UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
UNION ELECTRIC COMPANY	)	Docket No. STN 50-483 OL
	)	
(Callaway Plant, Unit 1)	)	

AFFIDAVIT OF SAUL HARRIS
IN RESPONSE TO REED CONTENTIONS 6 AND 16
(PROTECTIVE ACTIONS AGAINST RADIOIODINES
& MESSAGES WITH INSTRUCTIONS FOR LONG-TERM SHELTERING)

City of St. Louis	)	
	)	ss.
State of Missouri	)	

SAUL HARRIS, being duly sworn, deposes and says as follows:

1. I am Principal Health Physicist, Union Electric Company. Since 1947, I have been involved in monitoring airborne radionuclides both for occupational exposure and public health. This work has included extensive industrial hygiene practical experience relating to prevention of inhalation of airborne radionuclides. A summary of my qualifications and experience is attached as Exhibit "A". I have personal

knowledge of the matters stated herein and believe them to be true and correct. I make this affidavit in response to Reed Contentions 6 and 16 (Protective Actions Against Radioiodines & Messages with Instructions for Long-Term Sheltering).

2. The purpose of this affidavit is to explain the effectiveness of ad hoc respiratory protection as a protective action in the unlikely event of a release of radioactive material, including radioiodine, from the Callaway Plant during a radiological accident.

3. As a possible result of a reactor accident which results in a significant atmospheric release of radioactive material, the public may be exposed to radiation from three exposure modes. These include: (1) exposure to external radiation as the released material passes in the form of a cloud or plume; (2) exposure to external radiation from radionuclides deposited on the ground and other surfaces during and after passage of the cloud or plume; and (3) internal exposure due to inhalation of radioactive material settling out of the cloud or plume but essentially suspended in breathing air. In the event that projections of possible airborne concentrations of active materials indicate that projected internal doses to the public may exceed recommended protective action guides, protective action should and can be taken to minimize such inhalation exposure.

4. Among the several alternatives to minimizing internal exposure to radioactive material is the deliberate action by

the public to take advantage of emergency respiratory protection offered by the use of common household material as ad hoc respirators. Ad hoc respiratory protection from readily available materials such as fabrics, towels, sheets, etc., has been shown to be effective for both particles (dusts or aerosols), vapors, and radioactive gases including radioiodine. Such inhalation protection would be valid for the public remaining indoors (sheltering) or for brief movement outdoors during passage of a radioactive cloud or plume. In addition, such ad hoc respiratory protection would increase the inherent inhalant protection provided by sheltering within a structure. This protection is afforded either by natural sealing of the building or by certain ventilation strategies which inhibit air and dust movement from the exterior of the building into areas occupied by the public during passage of a released radioactive cloud or plume.

5. The effectiveness of ad hoc respiratory protection is expressed in terms of filter efficiency or penetration of dusts, aerosols or gases through the ad hoc respirator materials. Research into the effectiveness of emergency respiratory protection using common household and personal items has been undertaken for over 20 years, with much of the early work done at the request of the Atomic Energy Commission. Initial research studied some eighteen variations of eight household and personal items, with military personnel using these materials as respiratory protection expedients in a calibrated

atmosphere of particles in an aerosol. These early tests gave results (see attached Table "A") indicating that five variations involving a man's cotton handkerchief, commercially available toilet paper, and a bath towel, had a filtration efficiency greater than 85 percent (meaning that 85% of the particles were not inhaled because of the ad hoc respiratory protection). Resistance to breathing offered by each medium also was evaluated with a few of the variations rejected because of excessive breathing resistance. In general, the medium needs to be damp but not too wet (see footnote A in Table "A"); however, excessive wetting of the initial test material could increase resistance to breathing, indicating that use of very wet items is not generally practical. In all instances, a good fit on the face, to assure edges were sealed, is essential to obtain maximum effectiveness of the expedient material; however, this is also a limitation applicable to commercial] -available respirators. (See the 1963 American Industrial Hygiene Association Respiratory Protective Devices Manual, "Household Items for Emergency Use in Civilian Defense," pages 123-126; and the A.M.A. Archives of Industrial Health, "Emergency Respiratory Protection Against Radiological and Biological Aerosols," Vol. 20, page 91-95, Aug. 1959.)

6. Further research conducted by the Department of Environmental Health Sciences, Harvard School of Public Health, has been published as NUREG/CR-2272, Expedient Methods of Respiratory Protection, November 1981, for the U.S. Nuclear

Regulatory Commission; and as "Emergency Respiratory Protection with Common Materials," Am. Ind. Hyg. Assoc. Journal 44(1): 1-6 (1983) by D. W. Cooper, W. C. Hinds, and J. M. Price. In addition, remarks "On the Efficacy of Ad Hoc Respiratory Protection During a Radiological Emergency" were presented by James A. Martin, Jr., an NRC Staff member, as paper P/50 at the 1981 Annual Meeting of the Health Physics Society, based in part on the data by Cooper, et al. (Harvard University). The Harvard data were also included in a paper presented by D. C. Aldrich at an Electric Power Research Institute symposium on radiological emergency planning held January 12 and 13, 1982 and published in NSAC-50, "Are Current Emergency Planning Requirements Justified," NSAC-EPRI, May 1982. As discussed below, these papers reflect the current state of the art with respect to ad hoc respiratory protection.

7. The reports by Cooper and associates were the result of extensive studies of the ability of readily available fabrics to filter aerosols, gases and vapors expected to be emitted in the event of a major nuclear reactor accident using calibrated particles. The results, while somewhat different, were consistent as to the value of ad hoc material from those obtained earlier. Decreases in particle concentrations by a factor of ten or more were possible from the fabrics tested, when operated at a pressure drop deemed acceptable for breathing comfort. Protection from Krypton-85 by dry fabrics and from radioiodine using wetted fabrics (with water or a

baking soda solution) was appreciable. Follow-up studies by Harvard University are continuing.

8. These test results show that readily available materials can provide substantial reductions in concentrations of particles and certain water-soluble gases and vapors at pressure drops acceptable for respiratory protection during nuclear power plant accident conditions. Leakage around the seal to the face could reduce the protection provided, as noted in the earlier studies, but this problem is associated with the use of commercially-available respirators as well. Table "B" summarizes the data from these studies. Of importance was the finding that wetted sheets and towels would provide respiratory protection from iodine vapor, reducing iodine concentrations by a factor of ten.

9. While neither of the studies specifically address the duration of the protection, the earlier report stated that the dry bath towel and man's handkerchief variations did not appear to have any serious limitations as to the duration of use. The Harvard research did not indicate any significant breathing difficulties could be anticipated by the use of towels or handkerchiefs even when wetted. Comparing these materials with a 3M dust respirator, a half-mask fabric respirator, the authors of the reports felt the masks could be worn for hours without substantial discomfort and the fabrics could be tied or taped to the face for shorter periods during the passage of a puff or plume, during travel to shelter~~, or during relocation,~~

indicating suitable duration of use during nuclear accident scenario conditions.

10. In a qualitative sense, then, these research studies indicate that it would be advisable to cover the nose and mouth during possible exposure to airborne radioactive material following a nuclear reactor accident if the plume is likely to cause airborne concentrations that could result in radiation doses to the public in excess of protective action guides. Further research is underway to quantify this perhaps self-evident statement. As stated by Martin in the abstract for paper P/50, "These studies demonstrate that application by the public of ad hoc shelter and respiratory protection could provide inhalation pathway protection factors (PFs) of ten or more, with shelter providing a PF of two to ten and ad hoc respiratory protection providing an additional PF of three to twenty, or so."

11. Martin points out that "These potential PFs are very competitive with that of potassium iodide (KI) for the thyroid, but the former would protect other organs as well . . . ." (emphasis added). Martin further adds that ". . . ad hoc shelter and respiratory protection could be used to reduce doses in cases where expeditious evacuation would not be feasible . . . ."

12. Following an accident at the Callaway Plant, the public would be instructed in appropriate protective action by appropriate authorit~~ies, including when to initiate an~~d when to

stop the use of ad hoc respiratory protection (if needed at all). Proper instruction to families as to the use of ad hoc respiratory protection will be done through pre-established public messages and public information previously sent to residents. Parents would be able to monitor the proper use and comfort of ad hoc respiratory protection by the younger members of the family according to these instructions, with no likelihood that young children could suffocate from the use of ad hoc respiratory protection.

13. There is no mystery to the concept that ad hoc respiratory protection can be effective in providing inhalation filtering of potentially hazardous airborne material. It is common knowledge that covering the nose and mouth of family members with damp cloths is an effective ad hoc method of minimizing smoke inhalation during fires. Common sense as well as scientific research dictates that similar action be taken upon instruction by appropriate authorities following the release of significant quantitites of airborne radioactive material during a radiological accident at the Callaway Plant.

Saul Harris

Saul Harris

Subscribed and sworn to before me
this 16th day of May, 1983.

Barbara J. Pfaff

Notary Public

BARBARA J. PFAFF
NOTARY PUBLIC, STATE OF MISSOURI
MY COMMISSION EXPIRES APRIL 22, 1985
ST. LOUIS COUNTY

My Commission expires: 4/22/85.

Exhibit A

Resume

SAUL JOSEPH HARRIS

Education:	BS - Physics and Mathematics Queens College, NY 1943
	Electrical Engineering - ASTP Mass. Inst. of Techn. 1943-1944
	MS - Industrial and Management Engr. Columbia Univ., NY 1959
	MPA - Public Administration New York Univ., NY 1972
	DPA Candidate - Public Admin. New York Univ., NY Thesis Pending
Certification, Honors, Awards:	Certified Health Physicist American Board of Health Physics 1960
	Certified Safety Professional Board of Certified Safety Professionals 1973
	Recognized for "Devoted Leadership" by Boy Scouts of America for developing the Atomic Energy Merit Badge 1963
	Appointed Health Physicist Member, NY State Board of X-ray Technician Examiners by State Health Commissioner 1964-1975
Military Service:	US Army Signal Corps, Tech. Sargent, Carrier-Repeaterman, Overseas Duty in India-Burma Theatre 1943-1946
Special Skills:	Adjunct Lecturer, College of the City of NY, Dept. of Civil Engineering, MS-level Course in Radiation Safety Engineering 1967-1971
	Instructor in Public and Business Administration, Central Michigan University (DC Area) 1977-1982
Experience:	1943-1946 Military Service
	Included electrical engineering study at M.I.T., and Carrier-Repeaterman School at Fort Monmouth, NJ, and service in the India-Burma Theatre

1946-1947 Western Electric Co.

Equipment engineer on long-distance telephone equipment installation specifications, NYC

1947-1951 Brookhaven National Laboratory

Research associate in nuclear reactor physics, testing materials, metallurgy, and cooling system design; Health Physics surveyor for occupational and environmental radiation, design of nuclear instrumentation, Upton, NY

1951-1955 NY State Department of Labor, Division of Industrial Hygiene

Organized and managed a full-time radiation control program, including field inspections, chaired and directed a 24-member expert advisory committee to develop the first state-level comprehensive radiation code, NY, NY

1955-1959 Atomic Industrial Forum, Inc.

Technical secretary to committees on standards, public education, nuclear instrumentation and ASA standards committees; Assistant Manager for State Activities (in atomic energy), NY, NY

1959-1961 Baird-Atomic, Inc.

Technical Director of Atomic Accessories (Subsid. of Baird-Atomic) for product development and testing; served as regional nuclear sales engineer for nuclear instrumentation, Valley Stream, NY

1961-1972 US DHEW

With the US Public Health Service, then Food and Drug Administration and Environmental Protection Agency, served as regional radiation protection director in Region II of DHEW (initially NY, NJ, Penn. and Del.; later NY, NJ, Puerto Rico and VI), administration and technical assistance to state and local radiation protection programs, administer Federal formula and research grants, NY, NY

1972-1975 NY City Department of Health

Directed a major radiation control program to regulate medical and educational use of x-ray units and radioactive material, NY, NY

1975-1982 Edison Electric Institute

Engage in nuclear activities in the field of public health, radiation protection, nuclear power, emergency planning, Washington, DC

1982 - present Union Electric Company

Principal Health Physicist

Presentations and Papers:

Major Publications:

Nuclear Power Safety Economics, Pilot Books, 1961

The Impact of the Peaceful Use of Atomic Energy on State and Local Government, AIF, 1958

State Activities in Atomic Energy, AIF, 1958

Administrative Problems in Radiation Protection, NUCLEONICS, December 1954

Other Publications and Papers:

Over 150 presentations, papers, articles, and interviews on the following topics:

- monitoring fallout, instrumentation design, x-ray film characteristics

- radiation hazards from mass dental surveys, static eliminators, veterinary medicine, non-uranium mine radon exposure, x-ray shoe fitting fluoroscopes, radium dial painters

- planning and zoning aspects of atomic energy, examinations for x-ray technicians and for radiation professionals, development of national radiation standards, public understanding of atomic energy

Professional Societies and Committees:

American Nuclear Society

American Association of Physicists in Medicine

Health Physics Society

Included in Who's Who in Atoms; American Men & Women of Science - the Medical Sciences

TABLE 11.5

RESPIRATORY PROTECTION PROVIDED BY COMMON HOUSEHOLD AND PERSONAL ITEMS AGAINST AEROSOLS OF 1 TO 5μ PARTICLE SIZE

Item	Number of Thicknesses	Resistance, mm of H_2O	Number of Observations	Geometric Mean Efficiency, %	95% Confidence Limits for Mean, % Lower	95% Confidence Limits for Mean, % Upper
Handkerchief, man's cotton	16	36	32	94.2	92.6	95.5
Toilet paper	3	13	32	91.4	89.8	92.8
Handkerchief, man's cotton	8	18	32	88.9	85.5	91.6
Handkerchief, man's cotton	Crumpled	--	32	88.1	85.1	90.5
Bath towel, turkish	2	11	32	85.1	83.3	86.8
Bath towel, turkish	1	5	30	73.9	70.7	76.8
Bed sheet, muslin	1	22	32	72.0	68.8	74.9
Bath towel, turkish	1 (wet)	3	31	70.2	68.0	72.3
Shirt, cotton	1 (wet)	>150[a]	15	65.9	57.9	72.3
Shirt, cotton	2	7	30	65.5	60.8	69.6
Handkerchief, woman's cotton	4 (wet)	84[a]	32	63.0	57.3	67.9
Handkerchief, man's cotton	1 (wet)	98[a]	30	62.6	57.0	67.5
Dress material, cotton	1 (wet)	180[a]	31	56.3	49.6	62.0
Handkerchief, woman's cotton	4	2	32	55.5	52.2	58.7
Slip, rayon	1	6	32	50.0	46.2	53.6
Dress material, cotton	1	5	31	47.6	41.4	53.2
Shirt, cotton	1	3	32	34.6	29.0	39.9
Handkerchief man's cotton	1	2	32	27.5	22.0	32.5

a. Resistance obtained when checked immediately after hand wringing. This resistance began to decrease after about one minute when the material started to dry.

TABLE B ESTIMATED PENETRATION THROUGH EXPEDIENT RESPIRATORY PROTECTION MATERIALS AT 50 Pa (0.2 IN H_2O) PRESSURE DROP AND 1.5 CM/S FACE VELOCITY

DRY

Material	No. layers	Aerosol particle diameter (μm) 0.4	1	5	I_2[b]	CH_3I[b]
3M respirator[a] # 8710	2	.03	.004	<.01		
Sheet	20	.66	.64	.020	1.0	0.6[c]
Shirt	15	.54	.59	.070		
Lower-quality towel	20	.53	.41	.015		
Higher-quality towel	6	.24	.13	<.01		0.6[c]
Handkerchief	14	.61	.54	.032		

WET

Material	No. layers	Aerosol particle diameter (μm) 0.4	1	5	I_2[b]	CH_3I[b]
Sheet	6	.91	.88	.22	.45 .15[d]	.8[c] 1.0[d]
Shirt	6	1.0	.51	<.02		
Higher-quality towel	4	.20	<.01	<.01	.21 .10[d]	1.0
Handkerchief	2	.98	.95	.37		

a. Available commercially in single-layer thickness.
b. Taken from tests at 1.0 cm/s, assuming penetration is the product of single-layer penetrations.
c. Not shown to be statistically different from 1.00.
d. Wetted with 5% by weight baking soda solution.

Taken from NUREG/CR-2272 (Nov. 1981) at 84.