

SUPPLEMENTARY NOTES

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SUMMARY OF EVIDENCE

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IN THE CASE OF

CANCER VICTIM

AND

ATOMIC VETERAN

BJARNIE HANNIBAL PAULSON

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PREPARED BY

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VICE PRESIDENT

CANADIAN COALITION FOR NUCLEAR RESPONSIBILITY

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## NOTES

1. "Airborne contamination within the reactor hall at the time of the uranium fire was too high to be measured with accuracy. However, readings taken an hour later, 100 yards from the building, were as high as 200,000 [disintegrations per minute per cubic meter].... Light fallout occurred in the vicinity of the building and was detectable 4 days later on vegetation up to 5,000 feet downwind." Statement of Case, page 13H.
2. "Twelve days after the accident, samples taken in the reactor hall showed that air contamination was still 100,000 to 200,000 [disintegrations per minute per cubic meter]." Statement of Case, page 13H.  

In his oral and written testimony, Mark Goldberg observed that in the case of a radioactive metallic fire in the United States (Rocky Flats, 1957) almost all the radioactivity (97 percent) was associated with sub-micron particles (having a diameter 100 times smaller than that of an average human pore). See Transcript, 22 Jan 81, pp. 96-97; and written testimony, p.22. This information comes from an article by Mann and Kirchner in Health Physics, v.13. (See exhibit P-11 by Mr. Goldberg.)
3. "Since the NRU building was completely contaminated, an emergency headquarters was set up in an adjacent building.... Techniques familiar to every housewife were used for decontaminating floors, walls, ceilings and other exposed surfaces -- wet mopping, wiping with damp rags and vacuum cleaning." Statement of Case, page 13 I.
4. "Radiation fields around and over the pit were much higher than 1000 rads per hour (the available monitoring instruments were off-scale).... Radiation fields in the cab of the overhead crane used in these operations were 5 to 10 rads per hour, requiring a change of operators every 2 minutes." Statement of Case, page 13F & 13G.
5. "About 40 men, whose normal work did not involve exposure to radiation ... used long-handled tools to shovel the sand into metal garbage cans and carried the cans to an elevator.... Radiation levels at the can surfaces were up to 200 rads per hour. Prior permission had been obtained for all of these men to receive exposures of up to 5 rads, but in spite of the one-and-a-half-minute working time prescribed for each man, 14 of them exceeded the 5 rad limit." Statement of Case, 13G & 13H.
6. "Much more contamination was spread on roads used for transportation of debris from the uranium fire than escaped directly from the building. The roads were cleaned quickly by vacuuming, washing with fire hoses and, when necessary, removing part of the road surface." Statement of Case, p. 13H.
7. Two days after the fire, after the fuel fragments and most of the sand had been removed, "Radiation fields as high as 1000 rads per hour were measured 2 feet above the reactor deck and above the maintenance pit. Readings of 100 rads per hour at waist level were found in many parts of the main floor." Statement of Case, p.13H.
8. "The nozzle, attached to a long hose, could be manipulated from a distance by long holders. Many problems had to be overcome -- for example, the removal of highly radioactive vacuum filters (specially designed flasks were built to receive these), design of a cyclone sand separator to prevent clogging of the filters, and removal of pieces of paper that caused frequent clogging of the vacuum cleaner (long poles with adhesive-coated tips were used for this purpose)." Statement of Case, p. 13 I.
9. "It was deemed unwise, however, to use inexperienced workers to clean walls, ceilings, overhead crane, etc., in locations up to 90 feet above the floor. For this work, the services of a commercial firm of building cleaners and steplejacks were obtained." Statement of Case, p. 13 I.

10. "Altogether nearly 300 men took part in this operation, working in carefully timed relays to a maximum exposure of 3 rads. The average exposure per man was about 1.5 rads. At this time, since it was necessary to maintain a reserve of manpower for future operations, normal radiation limits (300 millirads per week) were reimposed for company employees." Statement of Case, page 13 I.
- "It was clear that the cleanup of the building could not be carried out by the NRU staff alone if these men were to remain within the permissible annual radiation limit of 5 rads." Statement of Case, page 13G.
11. "At this juncture, the armed forces and civil-defense college came to the rescue and provided about 70 men per day to work three 8-hour shifts for the next 6 weeks." Statement of Case, page 13 I.
- "Now the list of names that you have in the exhibit that was just filed, that's exhibit P-3, these are more experienced men. They are RCAF people ... who were at that time veterans already, and who were instructors in Atomic Warfare, [radioactive] decontamination, and the proper procedures to take in the event ... of nuclear attack or some type of incident requiring the handling of radioactive materials. So Mr. Paulson was a member of a specialist group within the forces who were summoned to supervise and instruct those who had no such training. Mr. Paulson himself had extensive training." Dr. Edwards, Transcript, 22 Jan 81, page 22.
- "Not included on that list was a contingent of 17 people who came down from the Civil Defence College in Arnprior. These were not military personnel, but they came down roughly the same time and participated in the same type of clean-up activities. They were also in a supervisory capacity to some extent in that they had prior training in proper decontamination procedures and proper protective clothing." Dr. Edwards, Transcript, p.26 22 Jan 81, page 26.
12. In a letter dated April 16, 1979, Mr. Paulson indicates that one of the duties of the RCAF personnel was "to supervise or escort army personnel into the contaminated area on numerous occasions." Statement of Case, page 13B.
- "We were all instructors, so therefore, we all went down there with the purpose of guiding the Army personnel -- making sure they dressed the way we were told they should dress, and making sure that they wore the respirator, and ensuring that they did not pull back the rubbery part for air [see note 14], because they were recruits taken right off the parade square at [Camp] Petawawa." Mr. Paulson, Transcript, 10 Sept 82, p. 116.
13. "Each man employed in the cleanup was provided with protective clothing, a full-face respirator, a film badge and a pocket dosimeter." Statement of Case, page 13 I.
14. "In the early stages of the cleanup, it was not unusual to find as much as 200 millirads per hour surface contamination on used suits." Statement of Case, page 13 I.
- "About 25,000 rubbers and 10,000 respirators were decontaminated in the month of July." Statement of Case, page 13J.
- "Some cases of internal contamination were traced to improper use of respirators -- for example, raising the face-piece briefly to breathe more easily or to speak to another worker." Statement of Case, page 13J.

15. "By taking special care to undress the wearer by turning the garment inside out, very few cases of skin contamination were encountered." Statement of Case, page 13 I.
- "About 2000 24-hour samples of urine were tested for radioactivity between May 24 and July 31.... Of these, less than 10 percent were positive." Statement of Case, page 13J.
- "A urine specimen received from Mr. Paulson on June 17, 1958, indicated negligible amounts of internal contamination.... [He was also] monitored for skin contamination and if negligible went into the showers and [was] monitored again before dressing. Records of these negligible contamination levels were not kept...." Statement of Case, page 15. (Dr. Muller)
16. "ADVOCATE: Now you ... were allowed into a contaminated area without a filter-fitted mask. Is that correct?  
McCORMAND: That is correct.  
ADVOCATE: I think the Canadian Pension Commission has recognized this and the radiation insult which was received was the subject of pension for Mr. McCormand."  
Transcript, 22 Jan 81, page 105-6.
17. "This is the occasion on which he wasn't wearing his cannister." Mr. Dunphy, Transcript, 22 Jan 81, page 113.
18. "McCORMAND: I was exposed to internal radiation ... deposited in my lungs at the time.... When I was exposed, I was taken off the job of going into the reactor....  
ADVOCATE: Mr. McCormand was taken off not because he had exceptionally high readings in terms of the records that were kept, but because of the physical circumstances. They knew that he'd been contaminated."  
Transcript, 22 Jan 81, pages 113-4.
19. Attached to Mr. Paulson's letter of 16 April 79 (Statement of Case, page 13A) were photocopies of three certificates: (1) an RCAF certificate (dated 13 April 53) qualifying him as a Ground Defenceman Instructor, having graduated from the Ground Defence School; (2) a Civil Defence College certificate (dated July 57) qualifying him as an instructor in Atomic, Biological and Chemical Warfare, having attended the Rescue Course "A, B & C" at Arnprior; (3) a diploma from the Joint Atomic, Biological and Chemical Defensive Warfare School (dated 4 November 60).
20. In the Pension Commission's Decision of July 11, 1980, Dr. Marko of AECL is quoted as saying that "our records show that between 10 June 1958 and 18 June 1958, Mr. Paulson received a total exposure of 905 millirems." Dr. Muller is also quoted as referring to "the decontamination work at Chalk River between June 10 and June 18, 1958," in the same Decision.
- However, a letter from Col. R. A. Cunningham to Mr. K. J. Dunphy dated 4 Jan 81 (exhibit P-4) indicates that "6th of June 1958 was the arrival date". Transcript, 22 Jan 81, page 24. The official AECL account of the accident (Statement of Case, pages 13 F to J) confirms June 6 as the starting date.
- "Mr. Paulson tells me he was there from June 6 to June 18." Dr. Young, Transcript, 22 Jan 81, page 54.
- "This cleanup should be considered in two parts.... From May 23 to about June 6 was the AECL portion, and the Armed Forces people were brought in after that date, from June 6 to about July 8th or so." Dr. Marko, Transcript, 10 Sept 82, pages 20-1.

21. "Twelve days after the accident, samples taken in the reactor hall showed that air contamination was still 100,000 to 200,000 [disintegrations per minute per cubic meter]." Statement of Case, page 13H. (That would be June 4, just two days before Mr. Paulson's arrival. Compare with note 1.)
22. "MEMBER: Were you actually performing monitoring and so on all that time, or did you arrive and four days later you started?  
APPLICANT: No, I started the first day we got there ... but there was ten days that I actually spent at Chalk River in the reactor.  
Transcript, 22 Jan 81, page 54.
23. "I made the mistake of picking up my meter, which had been contaminated from inside of the reactor. It's an error on my part, but it brings me to mind that I was barehanded...." Roger Reny, an instructor from the Civil Defence College, describing an incident of self-contamination during the NRU cleanup. Transcript, 22 Jan 81, page 106.
- "You have to remove the suits with the greatest of care not to touch with your hands the outside surfaces of the suit. Any part of your body that touches the outside is potentially contaminated and there you have a real problem." Dr. Karl Morgan, describing techniques used at Oak Ridge National Laboratory in the United States. Transcript, 10 Sept 82, page 65.
- "When taking the suits off, we were soaking wet from wearing the coveralls, underwear, rubbers, plastic suits, et cetera, and in taking those off our hands were contaminated.... As far as any contamination on the clothing, there was no way that it could not get over the body the way we undressed." Mr. Paulson, in Transcript, 10 Sept 82, page 123.
- "CHAIRMAN: I'm asking you if you touched the outside of the outside garment with your hands?  
APPLICANT: Yes I did.  
CHAIRMAN: With bare hands?  
APPLICANT: With bare hands. Yes."  
Transcript, 10 Sept 82, page 124.
24. Dr. Art Marko, Director of the Health Sciences Division at Chalk River, described the monitoring as "quick monitoring and, of course, we still use this technique even today." He responded to questioning as follows:
- "ADVOCATE: Do you know how long an inspection would take of an individual person emerging from the showers?  
WITNESS: Oh, I'd say as long as it takes to sweep the body and the arms  
ADVOCATE: So, it would be a reasonably brief sweep?  
WITNESS: It would be cursory, yes."  
Transcript, 10 Sept 82, page 16.
25. "Once you had your shower you left [by] another door, you were rechecked and if they detected any radiation you had to go back in, into the shower; yes, I was checked many times and had to go back." Mr. McCormand, unidentified, Transcript, 22 Jan 81, page 110.
- "I know for a fact that once I had to go back twice but -- I'm not positive, but I think it was three times." Mr. Roger Reny, Transcript, 22 Jan 81, page 110.
- "I was sent back on numerous occasions, myself -- and Mr. Draper here can verify that you were sent back for a further shower until you were getting pretty sick of showering." Mr. Paulson, Transcript, 22 Jan 81, page 110.

26. "Two of us were called aside and told that we had a very important job to do and that ... we'd have to be very careful, and the man that came in with me was Mr. McCormand.... McCormand was to cut through the hose of the vacuum cleaner but he was improperly briefed.... That particular vacuum, in my opinion, was used for picking up the sand and [other] contamination.... We were told to 'Get out, get out!' but we were approximately seventy seconds overdue in that particular instance." Mr. Paulson, Transcript, 22 Jan 81, page 108.

"ADVOCATE: Dr. Marko, was there a vacuum cleaner used in the early stages of the cleanup?

WITNESS: Oh, it was used lots of times, yes.... Well, to suck up ... the sand and the fuel rod debris, hot particles which would be collected on a filter which would be removed remotely....

ADVOCATE: But would the filter be removed manually? Someone would have to do that, physically do that function?

WITNESS: Oh, it depends on the [radiation] fields, and if the fields were high, you couldn't get very close.... So it wouldn't be done that way."

Transcript, 10 Sept 82, page 21-22.

27. "ADVOCATE: Why would someone have to cut the vacuum hose?  
APPLICANT: Because the vacuum hose led into the pit ... where the accident happened, where they picked up the sand and the debris... In order so that they [could work] behind the lead glass and by remote control pick up the vacuum cleaner, roll up the vacuum hose in order to transport it to the atomic graveyard or whatever they call it, this had to be done."  
Transcript, 10 Sept 82, page 118.

"They wanted to pick it up in the trucks and take it and put it away in the graveyard but they couldn't pick it up because the hose had stretched all down through the back into the reactor area." Mr. Paulson, Transcript, 22 Jan 81, page 108.

28. "It came about that two of us were selected to do a job. We were taken aside by the physicist and briefed. My original job was to remove the debris from the storage compartment for the rod, or what was left of the rod, so they could put the cover back on. I was told not to look directly at it, but to work out of the corner of my eye. The other chap was instructed on cutting the vacuum hose.... I think he was briefed improperly, or he didn't know enough about the situation; [he] tried to cut through the stainless steel portion ... so I took the saw from him and I cut through the hose, and then we were being yelled at by the physicist behind the ... lead glass that we had overstayed our time, in other words to get out, get out, get out, which we did." Mr. Paulson, Transcript, 10 Sept 82, page 118.

"I did my job. I came back. McCormand was to cut the hose of the vacuum cleaner, but he was improperly briefed. He was not told how far the metal, the stainless steel metal, went into the hose -- and with a hacksaw you cannot cut stainless steel. So I come to assist him. I took the saw from him and helped him by cutting through the hose of the vacuum, which was copper wire." Mr. Paulson, 22 Jan 81, page 108.

29. "That was where a lot of the dust, as far as I'm concerned, a lot of dust was accumulated by [that] vacuum cleaner." Mr. Paulson, Transcript, 10 Sept 82, page 118.  
See also the last sentence of note 26.
30. "ADVOCATE: Is that the day you had to repeat, that you were repeatedly sent back to the shower?  
APPLICANT: Yes, I was sent back to the showers three times that day." Transcript, 10 Sept 82, page 119.
31. "This patient had a lesion excised by the surgical department while in hospital from an area near the anus. Amazingly enough, the histopathological studies of that piece of tissue is reported as a basal cell carcinoma." Consultant's Report, Statement of Case, page 6.
32. "This is a very rare area for basal cell carcinomas." Dr. Howard Cohen, Dermatologist, exhibit P-1. See Transcript, 22 Jan 81, page 13.  
"This is a very unusual area for basal cell carcinoma. It's extremely rare." Dr. Jack Cohen, Plastic Surgeon, Transcript, 22 Jan 81, page 121.  
"My further interest in basal cell carcinoma of the anus led me to find the largest study to date of that tumor at that particular site, and from the British Journal of Surgery, very recently, in 1981, they could only find 34 cases in their institution over a 30-year period -- 31-year period -- representing much less than 1 percent of 8000 tumors from that area alone...." Dr. Herb Srolovitz, Pathologist, Transcript, 10 Sept 82, p.86.
33. "COHEN: ... five or six on the scalp, one or two of the cheek or nose area, one of the anal area ... several on the nose ... one on the left lower eyelid ... there was one I believe of the chest ...  
VOICE: What about the one that you removed from the pubic hair?  
COHEN: Ya. They're not common in that area also."  
Transcript, 22 Jan 81, page 120-1.  
"ADVOCATE: Since the last Entitlement Board Hearing in January of '81, I understand that you have developed additional skin cancers.  
APPLICANT: Yes.  
ADVOCATE: And I understand you had a couple on your lip?  
APPLICANT: I had my lip and both eyes.  
ADVOCATE: When were the ones on your eyes removed?  
APPLICANT: Two weeks ago Friday.  
ADVOCATE: And the ones on your lip?  
APPLICANT: That was about a year ago. They did that at the same time as they did the penile operation, the penis operation."  
Transcript, 10 Sept 82, page 115.
34. "It is interesting that he did have the basal cell [carcinomas] on the hair-bearing areas. This, combined with his history of working with the clean-up of radioactive material, made the possibility that this was responsible for a good part of his present problem.... Certainly with the locations of the basal cell carcinomas, one must suspect that the radiation was an important factor in the cause of this condition." Dr. Howard Cohen, Dermatologist, exhibit P-1. See Transcript, 22 Jan 81, page 14.  
"There were 16 individual basal cell carcinomas and, in my personal experience, it is an unusual number. I have encountered people who've had 3 or 4, and when that happens, I ask the clinician whether the patient may have the basal cell naevus syndrome, (and the patient is usually examined for that condition) or some other obvious reason for developing multiple basal cells. Sixteen is the most I've ever seen in one patient."  
Dr. Srolovitz, Transcript, 10 Sept 82, page 92.

35. "One could think of the basal cell carcinoma [naevus] syndrome, which is an inherited condition. He was examined for this, and appropriate X-rays were done, and he certainly did not fall into that category." Dr. Howard Cohen, exhibit P-1. See Transcript, 22 Jan 81, page 13.
- "Basal cell naevus syndrome, or at least the lesions that would arise in that syndrome, would occur usually at birth or in infancy or in adolescence. They do not arise when a person is fifty or sixty years old. Furthermore, they are associated with numerous other stigmata involving the skeletal system, the skin, the central nervous system, eyes and so forth. Mr. Paulson has been examined for these other stigmata and no other confirmatory evidence has been shown that might lead one to think that he has the basal cell naevus syndrome." Dr. Srolovitz, Transcript, 10 Sept 82, pages 81-2.
36. "The next tumor I'll show you is developing so low in the dermis that it would be out of the range of ultra-violet penetration into the skin." Dr. Srolovitz, Transcript, 10 Sept 82, page 75.
- "The hair protects against basal cell carcinoma that is related to ultra-violet light exposure.... We note that he had four of his sixteen, or 25 percent, on the scalp, even though he has a respectable degree of hair growth.... A fairly large percentage occurred on the eyelids, which is .. not a place where ultra-violet light hits.... The two other areas that are most unusual are the suprapubic area just above the pubic bone, which is not an ultra-violet light exposed area, and the perianal area. So, I think we have to invoke or evoke some other mechanism as the cause." Dr. Srolovitz, 10 Sept 82, pages 85-6.
37. "Arsenic ingestion used to be a cause of basal cell carcinoma and it would be important to know whether the patient had arsenic intake, say from well water, or whether he was given arsenic as a form of medication, which is rarely used these days. That would be important, to rule that out." Dr. Srolovitz, Transcript, 10 Sept 82, page 81.
38. "There are reports in the literature of all types of ionizing radiation leading to the development of basal cell carcinoma." Dr. Srolovitz, 10 Sept 82, page 81.
- "The most important factor leading to the development of basal cell carcinomas is radiation. Almost every form of radiation has been implicated and different forms, such as ultra-violet light and X-rays, may have additive effects. The damaging effects of radiation are cumulative, so even small doses can possibly increase the risk of developing skin cancers." Decision of the U.S. Board of Veterans' Appeals in the case of James W. O'Connor, 4 Aug 82, exhibit EB-15. (See Transcript, 10 Sept 82, page 133).
39. "The patient was in the army working on nuclear weapons in defence and came into contact that time with dust that emitted Alpha rays. Since then he has had several basal cell carcinomas." Summary of Clinical Findings, Jewish General Hospital, exhibit 31. Statement of Case, page 11.
- "The fact that Mr. Paulson has follicles that are enlarged and dilated on many of his skin biopsies certainly would have set the stage for ionizing radiation to have played a role.... If bacterial and fungal organisms can lodge themselves in a hair follicle, particle radiation could do that without any trouble." Dr. Srolovitz, Transcript, 10 Sept 82, page 95.
- "ADVOCATE: Dr. Morgan, earlier ... we were discussing the type of dose someone might get if such a particle did become lodged in their hair follicles or in their skin pores. Would ... those types of doses ... be sufficient to cause cancer of the skin?"

39. (continued)

WITNESS: From my numerous studies of various cases ... I would say the answer would have to be yes."  
Transcript, 10 Sept 82, page 60.

See also notes 34 and 38.

40. "As is known to specialists in this field, radioactive particles are mote like and if they settle in a follicle behind a hair they are virtually undetectable. All of my basal cell carcinomas were in the more hairy parts of my body.... In my opinion one danger they overlooked was that in removal of these respirators any emanating particles on my hand would be transferred to the hair follicles of the face and scalp. I might add that the concentration of the cancers on my face were on the right side, and that the cancer on my scalp which required 9 operations to remove, was also on the right hand side." Statement of Case, page 13B.

41. Referring to published studies of fires involving radioactive metals, Mr. Goldberg pointed out that "the average size of the ... particles was .32 microns; .32 microns is very small. I have the references here and they said that 97 percent of all the activity was associated with these sub-micron particles. This was plutonium metal.... What happened at Chalk River was slightly different. The fuel rod was uranium metal [which] was covered with aluminum, and it ignited at temperatures ... in the order of a thousand degrees centigrade, I think. Now, one of these studies ... said that the higher the temperature, the smaller the particle size; so the conclusion that you could reach is that [the particle sizes] coming from that burning fuel rod were probably of ... the order of .3 microns all the way up. Since it was at a high temperature you might think that you'd have many, many more particles at the smaller sizes -- and these are extremely small particles." Transcript, 22 Jan 81, pages 96-7. See also Mr. Goldberg's written testimony, exhibit P-11, page 32, where 5 references are cited on this topic. See also exhibits P-18 and P-19, two articles published in Health Physics from which Mr. Goldberg has drawn his facts.

42. "The thing that's extremely important in understanding the skin is understanding that it is not smooth; in other words, you may think skin is smooth, but it is not smooth. It has great undulations microscopically, areas where very small particles can be trapped very easily and [become] very difficult to remove." Dr. Young, Transcript, 22 Jan 81, page 36.

"Sweat pores ... are recorded by the ICRP -- International Commission on Radiological Protection -- as averaging about 72 microns in diameter. Some are larger than that. I'll discuss the size of hair follicles in just a minute. Now the ICRP notes that the total area of opening in the skin of the human being from just sweat pores is 94 centimeters -- equivalent to 10 centimeters by 10 centimeters of hole -- so this is a significant area or region for the entrapment of small particles. And the particles that I'm referring to are particles of one micron; so here we have a 72 micron diameter [pore] and we're discussing particles roughly in the range of one micron or less. Now this is a diagram of hair follicles.... There is an opening around the hair.... The diameter of these hairs in the human body range from 5 microns to 600 microns.... [MEMBER: Are you making the point that all these areas where there could be entrapment [of] particles and so on would not be detected by a monitor of some sort?] The range of an alpha particle is about one centimeter.... So that if you hold the monitor further than one centimeter away -- or let's say an inch to be generous -- then you wouldn't pick up the radiation from that, no. Certainly if you were looking for alpha particles and using a beta or gamma monitor, chances are -- especially at 2 or 3 inches -- you'd miss most of it, yes." Dr. Young, Transcript, 22 Jan 81, page 40.

43. "I was directly involved in numerous incidents of high-level radioactive contamination.... It seems to work its way into the pores of the skin, and just once, showering and scrubbing using a soft brush, very often would not bring out the contaminant. Maybe three or four showers still leaves level such that you check the employees over a period of weeks, day by day." Dr. Morgan, Transcript, 10 Sept 82, pages 36 & 38.

"Albert et al. suggests that the tumor formation may depend on irreparable damage to the hair follicles...." Dr. Morgan, Ibid., page 62.

44. "We are obviously looking at dilated pores here, deep in the hair follicle.... There's another incipient basal cell carcinoma growing from the bottom of a hair follicle here.... But this type of pattern is what seems to emerge looking at Mr. Paulson's numerous basal cell [carcinomas] in relationship to the hair follicles. [CHAIRMAN: How numerous are they?] Sixteen individual ones, clinically. This is just a higher view showing the cellular growth related to the dilated hair follicle pore -- we're deeper in the hair follicle now -- and the typical characteristics of a basal cell carcinoma." Dr. Srolovitz, 10 Sept 82, page 73.

"This is another basal cell carcinoma from the scalp and again we see the intimate relationship and the development of the tumor from hair follicle apparatus.... It's happening here, here, here -- all along in this area." Dr. Srolovitz, Ibid., page 75.

45. "We're back now with Mr. Paulson's skin.... You note that there are dilated pores ... and another follicle here with a very dilated pore.... We note that on cross-section of a pore which is markedly dilated, we have the central hair shaft and a huge space between the edge of the hair shaft and the follicle wall -- and in that is collected a horny material (keratin), and these blue dots represent bacteria. They are not causing any harm but they are nevertheless there. So we can understand that particulate matter [and] arthropods (micro-organisms) can fall into a dilated hair follicle. At the top of the pore and where the skin surface would be -- here -- we note that there is a clog closing off that pore, blocking it essentially.... Should this happen, then the entire normal function of the hair follicle and physiologic mechanism would be altered, causing stagnation and dilatation, possibly cyst formation." Dr. Srolovitz, Ibid., p.71.

"ADVOCATE: You heard Dr. Morgan talk about the size of the [radioactive] particles. Would those particles be able to lodge themselves in the skin hair follicles or pores?

WITNESS: If bacterial and fungal organisms can lodge themselves in a hair follicle, particle radiation could do that without any trouble.

CHAIRMAN: You said something previously about the size or something of the hair follicles [of] Mr. Paulson. Would this then make him more susceptible?

WITNESS: It would. It would. Dilated pores are more susceptible to the influx of material, sure."

Dr. Srolovitz, Ibid., p.95

46. "It is not known how much of the fission product content of the burned uranium became airborne, but the piece of rod that fell into the maintenance pit is estimated to have contained 200,000 curies of mixed fission products, 700 curies of iodine-131, and 13 grams of plutonium-239.... The ratio of fission products in the air samples was the same as in the burned uranium." Statement of Case, page 13H.

46. (continued)

Although the fission products are beta-emitters and gamma-emitters, "uranium oxide and plutonium oxide are both alpha-emitting substances." Dr. Edwards, Transcript, 22 Jan 81, page 19.

"Since this was burnt fuel, when there was an aerosol established both beta-gammas and alphas would have to be intimately associated." Dr. Marko Transcript, 10 Sept 82, page 15.

47. "ADVOCATE: Now when it says that they ... were monitored for skin contamination, what was the level that was considered safe? ... for alpha?

WITNESS: Alpha? One times ten-to-the-minus-fifth microcuries per centimeter squared.

ADVOCATE: And were they monitored for alpha contamination at Chalk River?

WITNESS: No.... Just to monitor for alpha particles is very tedious and time-consuming, and if you have a good marker like beta-gamma, we felt that [it] was sufficient just to use that for quick monitoring."

Dr. Marko, Transcript, 10 Sept 82, pages 15-6. See note 48.

48. "Theoretical and empirical investigations concerning the effects of surface distributions of alpha radiation sources on the skin have shown that ... the maximum working value for skin surface contamination (taken as ten-to-the-minus-fifth microcuries per centimeter squared) should be lowered by at least a factor of 10." Mark Goldberg, Exhibit P-11, page 13 Table VII in the same exhibit shows that this level of alpha contamination of the skin could lead to doses of more than 1000 rems per year to the basal cells, based on accurate measurements of skin thickness which were not available at the time of the NRU accident. See note 47.

49. "Let's consider as an example ... a particle that's very, very small: one hundredth of a microgram.... One can show by simple calculation that you would be getting ... at one inch ... .3 millirads per hour, [which] could easily be overlooked. At two inches it would be giving readings of .07 millirads per hour, which is way below -- you wouldn't even be able to see a fluctuation probably on the needle, if you move rather slowly by a source of this magnitude.... Now, were such a particle to get into the pores of the skin,... I found that the alpha dose for thirty days, if it resided there for thirty days, would be 270 rems ... [and] that would be out to one millimeter from the particle. If one wishes to go closer to the particle, say a tenth of a millimeter from this particle, then the doses go up...." Dr. Karl Morgan, 10 Sept 82, pages 50-2.

"CHAIRMAN: Just what are you going to demonstrate, doctor?

WITNESS: I want to demonstrate that you can pass over a small particle and not detect it, that would be on the skin.... See, you can easily miss that. See, it's quite easy to go by there and, you might suspect something, and you might not.... You can very easily miss these particles if you're a good surveyor and want to avoid contaminating your instrument."

Dr. Morgan, Transcript, 10 Sept 82, pages 45 & 48-9.

50. "He wore protective clothing and monitoring of other workers leads us to believe that there was no serious skin contamination. However, the possibility of skin contamination has not been completely eliminated." Dr. Lé-tourneau, Statement of Case, page 14C.

"The question if external contamination has contributed to the development of the cancer has to be considered.... It is not likely that very serious external contamination occurred and was missed on skin monitoring." Dr. Muller, Statement of Case, page 15.

50. (continued)

"ADVOCATE: So what you're saying is that it's possible that skin contamination could have gone undetected?

WITNESS: Unlikely, but it could have."

Dr. Marko, Transcript, 10 Sept 82, page 21.

The above three experts were all under the false impression that skin monitoring was done by highly-qualified health physics personnel, and that Mr. Paulson was assisted in removing his protective clothing. See notes 55 and 23 .

51. "If the person is wearing a film badge, usually, or normally, they would check the reading ... [both] behind the filter in the badge and behind the open window.... Behind this little lead filter, you'd get a blackening of the film, or darkening of the film, only from the gamma and X radiation.. In the open window -- and I haven't seen the open window reading ... for Mr. Paulson -- behind that, normally, you would get a reading that's several times the gamma reading. If he got one rad from gamma, he probably got, say, three to five rads from the beta radiation." Dr. Morgan, Transcript, 10 Sept 82, page 43.

"ADVOCATE: Would they take window readings, these film badges?

WITNESS: I don't think in '58 skin doses were being taken. That happened in '63. So it would be external doses, whole body doses mostly

ADVOCATE: So you're not aware of whether there was a window reading in these badges?

WITNESS: I doubt it, because as I say a window reading in these badges would have taken place in 1963."

Dr. Marko, Transcript, 10 Sept 82, page 19.

52. "ADVOCATE: What would cause a film to turn black?

WITNESS: Overexposure or exposure to light.... Overexposure would cover you know, penetrating radiation or surface contamination."

Dr. Marko, Transcript, 10 Sept 82, page 18.

"ADVOCATE: I'd like you to comment on ... the incident when your film badge was black. Do you recall that at all?

APPLICANT: Yes. I recall the time. We asked ... what dosage we'd received and we were told that the film badge was damaged or something, that it turned black and ... they had thrown it out.... This was the same day that I went and cut the hose. This was one [instance] where the badge was considered to be, what do you call it, damaged or defective."

Transcript, 10 Sept 82, page 120.

53. "ADVOCATE: When the monitoring was done after the showering, what type of instrumentation was used?

WITNESS: The standard beta-gamma survey meter at that time."

Dr. Marko, Transcript, 10 Sept 82, page 16.

See note 47.

54. "There is a very great difference in the concept of what gamma radiation will do and the concept of what an alpha particle will do.... One rad of alpha [radiation] would be in the neighbourhood of 20 times (or more) more effective [in] inducing ionizations than the rad of gamma radiation.... The difference in damage to a living cell, in the two cases, alpha and gamma, is like the difference in damage from a bulldozer or a rabbit running through a cornfield." Dr. Young, Transcript, 22 Jan 81, pages 45-7.

54. (continued)

"Alpha radiation doesn't penetrate very deeply into the skin, and as long as you can keep it outside the body -- as long as you can keep things like most of the plutonium isotopes, plutonium-239, plutonium-238, plutonium-240 -- when you keep those outside the body, there is no problem. The risk is that they can get into the body through the pores of the skin, and get into the body through wounds and abrasive surfaces of the skin, [as well as by] inhalation and ingestion. And, inside the body, the alpha emission is of great concern ... because the alphas, on the average, have a much higher energy than the betas or gammas.... You get an exceedingly large dose of alpha radiation close to the particle." Dr. Morgan, Transcript, page 42, 10 Sept 82.

55. "According to Jack White these people were nursed all along the way by our own experienced staff. After an assigned task was completed the protective clothing was removed with the help of our staff. They were monitored for skin contamination...." Dr. Muller, quoting Dr. Marko, Statement of Case, page 15.

"ADVOCATE: When the military personnel were involved ... who did the monitoring of them? Was it AECL personnel or army personnel?"

WITNESS: I think it was, as far as I understand from the records and reading reports, it was the Radiation and Industrial Safety Branch of AECL.

ADVOCATE: Because we've had testimony that it was done by the military, that they did their own monitoring.

WITNESS: Okay, I could be easily wrong on that.

ADVOCATE: You could be mistaken on that?

WITNESS: Yes."

Dr. Marko, Transcript, 10 Sept 82, page 14.

"ADVOCATE: Who was supervising the military personnel when they were disrobing and during the monitoring activities? Do you recall ... who was doing that supervision?"

APPLICANT: It was Flight Sergeant Draper at the time was in charge of the monitoring after we came out.... We were all instructors, so therefore ... we supervised the Army personnel in the cleanup....

ADVOCATE: Were ... AECL personnel ... involved in ... on-site supervision?"

APPLICANT: On-site supervision? If there were, I didn't see any." Transcript, 10 Sept 82, pages 116-7.

"As far as monitoring the body,... we went over the body up one side and down the other." Mr. Draper, Transcript, 22 Jan 81, page 109.

"If you'll excuse me but they mentioned about the civilian personnel instructing us how to go about this and all that. I can't remember seeing anybody from AECL inside the decontamination area where we were.... There were some that came outside while we were decontaminating a pipe, and so on. Once in a while they'd come, but nobody supervising nothing that I can remember." Mr. Draper, Ibid., page 117. (unidentified).

"I cannot, like Mr. Draper said, recall the civilian people ... being in charge of anything." Mr. McCormand, Ibid., page 117. (also unidentified).

"A statement was made about the monitoring, that it was done by the personnel of Chalk River. This is absolutely false." Mr. Paulson, Transcript, 10 Sept 82, page 32.

"We had to supervise the Army personnel when they undressed and get them into the showers, and then we did ourselves.... We waited until they went to the shower before we did." Mr. Paulson, Transcript, 22 Jan 81, p.79-80.

56. "ADVOCATE: Was the danger of skin contamination resulting from such an incident known in the scientific community in the 1950's?  
 WITNESS: Yes. In the early war years, studies were made at the [Argonne National Laboratory]. Drs. Finkel and Bruce and others carried on studies of contaminated skin. They published some early papers during the early fifties, showing that ... you should remove this contamination as quickly as possible.... We had directors' meetings ... at Oak Ridge and [Argonne] and Brookhaven and the various National Laboratories, and we always had visitors from Chalk River, and in these meetings we discussed these problems of skin contamination ... and the urgency of removing skin contamination as soon as possible after the event."  
 Dr. Morgan, Transcript, 10 Sept 82, page 37.
57. "You check the employees over a period of weeks, day by day.... You'd cut off all the hair ... from these areas; cut off the hair from the head and other parts of the body if they are badly contaminated.... If there was dust, and there often was, as in this case, we would always take fecal samples, that's very important." Dr. Morgan, Transcript, 10 Sept 82, page 38-9 & 66.  
 "WITNESS: If you ingested radioactive material that was sufficiently long-lived ... we could measure excreta from you ... but you would not measure that dose with an external dosimeter....  
 ADVOCATE: Were fecal samples taken of the military personnel involved in the cleanup?  
 WITNESS: No. Only thing they were analyzed for was urine."  
 Dr. Marko, Ibid., pages 30-1.
58. See Note 55.
59. "To my knowledge there has been no mention by the AECL of the levels of contamination recorded by skin monitors." Dr. Young, Transcript, 22 Jan 81, page 56.  
 "Records of these negligible contamination levels were not kept but a record would have been made of high levels of skin contamination." Dr. Muller, quoting Dr. Marko, Statement of Case, page 15.  
 "Negligible ... is a qualitative term, not a quantitative term. Negligible implies a subjective judgment which is based on one's perception of what is, and not on a significant numerical level." Dr. Young, Transcript, 22 Jan 81, page 57.
60. "In a journal article that looked at the unusual sites of basal cell carcinoma, we see in the perianal area -- less than half a percent of basal cells will develop in that area." Dr. Srolovitz, Transcript '82, page 86.  
 See notes 31 & 32.
61. "Detergents and abrasive materials ... were shown to be sufficiently abrasive that they increased the penetrability of these particles and this radioactive material into the skin.... You could put these sticky tapes over the surfaces and they seemed to pull out the contaminant ... but they tend to remove the horny layer of the skin, and that's man's protective layer. So then you're jumping from the frying pan into the fire, you probably would allow it to get further into the skin." Dr. Morgan, 10 Sept 82 pages 37-9.

## 61. (continued)

"If there is a very small abrasion in the skin, a very small abrasion will take you right down to an opening near the basal layer of the skin.... One can conclude that small abrasions would be areas of contamination in workers." Dr. Young, Transcript, 22 Jan 81, page 37-8.

62. "The very fact that Mr. Paulson did have sores in the anal region would have been a very good reason for not allowing him to go into the contaminated area, because it's quite well known that when there are sores existing on the body, it does make the living basal cells and so on more susceptible to radiation damage because that protective outer layer has been stripped away." Dr. Edwards, Transcript, 22 Jan 81, page 31.

63. "As far as I understand it, there is no record of how well each serviceman's skin was scrutinized [for scrapes] or cuts in the ... cleanup operation. It is puzzling that this is so." Dr. Young, Ibid., page 38.

ADVOCATE: Were you medically examined before you went to Chalk River? Mr. McCormand?

MCCORMAND: No, I think we moved too fast to be medically examined.

ADVOCATE: Then you weren't. Were you, Mr. Reny?

RENY: No.

ADVOCATE: Mr. Paulson?

PAULSON: No, I was not.

ADVOCATE: Mr. Draper?

DRAPER: No."

Transcript, 22 Jan 81, page 105.

64. "There may be a chance of hand contamination from these respirators, and contamination of the air, after which the dust might have settled on his body." Dr. Young, Transcript, 22 Jan 81, page 35.

MEMBER: The first manifestation of this disease was in the ... anal region.... How do you explain that?

Doctor: The man was stripped down and then removed the respirator ... with his bare hand.... He could have touched himself....

PAULSON: Being that we were dressed in plastics ... our pores were wide open. We had a measurement of maybe two or three inches of perspiration in our rubber boots.... [When] showering, that area was particularly noted [for] washing.

MEMBER: Would you not wash your hands between each [disrobing] operation you carried out?

PAULSON: No, there was no washing. It's [determined] now that they should have hosed us off before we ever undressed but this was not done.... There was no washing between taking off clothes ... and the last stage [which] was the underwear and the respirator"

Transcript, 22 Jan 81, pages 77-9. See note 23.

65. "We move on to the perianal basal cell carcinoma ... his largest tumor. It measured about one centimeter across at its greatest dimension.... It's developing in a hair-bearing area. It's unrelated to the intestinal tract. It's in perianal skin.... The central portion of the main tumor mass shows a basal cell carcinoma that again appears to be arising in an area where there may have been a follicular opening. I can't say that with great certainty because [the] tumor growth has obscured the normal architecture here. But, if we go on to the edge of this basal cell carcinoma, we have a better clue as to what could well have happened. We have a hair follicle here with a dilated pore and follicular plugging and we note ... another incipient basal cell carcinoma that is again coming from a hair follicle at the tail end. [CHAIRMAN: From the same hair follicle area?] A different hair follicle; a different hair follicle in the main tumor mass. And here

## 65. (continued)

is a third different hair follicle in which you have tumor growth growing out like a bouquet of flowers.... If allowed to grow, this would represent itself as another tumor, this is a second tumor, and then he had a third tumor which represented the main tumor mass in respect of size." Dr. Srolovitz, Transcript, 10 Sept 82, pages 77-9.

66. "The fact that Mr. Paulson has follicles that are enlarged and dilated on many of his skin biopsies certainly could have set the stage for ionizing radiation to have played a role. That can't be excluded." Dr. Srolovitz, Transcript, 10 Sept 82, pages 94-5.

67. "The fact that he developed 25 percent of his tumors on his scalp is unusual, and 19 percent around the eyelid is also unusual...." Dr. Srolovitz, Ibid., page 88.

See note 33, 34, and 36.

68. "The next tumor of the skin, which occurred on the scalp also, is occurring at a level of four millimeters or four thousand microns beneath the surface of the skin, which is here. And it's occurring in an enlarged cyst which has the characteristics of the hair matrix epithelium.... It is so deep in the skin that I couldn't include the entire tumor and cyst on one photograph.... The next photo shows the top of the cyst and the bottom of the cyst, the proliferating cells, and the keratin debris in the cyst cavity.... Again we have the characteristics of a basal cell carcinoma of hair matrix origin, developing at a depth that ... far exceeds where ultraviolet light would penetrate." Dr. Srolovitz, Ibid., pages 76-7.

See note 44.

69. "In a person who has sufficient hair on the scalp, the scalp is not a prime location for the development of basal cell carcinomas.... It's around 2 percent of the time the scalp is involved." Dr. Srolovitz, 10 Sept 82, page 75.

See note 36.

70. "The two other areas that are most unusual are the suprapubic area just above the pubic bone, which is not an ultraviolet-light exposed area, and the perianal area." Dr. Srolovitz, Ibid., pages 85-6.

See note 33.

71. "All my basal cell carcinomas were in the more hairy parts of my body. The most damaging was my nose. I received 4 skin grafts on the right side.... I might add that the concentration of the cancers on my face were on the right side, and the cancer on my scalp ... was also on the right hand side." Mr. Paulson, Statement of Case, page 13B

72. "Since [the] respirators had the charcoal filters on the right side, we were to use only our right hand to remove them. Hand under rubber face piece and pushing back over head as trained." Mr. Paulson, Statement of Case, page 13B.

See notes 23 and 40.

73. "It's been calculated that about 30 percent of the ultraviolet radiation is effective in getting through the skin.... The most damaging rays are in the range of 275 to 200 nanometers, and those rays really don't penetrate

## 73. (continued)

very far ... perhaps sixty microns, obviously much less than a millimeter of tissue. The longer wavelengths, 1000 or 1200 [nanometers], which are damaging but not as damaging as the ones around 300, will penetrate up to two millimeters into the skin -- but one would need very high quantities of this wavelength to cause [the] damage that 300 does." Dr. Srolovitz, 10 Sept 82, page 75.

See notes 36 and 68.

74. "Now, I ask myself ... is he developing his basal cell carcinomas on the basis of sun-damaged skin? The way we check for that, as pathologists, is that we look for elastic tissue degeneration. Elastic tissue degeneration is recognized by the clumping of dark fibers of elastic tissue -- elastotic change.... Now, I've applied the elastic tissue stain to the first basal cell carcinoma that we have. This is the exact same tumor that we looked at, and we see only very tiny fragments of elastotic material here.... This basal cell carcinoma does not appear to be arising in an area where there was extensive sun damage...." Dr. Srolovitz, Ibid., page 74.
75. "So, I think we have to invoke ... some other mechanism as the cause of the basal cells -- both on the scalp because of the high number, and in ... these areas that are shielded from sunlight." Dr. Srolovitz, Ibid., 86
76. "The probability of developing skin cancer (excluding melanoma) in a lifetime in Canada is approximately 5 to 10 percent. Assuming the worst case, then, the risk of developing skin cancer is [one in ten]." Dr. Létourneau, Statement of Case, page 14D.
- "Dr. Scotto notes the incidence of basal cell [carcinomas] in people who have them: 90 percent have one, ... 8 percent have two, 1.6 percent have three, but when you get down to 5, it's less than 1 percent.... So therefore, the incidence is no longer one in ten, but using Dr. Létourneau's figures ... instead of a risk of one in ten we are down to a risk of one in ten thousand, for five basal cell carcinomas." Dr. Young, Transcript, 22 Jan 81, pages 69 & 71.
- "Can I make another comment. There was no mention in that paper of any basal cell carcinomas occurring which had a multiplicity of greater than five; they reported zero out of a study of ten million people in four states -- so the probability [of that] is extremely low." Mr. Goldberg (unidentified), Ibid., page 71.
- "The figure that is listed from the provincial health authorities in this province, for the number of Quebeckers that will develop basal cell carcinoma, is, per year, for male and female together, four hundredths of a percent. If we [multiply] that by 70, which is a normal life expectancy, we have a rate of about 2.8 percent risk for ... developing ... one basal cell carcinoma. When we're speaking about 16 basal cell carcinomas, you can understand -- I haven't made a calculation, but I can easily see that the risk of developing sixteen would be infinitesimally small." Dr. Srolovitz, 10 Sept 82, page 85. [Assuming independence (and therefore multiplying the probabilities), the risk of 16 basal cell carcinomas would be 24 orders of magnitude smaller than that used by Dr. Létourneau (that is, 24 factors of ten).]
77. "The genetic predisposition would fall into two categories; the basal cell naevus syndrome and an entity called xeroderma pigmentosa." Dr. Srolovitz Ibid., page 81.

78. As regards xeroderma pigmentosa, "he doesn't have the genetic background, he doesn't have the type of skin; he doesn't have this particular type of pigmentation, he has no family members that show this." Dr. Srolovitz, Ibid., page 84. See note 82.
- As regards the basal cell naevus syndrome, see notes 35 and 79.
79. "Both a dermatologist and a plastic surgeon examined Mr. Paulson for this syndrome. X-rays were taken of the jawbones to see if he does have cysts in the jawbones, which would go along with this syndrome -- negative. His palms were examined ... he does not have palmar pits. He also had an ophthalmologic examination recently that showed nothing wrong with his eye function or eye structure." Dr. Srolovitz, Ibid., page 82.
- See note 35 and 80.
80. "The number of basal cell carcinomas that can occur with a basal cell naevus syndrome are variable, they can be from a dozen to two or three hundred, but they do tend to show a symmetrical distribution on the trunk; they can occur on the palms, which is a very unusual place for a basal cell carcinoma to occur." Dr. Srolovitz, Ibid., page 82.
- See note 35, 71, and 79.
81. See notes 35, 78, 79, and 80.
82. "A few words about xeroderma pigmentosa, which is a very disabling skin condition. The people develop numerous cancers of the skin of all types -- squamous cell, basal cell, malignant melanoma -- at an early age. Death from metastases occurs. They tend to have skin that is blotched.... These people have to stay out of the sunlight because they do not have the normal mechanism that we possess to repair their sun-damaged skin and they are prone to large numbers of skin tumors. Mr. Paulson doesn't have this." Dr. Srolovitz, Ibid., page 83.
- See note 78.
83. "As far as I know, and as far as the literature knows, that particular type of tumor that arose -- basal cell carcinoma -- don't arise in naevi and they don't arise from papillomas.... A papilloma usually is ... a rising piece of skin and ... those don't resemble even an early basal cell carcinoma. The early basal cell carcinomas are usually flat, they may bleed a little bit, maybe a little tiny bit raised above the level of the skin, but never to be confused with a papilloma.... The mole or naevus, if they become malignant they turn into something called malignant melanoma -- just an entirely different type of cancer than basal cell carcinoma." Dr. Jack Cohen, 22 Jan 81, Transcript, page 120.
84. The perianal tumor "has the same appearance as what we see in other locations: a raised border, a central depression and no mention of papillomatous or condylomatous-like growth, which basal cell carcinoma is not known to simulate." Dr. Srolovitz, 10 Sept 81, Transcript, page 86.
85. "WITNESS: Ionizing radiation can cause almost all forms of cancer.... Skin cancer is one of the more common forms.... It was my group that did the dosimetry on the survivors of Hiroshima and Nagasaki and we carried on numerous studies of persons in the field. Incidentally, in cases of test "Smoky", where many of our soldiers were exposed to fallout, there was an increase in skin cancer, a considerable increase of the various forms of cancer.
- CHAIRMAN: Excuse me. What actually does this have to do with our hearing this morning, Mr. Starkman?

85. (Continued)

ADVOCATE: ... Is the radiation exposure in a nuclear accident such as the one at the NRU reactor ... in any way comparable to the type of exposure you'd experience ... with bomb fallout from a nuclear explosion?

WITNESS: It has quite a few similarities."  
Transcript, 10 Sept 82, pages 56-8. Dr. Morgan.

"ADVOCATE: Is basal cell carcinoma not known to be caused by radiation?

WITNESS: At high doses, yes.... For skin cancers, the literature says hundreds to thousands of rems to produce skin cancers."  
Dr. Marko, Transcript, 10 Sept 82, page 24.

86. "WITNESS: I was told that one dermatologist had seen a man who worked in a local hospital, in a room that was adjacent to a room where there was a cobalt beam-emitting machine, and this gentleman developed six basal cell carcinomas on his back. We have some of the tissue in our hospital of this case and the assumption was that the cobalt beam machine was related to these multiple cancers.

ADVOCATE: Were they also related to the hair follicles?

WITNESS: ... No. They were not as related to the hair follicles as Mr. Paulson's."

Dr. Srolovitz, Transcript, 10 Sept 82, page 93.

"There is a recent decision from the Board of Veterans' Appeals in Washington D.C., concerning ... a Mr. James O'Connor, who participated in the Nevada nuclear testing, and developed basal cell carcinomas. They recognized his entitlement to a pension.... This person has basal cell carcinomas ... on his thighs and legs, an area not particularly exposed to the sun.... This veteran had an estimate of greater exposure than Mr. Paulson had, however ... Mr. Paulson's exposures could easily be well in excess of what they are recorded to be by AECL." Advocate, Transcript, 10 Sept 82, pages 132 & 134.

"I have some studies here that I'd like to present as evidence. One is a letter from Dr. Wrigley of Whittington Hospital to Lancet British medical journal, March 23, 1974, in which he states: 'Basal cell Epitheliomas have developed after scalp irradiation for ringworm, many after a short interval (one in our series from the London Hospital presented after only seven years).' ... I have one more article by Martin ... entitled 'Radiation Induced Skin Cancer of the Head and Neck' published in Cancer, January 1970, which describes patients who are irradiated for benign conditions with X-irradiation; [he] noted that more than two-thirds of the tumors in the series were basal cell carcinomas.... He also noted that there were 35 patients who died as a result of uncontrolled radiation-induced skin cancer, which seems to be more virulent and more recurrent." Dr. Young, Transcript, 22 Jan 81, pages 74-6. See exhibits P-8 and P-10.

See also notes 85 and 88.

87. "For skin cancers, the literature says hundreds or thousands of rems to produce skin cancers." Dr. Marko, Transcript, 10 Sept 82, page 24.

See notes 89, 91, 48, 49.

88. "This is the only epidemiological study ... looking for skin cancer in uranium miners.... They found a few squamous cell carcinomas but, in general, the predominant cancer was basal cell carcinomas that occurred mainly on the face, neck, head -- regions where they were exposed to ... uranium dust perhaps or ... radon daughters.... I think the main conclusion that you can draw from the study is that, for the first time ever, we've

88. (continued)

been able to implicate the alpha radiation as a direct source of skin cancer." Mr. Goldberg, Transcript, 22 Jan 81, page 90-1.

"The study showed, amongst the entire group of uranium miners, roughly a four and one half fold increase in the incidence of skin cancer, and that increased to about eight fold amongst those who had been working for ten years or more." Dr. Thomas, Transcript, 10 Sept 82, page 103.

89. "It was estimated that these people received about ... 2000 rems of radiation to the basal cell layer." Dr. Thomas, Ibid., page 103.

90. "They showed that, from studies in which they had injected plutonium into mice [under the skin], that they got about 50 percent skin cancers at the sites of these injections." Dr. Morgan, Transcript, 10 Sept 82, page 37.

"I seem to recall seeing another study ... reported in the United Nations [UNSCEAR] Report in 1977, that was on subcutaneous injections of plutonium causing basal cell carcinoma." Dr. Young, Transcript, 22 Jan 81, page 76.

91. "MEMBER: Dr. Morgan, you mentioned that injections made into mice and rats produced skin cancer. Did you have any idea how many rems would be involved in those injections?

WITNESS: Those were microgram quantities.... Very close to these areas of injection, the doses would be up in the hundreds to thousands of rems."

Transcript, 10 Sept 82, pages 40-1.

92. "Both beta-gammas and alphas would have to be intimately associated. I have talked with all kinds of physicists, chemists, metallurgists, and they can't think of any way to fractionate materials so you'd have pure alpha." Dr. Marko, Transcript, 10 Sept 82, 15-6

See note 46.

93. "The range of an alpha particle [in air] is about one centimeter.... So that if you hold the monitor further than one centimeter away -- or let's say an inch to be generous -- then you wouldn't pick up the radiation from that, no. Certainly if you were looking for alpha particles and using a beta or gamma monitor, chances are -- especially at 2 or 3 inches -- you'd miss most of it, yes." Dr. Young, Transcript, 22 Jan 81, page 40.

See notes 24, 47, 53.

94. "They never really thought of the skin as the thing that would be irradiated.... The [alpha] standards which were set for the skin were based completely on what you might inhale if the stuff became airborne." Mr. Goldberg, Transcript, 22 Jan 81, pages 102-3.

"Those figures [permissible levels of alpha contamination of the skin] should be changed because they are much too high." Mr. Goldberg, Ibid., page 103.

See notes 47, 48, and

95. TABLE VII (modified) Taken from exhibit P-11

Accumulated Doses for Curium-242 and Polonium-210 (in rems)

Surface Concentration: ten-to-the-minus-fifth microcuries per cm squared

Alpha-emitting radioisotope:	Curium-242			Polonium-210		
	22	33	44	22	33	44
Distance in Tissue (microns):						
Dose after 1 month	120	80	36	107	49	0
Dose after 1 year	1442	960	432	1287	588	0
Dose after 2 years	2886	1918	864	2575	1175	0
Dose after 5 years	7210	4795	2160	6437	2938	0
Dose after 10 years	14420	9590	4320	12874	5875	0

95. (continued)

"You can get large doses of radiation [from] very, very small concentrations [of alpha contamination], and I've indicated the precise numbers in the text. I don't think I want to quote them right now." Mr. Goldberg, Ibid, page 100. Exhibit P-11, Table VII.

See notes 48 and 49.

96. "So we did [not] detect it, but yet it could cause an exceedingly large dose inside the skin.... I found the alpha dose for thirty days, if it resided there for thirty days, would be 270 rems, and ... the beta dose for thirty days ... about 330 rems ... out to one millimeter from that particle. If one wishes to go closer to the particle ... at one-tenth of a millimeter the [alpha] dose would be over 2000 rads and ... the dose of the beta would be over 60 thousand rads. So this little particle, that's giving only the dosage you can't detect by moving reasonably slowly over it, ... out to these short distances can be giving doses of hundreds of thousands of rads of beta and [alpha] radiation."  
Dr. Morgan, Transcript, 10 Sept 82, pages 50 and 52-3.

97. "You can't spend all day on ... one man.... Maybe you spend only, say, three or four minutes on each person.... If we make a conservative assumption that you don't get any closer than one inch, we're saying that this person's very skilled, he can stay one inch [away] without touching my skin and yet make a reasonable survey -- but many times you'd be more than one inch.... Now let's let the geiger counter cool down ... and we'll see what happens, if we can detect that [radioactive source while] moving across.... [The needle] might have wavered a little bit, but you see you can easily miss that." Dr. Morgan, Transcript, 10 Sept 82, pages 46-8.

See note 50.

98. Uranium-238 has a half-life of 4 billion years, while plutonium-239 has a half-life of 24,000 years. Both are alpha emitters. Most of the fission products have half-lives which are less than one year. They are beta and gamma emitters.

99. "Mr. Paulson received 905 millirem on his film badge, presumably as a result of external gamma radiation.... We feel that this man's basal cell carcinomata has an extremely small probability of being induced by radiation recorded at Chalk River." Dr. Létourneau, Statement of Case, page 14C-D.

"I understand that Mr. Paulson received, while in Chalk River between June 10, 1958, and June 18, 1958, a total exposure of 905 millirem.... The probability of a skin cancer being produced by an exposure to 905 millirem is negligibly small compared to the probability of a skin cancer developing independently of radiation exposure." Dr. Muller, Statement of Case, page 15.

100. "As washing and showering were carried out until monitors proved the disappearance of all radiation, the Board concludes that no significant skin contamination took place during the cleanup job in July 1958." Entitlement Board Decision, 22 Jan 81, page 12.

"The applicant was required to shower three times on one occasion, so it can only be concluded that after the third shower he was extremely carefully monitored and was obviously passed as being absolutely clear of any lingering radiation." Entitlement Board Decision, 10 Sept 82, page 22.

101. "Penile fibromatosis is quite rare.... This is scar tissue.... When I applied the elastic tissue stain, I was very surprised to see that he has elastic tissue damage in the connective tissue and around which there are scars forming. One has to ask oneself, 'Why is there damaged elastic tissue in the penile skin?' I think one can exclude ultraviolet light radiation. One could think of chemotherapeutic agents (which he didn't take) one could think of radiodermatitis (which is a possibility).... When a pathologist sees this type of enlarged, atypical-looking fibroblasts and scar tissue, the first question he asks is whether there's been any exposure to X-rays or any type of radiation." Dr. Srolovitz, Transcript, 10 Sept 82, pages 90-1.

See note 33.

102. "ADVOCATE: Did you find in the literature that there is a threshold level ... or a safe level of exposure to alpha radiation?"

WITNESS: No, I think we are in agreement with ... virtually all accepted scientific knowledge these days that there is no absolute threshold, no value at which there is zero risk."

Dr. Thomas, co-author of Risk Estimates for the Health Effects of Alpha Radiation, published by the Atomic Energy Control Board. Transcript, 10 Sept 82, page 102.

"ADVOCATE: In a telephone conversation which I had with Dr. Marko on 19 January, this year, he defined 'negligible' as 'below the considered safe level', that I wasn't worthy of further action.... Now if you care to respond to the fact that there was or was not a threshold -- or is or is not a threshold of safety -- that might answer.

Dr. YOUNG: Well, the present theory is that there is no threshold of safety. The threshold theory went out in 1960." Transcript, 22 Jan 81, pages 57-8.

"The implication -- I'm sure Dr. Marko didn't intend it this way -- was that if one were exposed to doses of substantially lower than 2000 [rems] that there would be no risk, and that's of course obviously not correct. The risk merely increases in proportion to the increase in dose, so that even at relatively low exposures there would still be some risk, albeit fairly small." Dr. Thomas, Transcript, 10 Sept 82, page 104

103. "The question of the causal relation between exposure to ionising radiation and the occurrence of a cancer can never be decided with absolute certainty and always remains in the domain of probabilities." Dr. Muller, Statement of Case, pages 15-6.

"Essentially the problem, as is recognized by all other international agencies, is one of quantifying just how big is the risk for relatively small exposures." Dr. Thomas, Transcript, 10 Sept 82, pages 102-3.

"Everyone agrees that there is no safe level of exposure, that there is no threshold level when you're dealing with radiation exposure." Mr. Starkman, Transcript, 10 Sept 82, pages 134-5.

104. "There are two persons [who worked] in nuclear facilities in Ontario, who were compensated by the Workmen's Compensation Board, even though their exposures were within the levels which were supposedly safe. In other words, to say that you're within the prescribed level is not to say you're within a safe level. All it's really saying is that at this level, we think the risks are minimized. Now, it doesn't mean there isn't a risk, there continues to be a risk, it's just that the risk is minimized." Mr. Starkman, Transcript, 10 Sept 82, page 135.