REPORT OF THE EXPERT COMMITTEE ON THE REVIEW OF DATA ON ATMOSPHERIC FALLOUT ARISING FROM BRITISH NUCLEAR TESTS IN AUSTRALIA

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31 MAY 1984

ATMOSPHERIC FALLOUT COMMITTEE

Senator the Hon Peter Walsh
Minister for Resources and
Energy
Parliament House
CANBERRA ACT 2600

Dear Minister

The Expert Committee on The Review of Data on Atmospheric Fallout Arising from British Nuclear Tests in Australia has pleasure in presenting to you its Report.

Yours sincerely

C.B. Kerr
Chairman

MEMBERS

Dr K.W. Bentley
Mr D.W. Keam
Professor C.B. Kerr
Mr F.P.J. Robotham

31 May 1984

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TERMS OF REFERENCE

On 15 May 1984 Senator the Honourable Peter Walsh, the Minister of State for Resources and Energy, announced the establishment of an expert Committee to review the data on atmospheric fallout arising from British nuclear tests in Australia.

The members of the Committee are: Professor Charles B. Kerr (Chairman), Professor of Preventive and Social Medicine, University of Sydney; Dr Keith Bentley, Senior Research Scientist, Commonwealth Institute of Health and visiting fellow, Australian National University; Mr Donald W. Keam, Head of the Standards and Compliance Section, Australian Radiation Laboratory; and Mr Rob Robotham, Radiation Protection Officer, Melbourne University.

The Committee's terms of reference are:

1. To review the published scientific literature and other relevant scientific data on the short and long-term effects of fallout arising from British nuclear tests in Australia;

2. To comment on the adequacy of the data available and the data collection methodology;

3. To assess as far as possible in the light of standards prevailing at the time of the nuclear tests and now:
   (a) what were the fallout levels arising from each of the tests;
   (b) what hazard did those fallout levels represent both individually and collectively to the Australian population immediately after the tests and subsequently;
   (c) the adequacy of the criteria for safe firing of each of the tests.

4. To recommend any action that needs to be taken now by the Government in relation to the consequences of fallout arising from the tests and/or the data available.

5. To provide a report to the Minister for Resources and Energy by 31 May 1984 on the matters covered in these terms of reference.

INTRODUCTION

1. Mindful of the short time available (16 days) in which to cover its terms of reference and prepare a report the Committee adopted the following strategy. Noting that the Australian Ionising Radiation Advisory Council (AIRAC) had produced a major report "British nuclear tests in Australia - a review of operational safety measures and of possible after-effects" (AIRAC No 9) in January 1983, the Committee decided to use that report as a base-line document for review. AIRAC 9 had the following terms of reference:

(a) To review the scientific basis of operational safety measures for the protection against radiation injury of Australian personnel involved in the UK nuclear test program in Australia and express an opinion on the effectiveness of these measures, and

(b) To determine to the extent now possible the nature and the distribution of fallout from the nuclear tests, identify the potential harmful effects of this fallout, and express an opinion on the effectiveness of the arrangements made to protect the health of the Australian public during the nuclear tests.

These terms of reference are comparable to those of the present Committee.

2. The Committee reviewed AIRAC 9 according to its (the Committee's) terms of reference in conjunction with other published scientific material. Where the directions for AIRAC 9 and this Committee differ significantly are that the Committee was required to review "other relevant data on the short and long-term effects of fallout arising from British nuclear tests in Australia" and "to comment on the adequacy of the data available". In addition, there was virtually no consideration of minor trials in AIRAC 9. The Committee took advantage of its discretionary instruction to seek expert advice from relevant individuals or organisations (as, on an

apparently more limited scale, did AIRAC). Some members of the public, parliamentarians, organisations representing veterans of the tests and Aborigines and experts submitted information and data of relevance. Ultimately, the Committee used for its review material which it categorised as scientific, either published in the open scientific literature or official reports and data, some classified for restricted distribution and other relevant data, either communicated as documents or orally. The latter category included information which was broadly descriptive or anecdotal in nature.

3. With regard to its first term of reference the Committee defined "British nuclear tests in Australia" as including the 12 nuclear weapons tests from October 1952 to October 1957 (listed in Table 4.1 of AIRAC 9) and the experiments involving nuclear materials ("minor trials") conducted between 1953 and 1963. Review of the minor trials was justified on the grounds that the resulting atmospheric dispersal of radioactive material constituted a variety of fallout from British nuclear tests.

REVIEW OF PUBLISHED SCIENTIFIC LITERATURE AND OTHER RELEVANT DATA

4. There is a large scientific literature on radioactive fallout in Australia, most of it relating to movements from the northern to southern hemispheres and French nuclear tests in the Pacific. Partial bibliographies on the British nuclear tests were available to the Committee but no complete listing of published and classified scientific documents is available. The same holds for other relevant data. Only a few references from the open literature were identified in AIRAC 9. Accordingly, the Committee was in no position to undertake a comprehensive review. Nevertheless by directly pursuing documents related to matters in its terms of reference the Committee felt reasonably confident that the resulting partial review of available information was sufficiently rigorous to derive conclusions.

AVAILABILITY AND ADEQUACY OF DATA AVAILABLE

5. From its discussions with officials from several Commonwealth government departments and its experiences with locating specific documents, the Committee formed the impression that sufficient information on the British nuclear tests was in existence to answer most of the required questions. At this stage it can remain no more than an impression of availability because of difficulties with locating some of the UK Atomic Weapons Research Establishment (AWRE) and official Australian documents currently scattered around different federal and state governmental departments and the problems of access to documents accumulated over a period exceeding thirty years. Considerable bodies of relevant data were encountered that were neither listed nor identified in any systematic way. Then there are large bodies of official data including health physics information on Australians still held in the United Kingdom. Some health physics records have been destroyed - other records on radiation dosage were recommended for destruction in 1980. British official documents and comparable Australian materials are being progressively declassified although at present much essential data on the tests are accessible only to persons with the appropriate security clearances as possessed by members of the Committee.

6. In order to assess hazards on the nuclear test ranges and to evaluate adequacy of radiation protection standards and criteria for safe firing, the Committee needed to know how responsibilities were allocated between British and Australian authorities and personnel. The Committee worked on the principle that collection of health physics data was a British responsibility on the nuclear testing ranges and an Australian one beyond prohibited areas including the nuclear ranges. It assumed also that the Australian responsibility for safe firing conditions was as related in AIRAC 9. Although these arrangements appear to hold true as a general case, many organisational complexities were noted in official documents.

The existence of these complexities was confirmed in discussion with Dr J.L. Symonds who is addressing the matter in his forthcoming History of the British Nuclear Tests which is due for publication in late 1984 or early 1985.

7. There will, of course, be some information which for reasons of national defence and the provisions of the Nuclear Non-Proliferation Treaty can not be made available for review - for example, data on atomic weapons materials, precise yields, detailed radiochemistry of fissionable components and mechanical aspects of weapons. The Committee believed that exclusion of such data would not be a serious barrier to reviewing consequences of the tests because satisfactory degrees of required information could be derived indirectly from other sources. No general policy of limiting the availability of official documentation on matters before the Committee was encountered. There remain, however, serious difficulties in gaining access to what is available.

8. Problems with locating official documents made it difficult to judge the adequacy of some data. For instance, detailed information on the minor trials was discovered only towards the end of the Committee's period of inquiry. The material was deficient in health physics records, necessary for assessing any radiological hazards from the minor trials. As it stands the data on minor trials appear inadequate, but the Committee could not be sure that the desired information was not held in some other collection. The Committee was unable to ascertain to what extent, if any, Australians were involved with minor trials.

9. In general, the quality and scope of all official information relevant to the Committee's task improved as the nuclear series progressed. The first test, Hurricane, on the Monte Bello Islands is poorly documented and essential details may never have been recorded. Even though fallout monitoring data is more extensive for the Buffalo and Antler tests than

for previous ones, the Committee concluded that there was an overall inadequacy of data required for reasonably comprehensive measurements of fallout radiation dose-commitments and risk-estimates. It understands, however, that as the result of previous governmental agreements, information may be lodged in the United Kingdom which could be combined with that available in Australia to make a suitable data-base for the Buffalo and Antler tests.

10. It is evident from official sources, but not AIRAC 9, that there are inadequate data for the intermediate fallout zone within 400 km of test ground zero's for all tests. Most significantly, deposition and atmospheric monitoring sites were deficient for the area which incorporated known population centres within 400 km of the detonations at Emu and Maralinga ranges. As a consequence, estimates of possible exposure are relatively more uncertain for persons who were in the intermediate fallout zone than for those who lived more distantly.

11. With the exception of the third test of the Buffalo series and probably the second Totem test, in both of which there were aberrant dispersion patterns, considerable data exist on close-in fallout which was a potential hazard to those on the test sites. Information on actual radiation exposure doses is also extensive but incomplete especially for RAAF personnel involved in the tests and who were based at Amberley, Edinburgh and Pearce stations and RAN crews concerned with the Monte Bello tests. The main inadequacy of exposure records is lack of any information on the consistency with which a person in contact with a potential radiation hazard wore a dosimeter. There are several accounts from servicemen and others that wearing of film badges (dosimeters) was so erratic and, in some instances, the measuring of doses so arbitrary, that, in their opinion, little weight can be placed on the validity of records as an index of long-term dose commitment.

12. With some exceptions, movements of personnel into areas contaminated by immediate fallout are inadequately recorded. The exceptions include information on movements of scientists, health physicists, and troops purposefully stationed in positions near ground zero's. Here again there are reports (from official as well as from individual sources) of unplanned or variant incursions into contaminated areas.

ADEQUACY OF DATA COLLECTION METHODOLOGY

13. Methods for collecting data improved as the tests progressed. From information available to it, the Committee believed that health physics measurements first became reasonably comprehensive for the Buffalo and Antler series at Maralinga Range. To confirm that belief and its corollary that methods prior to Buffalo were inadequate would require access to data currently held in the United Kingdom.

14. Technology improved also for the physical measurement of fallout and the meteorological methods used for predicting and following fallout movements. However, the general strategy for achieving scientific objectives was to rely, in general, on single measuring techniques. This strategy would be considered marginal by standards of contemporary practice where the principle is to increase precision and reduce measurement errors by employing two or more methods for each objective. In some instances, where two measuring techniques were used for health physics purposes there was only limited or no correlation between results. It should be noted that the sticky-paper method of fallout measurement functions inadequately in conditions of heavy rainfull.

15. Several specific instances of methodological inadequacy were examined - some will be elaborated in subsequent sections. Monitoring of fallout deposition in water and sludges was attempted on a limited scale but problems with measurement prevented any useful analysis. For example, some determinations undertaken on water samples in Wagga during 1953

yielded results suggestive of fallout deposition from a lateral dispersion from the Totem series at Emu Field. Subsequent re-investigation in 1957 using different methods on water samples from a number of places including Wagga failed to detect evidence of fallout. The significance of this discrepancy could not be resolved and further attempts to achieve results were abandoned. Similar impasses relate to measurements obtained by academic groups and individual scientists independent of official monitoring systems. A much discussed instance involves the differences over interpretation of radioactive iodine data between the late Dr H.R. Marston of CSIRO and the Australian Weapons Testing Safety Committee (AWTSC). The member of the present Committee who had previously made a special study of the Marston case reviewed all available information on it including additional material submitted to the Committee. He concluded that the evidence remained generally as discussed in AIRAC 9 and that Dr Marston's data did not reveal any significantly increased hazard to the Australian population from this particular fission product.

16. Problems with obtaining reliable records of individual and collective dose-assessments have already been mentioned in Paragraph 11. Official reports contain accounts of instrument failure and difficulties with calibration. A former member of one of the health physics teams at Maralinga alleges such problems with personal dosimetry techniques that, in his opinion, the records with which he was involved are invalid.

17. With its advantage of hindsight the Committee noted two instances where data collection practices were not modified despite prior evidence of inadequacy. The need for making fallout level evaluations more valid for wide areas appeared to be recognised at an early stage of the series. However, subsequent efforts were directed mainly towards increasing the precision of measurement at each monitoring site rather than by extending the capability of fallout detection stations. There is a record on the second Mosaic test which relates that the

AWTSC were supplied with 50 sets of fallout deposition monitoring equipment by the UK AWRE but decided to employ only 28 sets. Subsequently, over 80 stations were used for the Buffalo and Antler series. The other instance followed detection of significant deviation from predicted down-wind fallout dispersal during the Mosaic tests. But no specific measures to cover similar dispersal phenonema were put into effect for the subsequent Buffalo and Antler tests.

18. Several different units have been employed to measure both radiation doses and radioactivity. The Committee constructed the following guide for its task. At the time of the British nuclear tests, the unit for radioactivity was the curie (C or Ci); fractions in common usage were one thousandth (millicurie, mc) and one millionth (microcurie, uc). This unit has been replaced by the Becquerel (Bq); one microcurie equals 37 000 Bq. Units used for radiation dose during the periods of the tests were: Roentgen (R or r) which measures ionising radiation in air, rad which measures energy deposited in tissue, rem which allows for differences between radiations in producing biological damage and rep, similar to the rem but less widely used in the past. For most practical purposes these radiation units are approximately equal one to another. The rad has now been replaced by the Gray (Gy) and the rem by the Sievert (Sv). In each case the relationship is 100:1, that is, 1 Gy = 100 rad and 1 Sv = 100 rem. A glossary of other technical terms and abbreviations is in Appendix 6 of AIRAC 9.

FALLOUT LEVELS ARISING FROM EACH OF THE TESTS

19. The Committee disputed parts of the account of fallout levels in AIRAC 9 which it regards as a greatly simplified and, to some extent, misleading, version of what took place. It was wrong, the Committee concluded, for AIRAC to have filled gaps in information on a specific test by bringing in assumptions based on other tests. Each test had an individual pattern of variables surrounding it and has to be considered in far more detail than attempted by AIRAC. Excepting the discussion of

"black mist" and Aborigines, AIRAC 9 contains very little on officially recorded anomalies, for instance, the movement of minor fallout plumes and precipitation of particles in local rainfall for which extensive documentation exists. The Committee was unable to reconcile all the AIRAC 9 data on gamma dose attributed to the Mosaic, Buffalo and Antler series with that contained in a previously published AWTSC account.

20. The Committee also disagreed strongly with the AIRAC 9 philosophy of avoiding most conservative estimates (the worst possible case) for radiation and contamination doses. AIRAC reduced the maximum possible exposure to fallout by a factor representing an estimate for average time spent indoors. The Committee agreed with the UK AWRE that this means of hazard reduction was an inappropriate modification; it is also inapplicable to Aborigines in regions close to nuclear test sites who spend most of their time in direct contact with the natural environment and very little inside houses as emphasised in an AWTSC report to the Australian Prime Minister during the Buffalo tests.

21. Working from official records the Committee attempted a review of fallout levels for each test and the special case of the minor trials. It proved impossible to draw any conclusions about the minor trials although from available data these were much more extensive operations than implied in AIRAC 9 and actually were numbered at least in the several hundreds.

22. Firstly, the Committee had to ascertain those parameters the measurement of which was essential for determining fallout precipitation rates and consequent residual radioactivity. To simplify this procedure, fallout was considered in three categories: immediate or close-in (over test range), intermediate (within 400 km of ground zero) and long-range (Australian mainland beyond 400 km). Derivation of estimates necessitates theoretical and empirical inputs to an extent which often makes firm conclusions virtually impossible.

Accordingly, the Committee assembled information according to meteorological and radiological criteria. However it became apparent that because of the nature of available data and associated errors of measurement any more precise calculations to compare with original estimates (as quoted in a modified form in AIRAC 9) constituted a task far beyond the time-scale of this Committee. In particular, lengthy examination is required for several parameters including acceleration of fallout deposition due to local meteorological conditions (eg thunderstorm activity and rainfall with resultant extensive scouring of atomic clouds), localised variability of deposition patterns in the intermediate zone, variant responses of meteorological instrumentation and weighted extrapolations of incomplete fallout deposition measurements.

23. The alternative strategy adopted by the Committee was to examine those parameters which it felt were essential for completing a thorough review of fallout estimations. As far as it could ascertain, the Committee believed there are serious problems in completing this task due mainly to inadequacies of available data. Specifically the deficiencies lie not only in availability of recorded information but also in the non-collection of relevant data. For example, in the intermediate zone of particular interest in assessing possible exposure to Aborigines and station employees from the Emu and Maralinga tests, there were often deficiencies in distribution of sampling sites in the track of the radioactive plumes because predictions had indicated alternative fallout patterns.

24. The Committee's conclusion on fallout levels was that with the currently available data base no confidence can be expressed that dose-estimates as listed in Appendix 5 of AIRAC 9 are within the correct order of magnitude for the intermediate zone.

25. The Committee had more confidence in existing estimates of close-in fallout doses because of the more extensive documentation available on the test ranges. With regard to long-range fallout, the Committee believed that although errors

of measurement still existed, particle deposition rates are more reliable. There are instances where local intensive rainfall resulted in increased deposition rates variously estimated as two orders of magnitude greater than would be recorded at the nearest sampling station outside the zone of aberrant weather eg heavy rain scouring to the northwest beyond the range site perimeter involving the low level cloud of the second test (Marcoo) of the Buffalo series. These local fallout variations at all distances from the site with their associated variant radiation doses are neither recorded nor discussed in AIRAC 9.

IMMEDIATE AND SUBSEQUENT HAZARDS FROM FALLOUT TO THE AUSTRALIAN POPULATION

26. The Committee had difficulty with the concept of collective dose-estimates (population dose-commitment) for the Australian population. It fully understood the use of this convention in radiation protection practice but believed that such estimates distort the true situation by including non-exposed urban populations who in the case of the British nuclear tests were specifically excluded from the risk of exposure by the criteria adopted for safe firing. The Committee believed a more legitimate approach is to concentrate on dose-estimates for communities considered specifically for each test. In this regard it differred from the concepts used in AIRAC 9 but because the usage of collective dose-estimates is an established international principle the Committee reviewed the AIRAC conclusions. For reasons stated previously there can be no dispute over the AIRAC statements that collective dose-estimates for long-range fallout on the Australian population were of negligible magnitude - less, in fact, than from fallout which was transferred over the equator from northern hemisphere tests.

27. Nevertheless, as stated in the previous section, variations in fallout at different distances from the ground zero's are a feature of nuclear tests and these variations are,

of course, a function of meteorological conditions prevailing at the time. In this regard considerable differences exist between the account of long-range fallout movements in AIRAC 9 and the findings of the Committee. Most differences appear to result from the simplistic approach taken in AIRAC 9 which did not take into account additional plumes (and stem materials) arising from variability in meteorological parameters with elevation above ground zero at the time of and immediately after, firing.

28. The Committee wishes to point out that although it cannot dispute the conclusions in AIRAC 9 which are based on conventional philosophy of collective dose-estimates it believes that a more realistic hazard evaluation would be provided by assessing the collective dose for each test relating to populations potentially exposed in the plume tracks. If it could be achieved such an exercise would generate results several orders of magnitude higher than those based on conventional philosophy.

IMMEDIATE AND SUBSEQUENT HAZARDS FROM FALLOUT TO INDIVIDUAL AUSTRALIANS

A. Australian personnel involved in nuclear test operations

29. Given the forementioned qualifications on availability and adequacy of information, there are extensive official data on radiological exposure to test site personnel and others exposed to close-in fallout. Only the special case of RAAF aircrew responsible for radioactive cloud sampling and ground staff handling contaminated aircraft was considered in detail in AIRAC 9. Additional information has been made available by servicemens' organisations, individuals involved in the tests or their relatives, the results of investigations into long-term health consequences of nuclear test personnel and many commentators.

30. The Committee was able to gain general information on exposure to immediate fallout on all sites although the data are relatively less adequate for the tests on the Monte Bello

Islands, Emu Field and the minor trials. With regard to the latter trials, and on the assumption that none involved criticality of fissionable material the Committee noted that dispersal of atmospheric particles, largely plutonium but also including uranium and beryllium (a toxic but not radiological hazard), did not extend beyond some 3 000 metres from the firing zones. Measures were taken to exclude general personnel from contaminated areas until the end of the trials but no information could be located for radiation protection practice between 1964 and 1967 when the first clean-up operation of minor trial sites took place. However there are records of relatively high exposures (including some doses exceeding then current standards) incurred by decontamination personnel. From the data presently available it is not believed that any Australians were involved in minor trials operations; all health physics monitoring was undertaken by the UK AWRE. There are records of high individual doses being received by members of survey parties who entered heavily contaminated areas from the nuclear tests within the first 24 hours and the next few days. At the Totem series the first up-wind incursions occurred 20 minutes after detonation. Records reveal that scientists and technicians sometimes took calculated risks on personal exposure and received relatively high doses over a short period (but below levels associated with acute radiation injury). The records also indicate that the then current standards for exposure for "special events" were adhered to. These "special events" were individually managed by the Range Commander with regard to recovery of information or materials which otherwise would have been permanently lost. The upper limit of all permissible exposure as laid down in UK regulations for the tests was 50 rep of which the gamma component should not exceed 10R (use of radiological units is considered in Paragraph 18). This differs from the upper limit given in AIRAC 9 where different units are employed but only the gamma component has been considered and so the AIRAC 9 upper limit is relatively less than the actual total exposure permitted at the time of the tests.

31. Although regulations required that personnel who exceeded permissable dose limits were to be removed from radioactive work the records indicate exceptions to this rule.

32. The Committee found little reference in official documents to the "indoctrination trials" involving Australian servicemen during the first and second tests of the Buffalo series. It understands that dose measurements for exposed troops are held by the Commonwealth Department of Health. The Committee was unable to examine these data but was told that the mean dose received by troops was of relatively low order (a gamma dose of less than 0.5R). There may have been, of course, individual exceptions who received higher dosage. There is only oblique mention in AIRAC 9 of these troop movements and positions within the potential immediate fallout zone where of course they would also face hazards from the initial radiation pulse and secondary irradiation from neutron activation of materials. With reference to the distances between service personnel involved in these trials and ground zero's of the tests there are marked discrepancies between AIRAC 9 estimates and those recorded in information released by the UK Department of Defence in April 1984 (the forward positions being over 600 and 1 100 metres, respectively, advanced in the British report by comparison to the limits given by AIRAC). There are also time discrepancies for the first test of the Buffalo series; exposure of troops during the day of firing and for three days subsequently according to the British account, at three days after detonation according to AIRAC 9.

33. The Committee searched carefully for records of unplanned incidents or unauthorised entries into zones contaminated by fallout. Health physics records for Maralinga contain information relating to unscheduled events such as breakdown of transport for a survey party in an immediate fallout zone. There was a planned intrusion into a contaminated area to facilitate construction for the Antler series in March 1957. Some exposure data relating to the incidents were also recorded. It is in this area of incident exposure that several

claims have been made by individuals who believed they received significant radiation doses. The Committee was in no position to carefully interpret such claims, but believes that in some instances, and assuming that identification of the circumstances can be made, sufficient data are available to provide reasonable estimates of exposure and hence risk.

34. Exposure of RAAF aircrew who penetrated radioactive clouds and of ground crews who decontaminated the aircraft is another source of concern for individuals who believe they received relatively high doses of radiation.

35. Initial UK AWRE predictions of negligible aircrew contamination resulted in no radiation monitoring facilities being made available to RAF personnel entering the cloud from the Hurricane test. At the next test, Totem 1, again involving RAF aircrew, radiation monitors were installed and following entry into the primary fallout plume, high readings of 5.8R per hour were recorded. On landing the total integrated gamma doses were 18-21R for the crew. Subsequent experience with airborne contamination monitoring inside the cockpit of the same type of aircraft indicated that flight personnel would have been exposed to a combined external and lung radiation burden exceeding 50 rem. These very high recordings were the reason permission was not granted for direct aircraft sampling of the cloud from Totem 2. This sequence of events is recorded in an unclear fashion in AIRAC 9.

36. The Committee did not find evidence that RAAF aircrews were involved in penetration of immediate fallout clouds until the Antler series. Some crews, however, were involved in cloud tracking exercises for which the individual exposure rates could not be located. During the Antler series, aircraft which penetrated the clouds were equipped with continuous monitoring equipment which allowed immediate recognition of exposure levels. The procedure was that passes through the radiation plume were to be continued until 2.7R was accumulated in the cockpit after which a final pass was made through the stem.

During the third test of the Antler series the primary sampler registered 10R halfway through the first penetration and emergency exit procedures from the fallout plume were initiated. Although from earlier experiences, direct contamination by highly activated fallout particles was known to provide the greatest contribution to the radiological hazard, no records could be found to indicate monitoring of cockpit contamination. Exposure records of Australian aircrew involved in cloud sampling after the second and third Antler tests indicate that their cumulative external dose varied from 2.7-15R gamma radiation. It was further recorded that difficulties were experienced with obtaining previous radiation histories of the crews, some of whom had participated in former cloud monitoring flights. No reliable calculations are possible for total exposure to aircrew throughout the entire series. The Committee cannot accept that the minimal dose-rate estimations tabulated in AIRAC 9 represent the total exposure experience of Australian aircrew. The AIRAC estimates do not correlate with either observed results or the high levels of external contamination of aircraft detected on return to their bases.

37. Responsibility for decontaminating aircraft was shared jointly between British and Australian personnel. The Committee found that information on the hazard faced by decontamination crews was most inadequate. Even for the final Antler series the procedures were recorded as being conducted by persons with no relevant experience of radiation control. No health physicist was attached to decontamination groups. Difficulties over monitoring adequate facilities, the lack of trained personnel and evidence of aircraft remaining highly contaminated are reported throughout the entire test series. Even after steam cleaning, extremely high radioactivity count rates were noted in some instances. There were deficient facilities at Pearce airfield which was designated at short notice as an official decontamination base. During the period between the Mosaic and Buffalo series a decision was taken not

to decontaminate aircraft which consequently remained radioactive for 5 months. Early predictions that rainfall would substantially assist in decontamination proved unfounded.

38. For operaticns conducted from Amberley airbase, AIRAC 9 states that decontamination personnel were required to carry dosimeters and have details of their exposure maintained by the Senior Medical Officer. Evidence tendered to the Committee indicates that medical records did not contain radiation dose measurements. The Committee was also told that there were no details of duties ascribed to individual personnel, so that identifying from records whom was involved in decontamination procedures is impossible. This latter deficiency in available records was confirmed during the Committee's searches for information on decontamination procedures throughout the entire series. The most comprehensive data exist for the Antler tests but neither occupational classifications nor identification of Australian servicemen were adequately recorded even when it was ascertained from other sources that the latter had taken part in decontamination procedures. The Committee believes that utilising British information not in its possession, an account of cumulative doses could be derived. Radiation dose records of personnel groups including those unidentifiable persons involved with decontamination indicate a wide range of levels. The Committee felt that some of those with doses at higher levels (but still within permissible limits) may have had significant contamination exposures. Information from available data is too deficient to draw more than speculative conclusions and the Committee considers that the exposure status of decontamination personnel requires further resolution.

39. An indirect attempt to judge the degree of hazard experienced by veterans of the nuclear tests was made by the Commonwealth Department of Health and recorded in "Health of Atomic Test Personnel", 1983. There were two approaches. The first was to conduct a survey by postal questionnaire of Australians who had taken part in the tests in order to identify any associations between their involvement and

subsequent illnesses, especially those which were known to be related to radiation. Various comparisons were made between different groups of veterans, selected on the basis of variable factors including assumed exposure to radiation and whether or not the veteran had sought attention for an illness he regarded as related to nuclear test experience. It proved impossible to compare illness frequencies with those recorded for a matched cohort from the general population. Analysis of results indicated statistically significant associations between some categories of ill-health for which radiation exposure could be causally involved (certain cancers, cataract and infertility) and nuclear test participation. However, any possible causal contribution from radiation exposure to the observed significant associations was rejected in favour of the operation of chance. In the light of its findings among certain nuclear test groups for which there are inadequate dose exposure data or, in the case of RAAF aircrew, decontamination personnel and crater-samplers, observed or assumed relatively high exposures, the Committee questions the assumptions on which significant associations were rejected.

40. The Committee, with some expert assistance, recognised that the survey was well conceived and pursued energetically. However, taking into account methodological difficulties with sampling and internal comparisons, misunderstandings over directions in the questionnaire, other problems identified in the report, and especially the inadequacies in exposure status of several classes of respondents detected by its own inquiry, the Committee concluded that the study cannot be regarded as providing definitive information on the relationship between participation in the nuclear tests and current health status.

41. The other approach by the Commonwealth Department of Health was to compare the causes of death of Australian nuclear personnel with those of a matched control group. An excess of cancer was found among the nuclear participants but interpreted as not being related to radiation exposure. Again, the Committee believes that methodological problems reduce the strength of these retrospective findings on mortality.

42. The Committee was informed that many individual accounts of illness or death ascribed to radiation from the British nuclear tests were lodged in government departments. It was aware also of similar reports known to organisations of ex-participants in the nuclear tests or recorded in the newspapers. Several comparable accounts were submitted to the Committee.

B. Aborigines in South Australia

43. Aborigines and the organisations which represent them believe that some Pitjantjatjara people were killed or disabled as a consequence of the British nuclear tests.

44. Under the heading "Aboriginal Welfare", AIRAC 9 records the attempts made to prevent Aborigines from entering the nuclear test ranges. These included briefing managers of pastoral properties on the need to control movements of Aborigines, the use of patrol officers on the Emu and Maralinga ranges until cessation of minor trials in 1963 and air surveys prior to nuclear tests. The conclusion was that although the possibility of an intrusion could not be excluded "it seems most unlikely that any Aboriginals were present elsewhere than the fringes of the Prohibited Area at the firing times and in the period following them". There follows an account of one Aboriginal family which traversed the Maralinga range between the Buffalo and Antler test series.

45. AIRAC supported its case on the unlikelihood of Aboriginal intrusion by quoting the opinion of patrol officers. Yet official reports submitted by the officers also contain evidence of considerable Aboriginal movements on the fringes of the prohibited areas and sometimes within them, uncertainties about the presence or absence of Aborigines on the ranges and inability for logistic reasons to proceed with ground searches prior to the first test of the Buffalo series.

46. Nowhere among discussions of Aborigines in AIRAC 9 is there reference to the work of anthropologists who have covered matters relating to the nuclear tests during the course of several years work with Aboriginal people in the region of the nuclear ranges. The Committee sought the views of several of these anthropologists who were also fluent in languages spoken by the Aborigines. It was found that closure of the mission at Ooldea Soak in June 1952 in order to remove several hundred Aborigines further south to Yalata mission (an event not mentioned in AIRAC 9) was of considerable anthropological significance. This was because rapid dislocation from their homelands caused confusion and distress among the Ooldea people which is held to be a major reason for the depressed and unhealthy state of the contemporary Yalata community - and is reflected also in other settlements containing dislocated Aborigines, for instance at Cundeelee, Gerard and Ernabella. The state of mind of the Aborigines, their use of traditional travel routes, some of which traversed the prohibited areas, their tendency to easily avoid Europeans if they wished and records of oral accounts from older persons of movements within the area form the basis for a common view among the anthropologists that Aborigines were highly likely to be moving around hazardous zones during the test period. There are also accounts from servicemen on the test sites that Aborigines other than the single recorded family were encountered on the ranges from time to time and put through decontamination procedures. The Committee noted also the claim of Aboriginal deaths ascribed recently to the late Mr J.P. Burke who had served at Maralinga. At present there is insufficient evidence to resolve the question, but the Committee believes that the anthropologists' case for an Aboriginal presence increases the probability that some could have been in hazardous circumstances.

47. AIRAC 9 considered in detail the arguments for Aboriginal people being affected by radiation, largely with reference to the "black mist" situation. AIRAC 9 dwelt on doubts and uncertainties in Aboriginal recollection of events and provided

a detailed examination of fallout movements around Wallatinna station during the Totem series at Emu Field (the most likely circumstances for contamination by fallout). After exhaustive discussion and a comparison with the Marshall Islands fallout incident, AIRAC concluded that "the nuclear tests caried (sic) out at the Emu and the Maralinga test ranges cannot have been the cause of acute, ie short-term, illness or the early death of Aboriginals at the Wallatinna or other pastoral stations in South Australia". This view was supported by estimates of very low exposure doses.

48. The Committee was not so certain about the behaviour of fallout patterns after each of the Totem series for reasons already mentioned in connection with inadequacy of intermediate zone fallout information. AIRAC 9 concentrated on fallout possibilities from the first Totem test and assumed that shearing of the highly projected cloud from the second test could not be incriminated in any way. Although the possibility of significant intermediate zone fallout from the second test cannot be excluded the Committee felt that atmospheric concentration of particles arising directly from either stem debris or from radiochemically activated fallout of desert sand and scrub would have been insufficiently dense for visual observation.

49. The essential questions about the first Totem test concern arrival of fallout at Wallatina and Wellbourne Hill Stations, the harmful nature of any deposition or cloud material and creation of visual phenomena that took the appearance of a cloud or mist. AIRAC 9 concludes that the fallout plume was in the vicinity of the stations until about 5 hours post-firing. Its estimates of maximum radiation doses do not take into account fallout from stem materials or adventitiously included desert debris nor did they allow for enhanced rates of deposition. It is implied in AIRAC 9 that dose-rate assessments can be derived for the Wallatina area. The Committee, however, noted absence of deposition monitoring stations within a radius of about 100 km and so assumes that

the AIRAC figures are long-range extrapolations of doubtful validity. AIRAC 9 favours explanations other than fallout debris precipitation to account for visual black mist phenomena.

50. The Committee examined an 1983 British report on fallout from the first Totem test. This account agreed with AIRAC 9 on plume arrival times and disposition at Wallatina but because additional parameters were examined the conclusion was that the possibility could not be excluded of a visible cloud at the atmospheric boundary layer. In these circumstances, the report continued, a fine drizzle of black particles also would have been noticed. The British report noted that levels of radioactivity associated with estimated deposition and air concentration have yet to be determined. When the dose-estimates are available the Committee believes conclusions on the probability of harmful effects of fresh fission products will be much more firmly based than indicated by AIRAC 9.

51. AIRAC 9 examined the opinions of Aborigines from the point of view of scientific objectivity and speculated about the creation of "black mist" mythology. Here again, no contribution from anthropologists was identified. Anthropological techniques for gaining access to, and analysing the oral history of events among Aborigines are of greater potential efficiency than random interviews by Europeans. Cause-and-effect belief systems are a predominant feature of Pitjantjatjara culture and the task of distinguishing facts about any harmful event from what may be incorporated into myths is obviously a highly specialised procedure. Current beliefs among Aborigines in the test region not only incorporate "black mist" harmful effects but also traditions about localities rendered dangerous by "poison" from the atomic bombs. The Committee acknowledges that analysis of "black mist" beliefs is fraught with difficulties but concluded that the matter deserves further expert analysis.

52. There have been several accounts dating from before the tests of poor health and excess mortality rates among Aborigines who live in the region of the nuclear tests. The South Australian Health Commission produced a report in 1981 entitled "A Survey of Diseases that may be Related to Radiation among Pitjantjatjara on Remote Reserves". Difficultíes with locating and identifying persons, the nature of diseases and causes of death inhibited all but the most tentative conclusions. In a general pattern of relatively poor health, an aggregation of five deaths from cancer at Yalata in 1979-80 was noted but the relationship of this occurrence to any possibility of acute radiation exposure remains unknown. No trend that could be in any way radiation-related was noted in the survey and the overall conclusion was that for several reasons, including continuing concern about long-term radiation effects, an appropriate data base for monitoring the health status of Aborigines should be maintained.

53. Initiatives have been commenced recently by the South Australian Government for a major research project into the possible radiation experience of Aborigines. The project has full co-operation of the Pitjantjatjara Council. In progress are collection of all oral history accounts of "black mist" and other related phenomena, the charting of movements in and out of the nuclear ranges and a review of literature on the subject. The next stage is being planned and the aim is to search for objective evidence of residual biological or environmental contamination by fission products or weapons materials. Techniques being considered include urine studies for detecting Strontium-90, investigation of bone deposition in any available autopsy material, cytogenetic studies to detect chromosomal damage and isotope content of long-standing water tanks and dams. An epidemiological survey to extend the study reported in 1981 is also being planned.

COMPARISON OF RADIATION PROTECTION STANDARDS ADOPTED DURING THE NUCLEAR TEST PERIOD WITH CURRENT STANDARDS

54. The Committee understood that the development of standards up to and including the period of British nuclear tests was as follows:

> The organisation responsible for recommending permissible levels of exposure to ionising radiation is the International Commission on Radiological Protection (ICRP).
>
> The first recommendation for limiting radiation doses were made, by ICRP, just 50 years ago, in 1934. These 'tolerance doses', as they were popularly known, of 0.1R (Roentgen)/day remained in use for 16 years.
>
> The development of nuclear weapons during the second world war meant that problems of ionising radiation exposure expanded from the relatively limited field of medical usage (X-rays and radium) to a broader range of radiations and radioactive materials.
>
> Consequently in 1950, ICRP made a further series of recommendations. The maximum permissible dose now became 0.5R to the whole body, in any one week, when measured at the surface of the body. ICRP stated that this corresponded to a dose 'of 0.3R per week measured in free air'.
>
> This ambiguity between 'free air' and 'body surface' doses was removed in 1955 when the limit was set at 0.3R per week.
>
> The next major recommendations were published in 1959 when the important concepts of yearly accumulated dose and limitations on exposure of members of the public were introduced.

ICRP recommended an annual limit of 5 rem per year to the whole body, averaged over the years since the age of 18. A further restriction was a limit of 3 rem in any period of 13 weeks.

The recommended limit for an individual member of the public was 0.5 rem per year. It should be noted that this proposal was first circulated unofficially in 1956.

55. In 1977 ICRP introduced a comprehensive set of recommendations, the basic limit remaining at 5 rem per year. This figure is now known as a dose limit rather than a maximum permissible level. These recommendations allow for the fact that different organs in the body have different radiosensitivities through allocating various weighting factors to them. The dose limits are based on summation of doses from both external irradiation and internally deposited radioactive materials.

56. A summary of maximum permissible levels and how they were related to the various test series are:

Date	Test Series	Recommended maximum permissible whole body dose Radiation Workers	Members of the Public
1952	Hurricane)	0.5R/week at the body surface	Not given
1953	Totem)	0.3R/week in free air	
1956	Mosaic)	0.3R/week	Not given (but under discussion by late 1956)
	Buffalo)		
1957	Antler)		
1959 to 1963	Minor trials	5 rem/year (not greater than 3 rem in 13 weeks)	0.5 rem/year

57. In addition, ICRP made provisions for single specifically planned or emergency exposures over and above the limits listed.

58. With regard to philosophy of the ICRP recommendation there are two major considerations:

1. A large dose of radiation delivered in a short period of time can have a direct effect, eg radiation sickness, epilation and blood cell changes, within a relatively short period of time.

   The health physicist aims to prevent the occurence of such effects by limiting doses to substantially below 0.25Sv (sievert), equivalent to 25 rem.

2. A low dose of radiation delivered over long or short time intervals may lead to an increased risk of disease, usually some form of cancer, at some later date, perhaps as long as 30 years after the time of exposure. There are also risks of genetic damage.

   The health physicist's objectives are to limit such effects to 'acceptable levels'. What are acceptable levels, is of course, a matter of judgement. In general ICRP aims to set levels such that at the dose limit, the occupational risk of death from radiation exposure is comparable to or less than other occupationally induced fatalities.

59. The way this philosophy has been developed is best illustrated by quotations from the various ICRP recommendations.

1950 'While the values proposed for maximum permissible exposures are such as to involve a risk which is small compared to the other hazards of life, nevertheless in view of the unsatisfactory nature of much of the evidence on which our judgements must be based, coupled with the

knowledge that certain radiation effects are irreversible and cumulative, it is strongly recommended that every effort be made to reduce exposures to all types of ionising radiations to the lowest possible level.'

1959 'Any departure from the environmental conditions in which man has evolved may entail a risk of deleterious effects. It is therefore assumed that long continued exposure to ionising radiation additional to that due to natural radiation involves some risk. However, man cannot entirely dispense with the use of ionising radiations, and therefore the problem in practice is to limit the radiation dose to that which involves a risk that is not unacceptable to the individual and to the population at large. This is called a "permissible dose"

The permissible dose for an <u>individual</u> is that dose, accumulated over a long period of time or resulting from a single exposure, which, in the light of present knowledge, carries a negligible probability of somatic or genetic injuries; furthermore, it is such a dose that any effects that ensue more frequently are limited to those of a minor nature that would not be considered unacceptable by the exposed individual and by competent medical authorities.'

1977 'Most decisions about human activities are based on an implicit form of balancing of costs and benefits leading to the conclusion that the conduct of a chosen practice is "worthwhile". Less generally, it is also recognised that the conduct of the chosen practice should be adjusted to maximise the benefit to the individual or to society.

For the above reasons, the Commission recommends a system of dose limitation, the main features of which are as follows:

(a) no practice shall be adopted unless its introduction produces a positive net benefit;

(b) all exposures shall be kept as low as reasonably achievable, economic and social factors being taken into account; and

(c) the dose equivalent to individuals shall not exceed the limits recommended for the appropriate circumstances by the Commission.'

60. Recommendation (b) in the 1977 statement is known as the ALARA principle, ie all exposures should be kept As Low As Reasonably Achievable. This concept underpins all current radiation practice.

61. During the British nuclear weapons test periods no significant changes occurred to the recommended dose limits. Until the start of the 1959 minor trials series, permissible doses were based on weekly limits and no figures had been established for exposures of the public.

62. Given the prevailing standards, the health physics control procedures established for the various tests appear to have been satisfactory. What is less clear is how effectively those procedures were implemented.

63. As mentioned previously the Committee received anecdotal material suggesting that radiation dosimeters were not always worn in high dose areas, calibration facilities were often less than adequate and health physics personnel had limited training given the level of supervision they were expected to exercise. The Committee has been unable to confirm or dismiss these accounts.

64. It is probable that standards currently held would be breached by the atmospheric testing results obtained during the 1950's. However, had the current standards of radiological

protection been applied to the various 1950's nuclear tests, several important control procedures would have been applied more rigorously. These include:

(a) The change from weekly to annual dose summation would have required more thorough dose measurement and recording. Under the standards prevailing at the time, a dose of 0.3R in any one week would not have warranted reduced exposures in succeeding weeks. Current standards require reduction of radiation exposures in the weeks following a reading above or close to the derived weekly or monthly limit, to ensure that the annual limit is not exceeded.

(b) The Hurricane Trial Orders stated that "the actual dosage received must be kept to a minimum ...". Similar requirements were included in the regulations for subsequent tests. The current ALARA principle is a more forceful requirement and would have required control offices to check and recheck the authorisation of particular radiation exposures, especially those at or near the dose limit.

(c) Nowadays a greater use of the practice of 'dose splitting' would probably be considered appropriate, for instance, by arranging for 10 people to each receive 0.1R on a particular operation rather than two receiving 0.5R.

(d) The current practice of adding external and internal doses (that is, combining the doses from inhaled or ingested radioactive materials to the doses received externally) would have, in the past, required tighter contamination control and a greater range of airborne contamination monitoring.

65. The Committee concluded that on the evidence available the external radiation doses received by nuclear test participants, other than in critical groups identified in this report, were not excessive even by today's standards. If current control procedures had been effectively applied to the former test situation the Committee believes that, in general, doses received by participants would have been reduced by perhaps no more than a factor of two. Even given the various identified uncertainties in dose assessments the Committee believes it is unlikely that participants exceeded the currently accepted life-time dose. It should be noted that this view is not related to the derivation of risks arising from radiation exposure, a summary of which is given in AIRAC 9.

ADEQUACY OF CRITERIA FOR SAFE FIRING OF EACH OF THE TESTS

66. Initial criteria for safe firing were agreed between the Australian and British governments. At the Hurricane test Australians appeared to have observer status but thereafter took an increasingly complex role in reviewing criteria for the subsequent series. Criteria changed for every series; the Committee were unable to discover the criteria for conducting the minor trials. The ultimate responsibility for permitting a detonation rested with the British site commander for the Hurricane test, then with an interim Australian Committee and subsequently the responsibility resided with the AWTSC.

67. Main principles of criteria are summarised in AIRAC 9. It should be noted that the AIRAC reference to provisions of safe limits for members of the public involves standards that altered during the course of the tests (see Paragraph 56) with the ICRP recommendations of a 500 mrem per year maximum permissible exposure for members of the public being first adopted for the Antler series.

68. Stringent criteria were applied to the principle of dose minimisation arising from fallout. In practice, theoretical predictions of meteorological criteria were not fulfilled on

several occasions. After reviewing criteria for the Hurricane and Totem series, in 1955 the AWTSC recorded their opinion that meteorological facilities at the previous trials were inadequate and at future tests "every means should be adopted to make meteorological information as complete as possible". The Committee, taking into account the modifications to criteria throughout the entire series, noted progressive attempts to strengthen provisions towards achieving safety objectives. Instances have been described in previous sections where meteorological criteria proved inadequate. Overall fulfillment of these criteria were regarded by the Committee as adequate only for the Buffalo and Antler series.

69. The Committee had some reservations about the criterion adopted for permissible body surface contamination. There is evidence from official documents that criteria for limiting exposures to intermediate range fallout were not sufficiently conservative for maintaining radiation standards applicable at the time of firing.

70. With the exception of the reservations expressed, the Committee believed criteria were generally adequate for each test. Problems that arose reflected failure to fulfill requirements rather than inadequacies in the formulation of criteria.

DISCUSSION AND CONCLUSIONS

71. The Committee was faced with drawing conclusions from information on the conduct and consequences of a large and potentially dangerous venture commencing 30 years ago and which directly involved over 15 000 Australians during a 12 year period. In fulfilling its instructions, the Committee has reported events and practices which may have harmed some Australians and, in certain instances, reflected inappropriate policy and management. However, taking into account the ethos prevailing 30 years ago and the state of technological development during those times, the Committee does not wish to

give the impression that it found evidence of widescale incompetence, negligence and disregard for human health and safety.

72. To facilitate its task the Committee used as a base-line document the most comprehensive public account of the British nuclear tests in Australia, AIRAC 9, produced by the Australian Ionising Radiation Advisory Council in 1983. As it progressed through official documents and other relevant data, the Committee found a large number of matters to criticise in AIRAC 9. It disagreed with AIRAC on many fundamental issues including interpretation of information on fallout levels, progress of radioactive clouds, dosage estimates, risks of exposure to certain groups and aspects of management and arrangements during the tests. Most of all it disagreed with the philosophy used to construct AIRAC 9 - the use of simplified assumptions which do not accurately reflect the complexities of what took place and the constant endeavour to present the best possible case which results, to quote The Canberra Times, in a comfortable picture of the British nuclear tests.

73. On the basis of comparisons with official documents little in AIRAC 9 can be regarded as factually incorrect - the use of language is too subtle. As an example and typical of the "best case" approach was the statement relating to weapons yield at the second test of the Mosaic series. This involved a weapon with an approximate yield of 60 kilotons. With reference to all nuclear weapons detonated in the tests AIRAC 9 stated "... that in no case was the yield much more than the 20 kilotons nominally associated with the nuclear weapons used on Japan and in some cases it was much less". This statement could be regarded as technically correct because both a 60 Kt and a 20 Kt yield have been classified as falling into the same "kiloton, or low intermediate" range of yield. But the AIRAC statement is not scientifically objective nor does it adequately inform members of the public who may believe that a

60 Kt yield weapon has three times the fallout effects of one with a 20 Kt yield (which is not so due to other physical constraints on fallout).

74. The Committee found many examples of this obfuscating use of language especially in those parts of AIRAC 9 which dealt with matters of political and public sensitivity. There are also significant omissions of highly relevant data. The Committee concluded that AIRAC 9 could not be regarded as an authoritative scientific account nor as an informative public record of important aspects of the British nuclear tests.

75. The Committee had access to much of the official material and other data used in the preparation of the AIRAC report. It assumes therefore, that AIRAC was constrained by interpretations of secrecy and possibly other pressures which did not constrain the present Committee. It further assumed that this was the reason that AIRAC had to treat information in the way it did. Accordingly the Committee wishes to state that its criticism is directed only towards the document AIRAC 9 and not towards the Australian Ionising Radiation Advisory Council, the scientific capabilities of whose members it holds in high regard.

76. The Committee concluded that there was need for a comprehensive public account of the consequences of the British nuclear tests on Australians and their environment. Such a work should be objective according to scientific standards and written in a clear and communicative style. It should be designed to complement Dr Symond's History of the British Nuclear Tests, which the Committee understands will concentrate on aspects of policy, planning, administrative arrangements and conduct of the tests.

77. The Committee discovered the existence of an enormous quantity of official records on the British nuclear tests. Due mainly to the problems of records management over a period of 30 years, the unknown or uncertain location of particular

records or even knowledge of their availability presents great difficulties of access to information. At present the official records are dispersed among many Australian and British locations. There is also a large and expanding body of other relevant data, much of which is also stored in government departments. Due to many outstanding questions about the conduct and consequences of the tests (and the high probability that many of the questions may be satisfactorily answered if additional data bases are created) the Committee believes there should be priority for developing a national Australian repository for documentation including those relevant materials currently held in the United Kingdom. No criticism is intended of officials who maintain current records systems; it is simply that the task is so great and the pressures on information so heavy that the creation of an expertly managed national repository appears the only solution.

78. Under interpretions of secrecy provisions for official documents that prevailed during the Committee's investigation no problems were encountered by those members with the appropriate security clearances. However, the Committee strongly supports moves to progressively declassify all but the most militarily sensitive British and Australian documents. From the Committee's experience with the data it can foresee much public confusion and concern arising if the declassification process is delayed - especially as under the British 30 year rule, documents relating to Australians may continue to become publicly available in the United Kingdom while remaining classified in this country.

79. The Committee believed it could draw general conclusions about the adequacy or inadequacy of major bodies of data but was less confident on some specific aspects because of uncertainties over what was available. There appeared to be a marked inadequacy of information on dispersal of material during the minor trials and its consequences. Data on nuclear tests became more adequate as the series progressed. Information on fallout deposition was deficient for the

intermediate zone but more adequate for the close-in and long-range zones. There was a general inadequacy of data on radiation doses for dose-commitment estimations and serious limitations in exposure records for some groups of servicemen although the position was complicated by uncertainties over availability of records. A similar situation related to information on some personnel movements in contaminated areas.

80. The Committee found some problems with the adequacy of data collection methodology relating to meteorological prediction, the physical measurement of fallout and individual and collective dose-assessments. It noted also a tendency not to learn from previously observed methodological inadequacies with reference to monitoring fallout and anticipating its dispersal. However the Committee had the benefit of hindsight and wishes to emphasise that some relevant technologies were in their infancy during the 1950's and much instrumentation was primitive by today's standards. The Committee noted evidence from the records of a general degree of competence and the ability to make the best use of marginally effective methods among those scientists who collected data related to fallout.

81. On reviewing data on fallout levels the Committee disputed strongly the manner in which AIRAC 9 had dealt with radiation doses, in particular its avoidance of the most conservative estimate principle and its derivation of dose-estimates, especially in the intermediate zone. The Committee reviewed parameters needed for thorough review of fallout estimations and identified difficulties in completing this task. It noted also that further analyses were still required to judge the significance of some variations in fallout deposition associated with local differences in weather conditions. British studies are continuing in this area.

82. Although the Committee had reservations about the use of collective dose-estimates and preferred the critical group concept it concluded that there was negligible hazard from long-range fallout on the Australian population.

83. When examining information on Australian personnel involved in nuclear test operations, the Committee was handicapped through inability to locate data on certain important issues. Relatively high doses (but below levels associated with acute radiation injury) were observed or assumed with varying degrees of confidence for some scientists, technicians and military personnel who made planned or unplanned incursions into areas contaminated by immediate fallout. The hazards to aircrew who penetrated and tracked radioactive clouds could only be partly elucidated through difficulties with obtaining records of cumulative dose and deficiencies in monitoring the exposures from contamination on and in aircraft. Problems with occupational classification and inadequate records prevented even an approximation of dose-estimates for decontamination crews although the Committee believes some may have experienced significant contamination exposures because of extremely high levels measured on aircraft surfaces.

84. The Committee reviewed evidence from retrospective epidemiological studies on the association between participation in the nuclear tests and illness or causes of death, especially involving those conditions known to be related to ionising radiations. No significant associations could be upheld. However the Committee noted the serious methodological problems that surrounded the studies and concluded that because of these difficulties and, in particular, the lack of information to identify the exposure status of many personnel, the retrospective epidemiological approach may be of limited value. If more precise exposure data are found, then case-control studies of selected groups among nuclear personnel may provide useful information about relationships with any subsequent radiation-related illness.

85. A considerable collection of data on the health of Australian participants in the tests has been accumulated in governmental departments and elsewhere. There is little doubt that this collection will increase substantially. Many records

relate to specific health concerns or claims for compensation from individuals who believe they were exposed to radiation during the tests and have some health problem which may be ascribed to it. These data are, in general, subject to conditions of privacy legislation. They relate to problems which require resolution by specialised means. The Committee believed that health records containing information associated with the nuclear tests constituted a special class of data. Some categories of record may be suited for management by a health statistics unit; others, certainly the majority, would come under the professional responsibility of specialists in occupational medicine and hygiene. The Committee concluded that health data should be brought together in a single repository so that the records may be effectively managed. It felt that the most appropriate repository would be in either the proposed National Institutes of Health or the proposed National Institute of Occupational Health and Safety. A member of the Committee believes there may be a special case for retaining dose exposure and other dosimetry records in the Australian Radiation Laboratory. The rest of the Committee felt that if such were to be agreed, duplicate records should be held in the main health repository.

86. A large number of individual cases are known where an association is claimed between exposure to a radiological hazard from the British nuclear tests and an illness or disability. Some cases have been resolved, many await resolution and it is probable that more will be presented. The Committee concluded from its review of data that sufficient information of adequate quality exists, or is likely to exist, to aid in resolution of a proportion of these outstanding cases. It acknowledges that in some instances, the data may be unavailable or too inadequate for solution of the problem.

87. The Committee did not discuss in detail the subsequent hazard from minor trials manifest largely as plutonium contamination at Maralinga. Data on all aspects of the minor trials are sparse but the Committee is aware of earlier surveys

and prior efforts to reduce the risk of exposure to plutonium. It discussed with those members of the Australian Radiation Laboratory who are engaged in the current survey at Maralinga the nature and extent of their task. The Committee concluded that the survey is a thorough and necessary pre-requisite to a solution for minimising the persisting hazard from particles of plutonium and other radioactive debris.

88. The Committee differed from AIRAC 9 in its interpretation of reports of deaths and illness ascribed to fallout which have been related by Aborigines who were in the intermediate fallout zone during the Totem series at Emu field. The Committee concluded from evidence provided by anthropologists and some reports by patrol officers that the probability of Aboriginal movement through the nuclear ranges during the test period was higher than previously acknowledged. Nor could the Committee dismiss the possibility that the "black mist" may have represented a deviant pattern of fallout deposition from the first Totem test. Persisting beliefs among the Pitjantjatjara people of the harmful effects of "black mist" and related phenomena have not been fully investigated. The Committee concluded that the matter required further examination.

89. Initiatives have been commenced by the South Australian government to identify any consequences of radiation exposure among Aborigines and examine the oral evidence of "black mist" and its effects. Having examined the nature of the project the Committee concluded that it should provide information to assist in resolving a very complex matter. The investigation is in accordance with the Committee's opinion that the issue be further examined. It believes, however that the South Australian initiative should be supported as a national venture and that the project be adequately resourced to achieve its objectives.

90. The Committee compared those radiation protection standards prevailing during the period of the tests with the current standards. It was found that current practices involves more rigorous control procedures than formerly and

that even by today's standards the external radiation received by nuclear test participants (with the possible exception of certain critical groups) did not appear excessive.

91. The Committee had some reservations about details of the meteorological and radiation protection criteria adopted to ensure safe firing at each of the tests. However, the Committee concluded that, in general, the criteria for safe firing were adequate for each test.

92. During its investigation of information on the British nuclear tests the Committee found evidence of certain practices and circumstances which conferred a degree of radiological risk to sections of the Australian population. These were variant events - in general and with only relatively few exceptions there was widespread respect for the harmful consequences of radioactive fallout and considerable care was taken to minimise such consequences. But with such a large and prolonged endeavour it is unrealistic to assume that things did not go wrong and on occasions they did. It is equally unrealistic to assume that the nuclear test authorities had the means at their disposal to prevent the occurrence of all untoward events or harmful practices. That they did not have all the means was evident to the Committee who believe that accounts which minimise difficulties encountered during the tests are not appropriate.

93. The Committee encounted many accounts of personal and sometimes corporate beliefs that individuals or groups of people were damaged even to a fatal degree by fallout from the nuclear tests. The Committee was aware that a much larger number of such reports have been accumulated in government departments and elsewhere. It is probable that more evidence of this nature will accumulate over the next two decades.

94. The Committee was in no position to make judgements on claims or assertions relating to health problems and other adverse consequences of the nuclear tests. It was aware that

public attitudes towards nuclear weapons and the harmful nature of ionising radiations have changed since the tests although the Committee noted in some official reports remarks about "rumours" and "exaggerated fears of radiation" held at the time. Moreover, given the current climate about nuclear matters, the Committee suspected that some of the data it had seen and which are likely to be made public in this country or the United Kingdom may create additional fears and anxiety.

95. The Committee concluded that the accounts of human damage ascribed to fallout or other consequences of the British nuclear tests are, for the most part, based on genuine beliefs that the events are related in a causal manner. Although it did not wish to minimise the difficulties associated with resolving such matters the Committee concluded there was adequate information available, or likely to be available, that could be used to draw useful conclusions on at least a proportion of unresolved incidents thought to be related to consequences of the nuclear tests.

96. The most appropriate procedure to resolve outstanding issues, the Committee concluded, would be a public inquiry with adequate powers to determine how the conduct and consequences of the British nuclear tests affected the health and well-being of Australians. From its review of available data the Committee believed that such an inquiry should place emphasis on Australians who served at the nuclear test sites and related facilities and on those, mainly Aborigines, who lived in the region of these tests.

RECOMMENDATIONS

97. The Committee recommends that:

1. The Government hold a public inquiry to determine how the conduct and consequences of the British nuclear tests affected the health and well-being of Australians with emphasis on those Australians who served at the nuclear test sites and related facilities and on those, mainly Aborigines, who lived in the region of the tests.

2. The Government negotiate with the South Australian Government towards the objective of subsuming as a national venture the initiatives recently commenced by the South Australian Government for a major investigation into the effects and consequences of British nuclear tests on Aboriginal people.

3. The Government develop and maintain a single national repository for all documentation on the British nuclear tests including relevant material currently held in the United Kingdom and with the exception of data on health aspects (see recommendation 5).

4. The Government commission a comprehensive and authoritative public account of the consequences of the British nuclear tests to complement Dr Symond's forthcoming History of the British Nuclear Tests.

5. The Government develop a national repository of health data related to the British nuclear tests and support its maintenance by a unit within either the proposed National Institutes of Health or the proposed National Institute of Occupational Health and Safety.

Kerr Report: Criticism of AIRAC 9

1. Fallout levels estimation (para. 19)
2. Lack of "officially recorded anomalies" eg. minor fallout plumes (para. 19, 25, 27)
3. Gamma dose record for Mosaic, Buffalo and Antler ≠ AWTSC (para. 19)
4. Avoids "most conservative estimates" (para. 20, 81)
5. Disagrees with dose estimates for intermediate zone (para. 24, 81)
6. Upper limit calculations for Totem tests (para. 30)
7. Indoctrinee Force (para. 32)
8. Sampling of cloud: Totem 2 (para. 35)
9. Dose rate estimations for RAAF (para. 36)
10. Decontamination exposure records (para. 38)
11. No consultation with anthropologists (para. 46)
12. Black mist (para. 48-50, 58)
13. Dose rate estimation for Wallatinna (para. 44)
14. Summary of criticism (para. 72)
15. Yield of Mosaic test (para. 73)
16. Omissions of highly relevant data (para. 74)