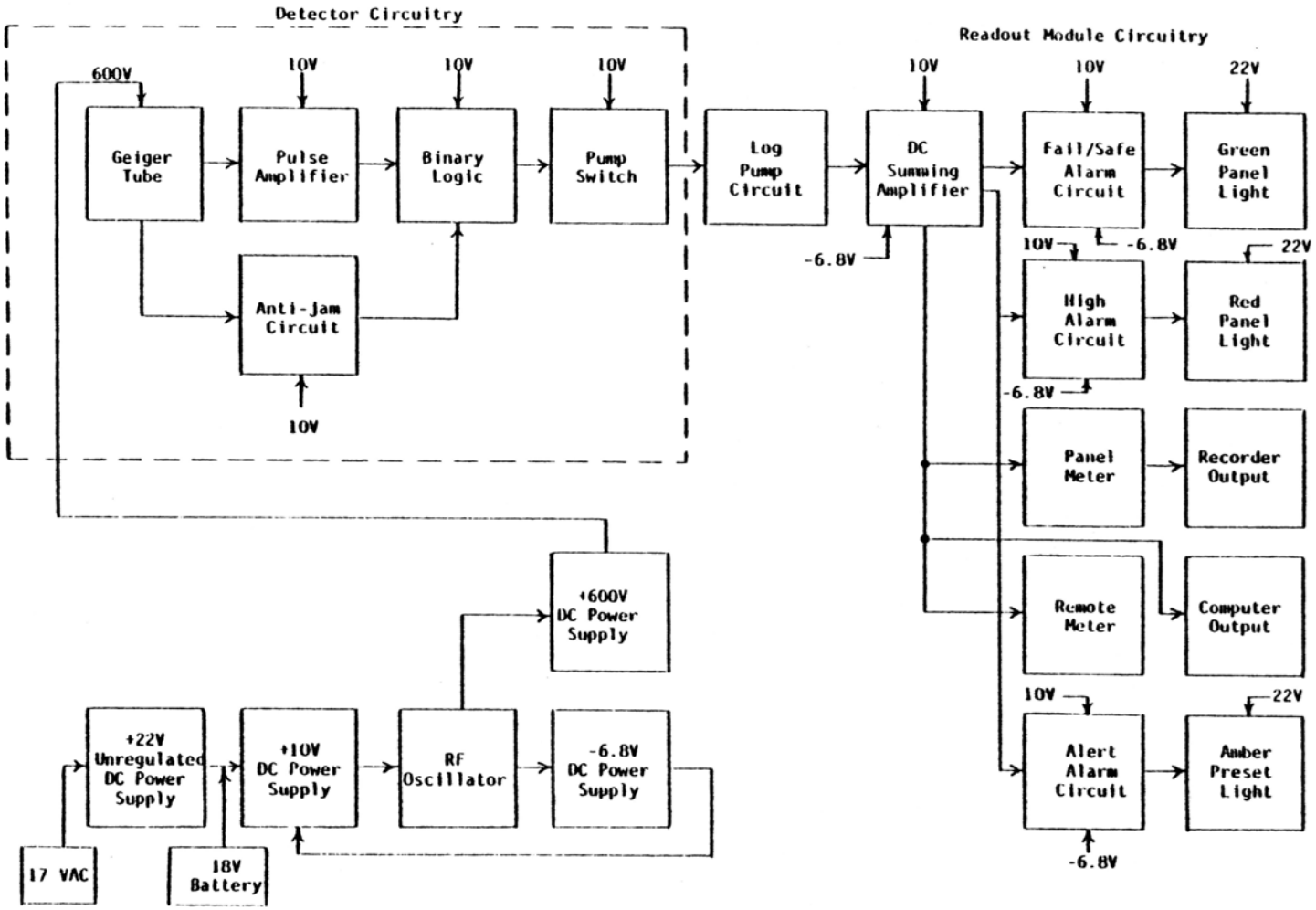


Figure 2-3 Functional Layout of Detector and Readout Module.

Technical Conclusion of Containment Area Monitor Erroreous Dose Rate Readings

- Based on the measurements, data reduction and circuit analysis of HP-R-212, there is indication of a failure of the instrument
- The observed output signals and resistance measurements suggest that the Geiger-Mueller tube was in a continuously ionized state
- All the output was being generated by the “anti-jam” circuit
- Also, there was indication that one of the output driver transistors, Q7, had failed
- Technical Conclusion: the 6 volts is interpreted as a 45 mR/hr detector response by the readout module!

Venting of Kr-85 Gas in TMI 2 Containment

1. A large quantity of Kr-85 gas was collected in the containment dome
2. Determined there would be less occupational dose to workers if it was vented to the upper atmosphere
3. The Plant Manager and his family stayed in a trailer at the base of the containment structure on the Saturday night when the gas was vented to the atmosphere

Illinois Governor TMI 2 Accident Response: State-owner NPP Radiation Monitoring System

- Illinois Governor wanted a radiation monitoring system installed at each nuclear plant operating in his state
- Illinois has the most nuclear plants in the US
- Illinois legislature passed bill requiring each nuclear unit to pay $180,000 per year to the state radiation safety department

State Owned Stack Monitoring System Installed in 1983-85

- State-owned and operated stack radiation monitoring system were designed and installed at each effluent release point at each plant
- Some plants had multiple release points
- Highly sophisticated radiation monitoring system were installed with GeLi detectors and automatic iodine canister sample changers

Pressurized Ion Chamber Installed

- Pressurized ion chambers were install in a ring around the BWR and PWR sites
- To measure direct radiation shine from the reactor building under accident conditions, e.g., BWR

Vehicle Washdown at Hospital

- Hershey Medical School hospital set up at vehicle decon station at the emergency room access.

Independent Academic Monitoring

- Penn State Nuclear Engineering Department developed at compressed gas sampling system to increase the sensitivity to noble gases (Kr-85) detection in the environs.
- The technique employed scuba bottles to compress the volume of sampled air
- Scuba bottles were counted on a GeLi system

Research on Improved Iodine Monitoring

- Susquehanna funded research at Penn State to develop an improved radioiodine monitor
- Objective was to avoid measuring compton scattering effect from noble gases in the I-131 channel
- Employed a 30-second nitrogen purge to clear xenon from charcoal canister during counting cycles
- Tested on FOFT Test at Idaho Engineering Lab

PP&L Installed City Hall Radiation Monitor in Berwick, Pennsylvania

- Health Physics staff at Susquehanna installed and calibrated a pressurized ion chamber envirnonmental monitor easily accessible to all local residences at City Hall
- Pre-operation environmental levels were carefully documented and compared with operating environmental radiation levels and reported in local papers

Regaining Public Trust

- Given the challenges of starting two GE BWR units 80 miles upstream of TMI 2 on the Susquehanna River, Pennsylvania Power & Light Company provided an annual research grant to a local College Physics Professor
- The Professor measured rain/snowfall, TLD based environmental dose levels and other environmental data.
- Published research results in the local papers

Independent, Academic Environmental Surveillance Program

- PP&L provided an annual research grant to the Philadelphia Academy of Natural Sciences and Emory University to conduct environmental studies in the vicinity of the Susquehanna site
- Established plant fence line gardens and control gardens to analyze for plant operational impacts
- Idea came from Japanese similar practice

TMI-2 Accident Impact on Local Businesses: Hershey Foods

- Radiation Management Corporation was requested to test “Hershey Chocolate Bars” for several months following the accident
- Milk came from potentially impacted dairies near Hershey, Pennsylvania

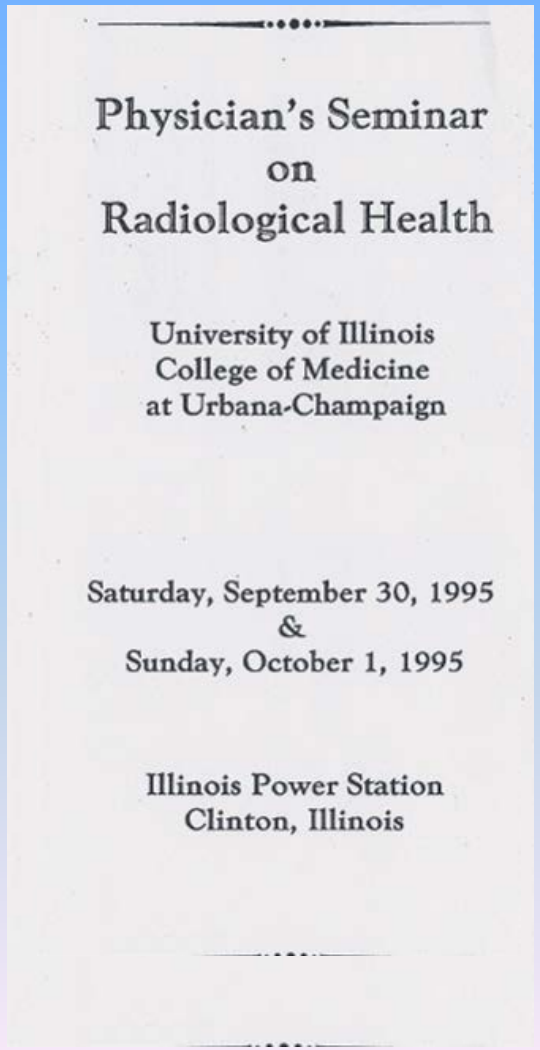
Radioiodine Study Funded by Nuclear Utility

- Iodine physiology was studied at Hershey Vet. School with funding from the Susquehanna plant
- Iodine uptake to the thyroid from topical application of iodine to the skin was studied in monkeys and begals
- Found 95% stable iodine uptake in thyroid in 30 minutes via absorption of 3 ml of stable iodine applied to the skin > blood > thyroid
- Surgeons and scurb nurses found to be protected due to frequent washing with betadine disinfectant

Local Physicians Seminars in Radiological Health Established

- The PP&L Utility President established a Radiation Advisory Committee composed of nationally and internationally renowned health physicist professors and medical doctors to advise him on Radiological Safety
- The Radiation Advisory Committee recommended initiating annual Local Physician Seminars on Radiological Health

Physician Demographic Studies are First Conducted to Determine the Target Physician Audience to Send the Announcement



Physician's Seminar
on
Radiological Health

University of Illinois
College of Medicine
at Urbana-Champaign

Saturday, September 30, 1995
&
Sunday, October 1, 1995

Illinois Power Station
Clinton, Illinois

Justification for Seminar Program

- Local physicians are highly trusted by the local community on public health issues
- They are scientifically trained and generally active on community health issues
- Once trained on radiological health topics, local physicians can provide invaluable input to the local community to give confidence in the safe operations of the nuclear plant in their neighborhood

Lessons Learned from TMI 2 Accident Evacuation Protocol vs Actual Public Response

- The radiologist in the community has been termed the "litmus paper people" in the community
- In other words, in a nuclear emergency, if the radiologist's family evacuates, the rest of the community will take note
- Physicians can also provide medical consultation to plant employees and spouses on health effects of low level radiation exposure.

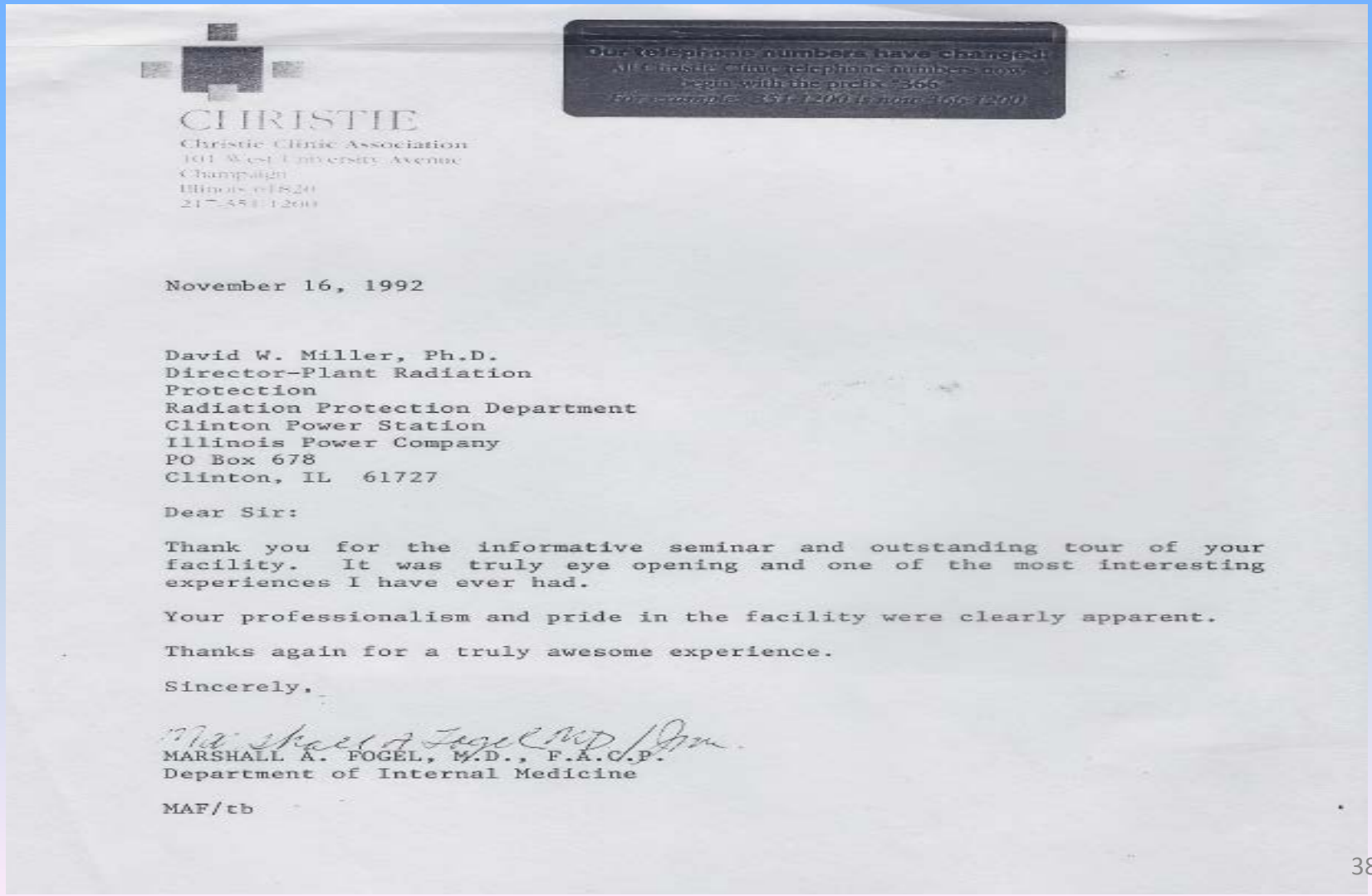
Bruce Kenyon, Sr. VP Nuclear-Susquehanna Nuclear Plant, Dr. Champlin,MD (Treated Chernobyl Liquidators) & Dr. Victor Bond, MD (Chairman, Susquehanna Radiation Advisory Committee to Company President) at Local Physicians Seminar on Radiological Health

Evidence of Extra Commitment to Local Community

- Local physicians appreciated the opportunity to discuss radiological health issues with experts at annual continuing medical education course
- A cadre of 50 physicians were trained in various topics related to radiological health including cell biology, radio-iodine physiology, external/internal dose and management of contaminated injuries from a nuclear facility

Local Physicians Presented with Susquehanna Logo & Course Completion Certificate from Hershey Medical School to Frame on Their Medical Office Wall

Physicians Wrote Letter of Appreciation to Susquehanna's Management



CHRISTIE
Christie Clinic Association
101 West University Avenue
Champaign
Illinois 61820
217-351-1260

Our telephone numbers have changed!
All Christie Clinic telephone numbers now begin with the prefix "366"
For example: 351-1200 is now 366-1200

November 16, 1992

David W. Miller, Ph.D.
Director-Plant Radiation Protection
Radiation Protection Department
Clinton Power Station
Illinois Power Company
PO Box 678
Clinton, IL 61727

Dear Sir:

Thank you for the informative seminar and outstanding tour of your facility. It was truly eye opening and one of the most interesting experiences I have ever had.

Your professionalism and pride in the facility were clearly apparent.

Thanks again for a truly awesome experience.

Sincerely,

MARSHALL A. FOGEL, M.D., F.A.C.P.
Department of Internal Medicine

MAF/tb

Questions

- Thank you

University of Illinois
at Urbana-Champaign
Department of Nuclear, Plasma, and Radiological Engineering