The Parliament of the Commonwealth of Australia

Parliamentary Standing Committee on Public Works

Report Relating

to the

Upgrade of transonic wind tunnel at DSTO Fishermens Bend, Vic.

(Sixth Report of 1994)

Australian Government Publishing Service
Canberra

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Senator Bryant Robert Burns	Mr John Neil Andrew MP
Senator John Robert Devereux	Mr Raymond Allen Braithwaite MP
	Mr Russell Neville Gorman MP
	Mr Robert George Halverson OBE MP
	Hon. Benjamin Charles Humphreys MP

Sectional Committee on the proposed Upgrade of transonic wind tunnel at DSTO Fishermens Bend, Vic

Mr Colin Hollis MP (Chairman)
Hon. Benjamin Charles Humphreys MP (Vice-Chairman)
Senator Bryant Robert Burns

Committee Secretary:	Peter Roberts
Inquiry Secretary:	Michael Fetter
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EXTRACT FROM THE VOTES AND PROCEEDINGS OF THE HOUSE OF REPRESENTATIVES

No. 82 dated Wednesday, 29 June 1994

5 **PUBLIC WORKS – PARLIAMENTARY STANDING COMMITTEE – REFERENCE OF WORK – UPGRADE OF TRANSONIC WIND TUNNEL AT DSTO FISHERMENS BEND, VIC.**

Mr Walker (Minister for Administrative Services), pursuant to notice, moved – That, in accordance with the provisions of the *Public Works Committee Act 1969*, the following proposed work be referred to the Parliamentary Standing Committee on Public Works for consideration and report: Upgrade of transonic wind tunnel at DSTO Fishermens Bend, Vic.

Question – put and passed.

PARLIAMENTARY STANDING COMMITTEE ON PUBLIC WORKS

UPGRADE OF TRANSONIC WIND TUNNEL AT DSTO FISHERMENS BEND, VIC

On 29 June 1994 the House of Representatives referred to the Parliamentary Standing Committee on Public Works for consideration and report to Parliament the proposed upgrade of the transonic wind tunnel at DSTO Fishermens Bend, Vic.

THE REFERENCE

1. The Defence Science and Technology Organisation's (DSTO) Aeronautical and Maritime Research Laboratory (AMRL) has its headquarters at Fishermens Bend. The primary mission of AMRL is to develop, maintain and exploit for the benefit of Australian defence, scientific and technological skills in areas essential to aircraft, air vehicles and relevant aspects of weapons.

2. The proposal referred to the Committee is required to more effectively meet current and foreseen defence requirements for aerodynamic data in the transonic speed range, in combination with developing computational fluid dynamics capabilities. It is proposed to replace a range of components including:

- compressor system
- compressor drive
- tunnel test section
- installation of a new cooling system
- a new plenum evacuation system
- a new model support system.

3. When referred to the Committee the estimated out-turn cost of the proposed work is $12.7 million at December 1993 prices.

Need for proposal to be referred to Committee

4. The proposal is essentially a project which will replace and upgrade existing specialised fixed equipment. Before the proposal was referred to the Committee Defence sought clarification of the need for it to be referred to the Committee. There was some doubt as to whether the definition of 'a work' in the *Public Works Committee Act 1969* (the Act) includes within its scope replacement and upgrading of specialised fixed equipment outlined in paragraph 2.

5. The Committee sought the advice of the Attorney-Generals Department which advised that 'Work' is relevantly defined in section 5 of the Act as follows:

> '"work" means an architectural or engineering work, and includes:
>
> (a) the construction, alteration, repair, refurbishment or fitting out of buildings and other structures;
>
> (b) the installation, alteration or repair of plant and equipment designed to be used in, or in relation to, the provision of services for buildings and structures;
>
> but does not include:
>
> ...
>
> (j) the installation, alteration or repair of plant or equipment where the plant or equipment:
>
> (i) is not designed to be used in, or in relation to, the provision of services for a building or other structure; and
>
> (ii) is not necessary or desirable to make a building or structure a complete building or structure;
>
> ...'.

6. The Attorney-General's Department advised that the wind tunnel is a structure which comes within paragraph (a) of the definition of 'work' because it involves the refurbishment of a structure. However paragraph (j) of the Act excludes certain plant and equipment. The effect of paragraphs (b) and (j) of the definition of 'work' mean that the upgrading of the wind tunnel would need to be referred to the Committee if:

- it involves the repair of plant and equipment designed to be used in the provision of services for the wind tunnel (which is a 'structure')
- the plant or equipment is necessary or desirable to make the wind tunnel a complete structure.

7. The view was that the proposal referred to the Committee met both conditions. In brief, the plant and equipment involved in the project will be used in the provision of services to the wind tunnel because the equipment is necessary to enable the efficient functioning of the wind tunnel. Expressed another way, the plant and equipment is necessary to make the wind tunnel a complete structure.

8. The Committee believes this interpretation of the Act may have wider ramifications for works of a similar nature which departments or agencies may consider do not constitute a referable proposal. It will highlight this in its next General Report to Parliament.

THE COMMITTEE'S INVESTIGATION

9. The Committee received a submission and drawings from the Department of Defence (Defence) and took evidence at a public hearing held at Fishermens Bend on 14 September from:

- Department of Defence
- Automotive, Food, Metals and Engineering Union
- Association of Professional Engineers, Scientists and Managers Australia.

10. Prior to the public hearing the Committee inspected the existing transonic wind tunnel, the low speed tunnel and a number of other facilities

at Fishermens Bend. The Committee inspected the S-1 wind tunnel at Salisbury on 13 September.

11. Written submissions about the proposed work were also received from:

- Returned and Services League of Australia
- Commonwealth Fire Board
- Commonwealth Department of Primary Industries and Energy
- Association of Australian Aerospace Industries
- The Royal Aeronautical Society
- Australian Heritage Commission
- Victorian Environment Protection Authority
- Dominion Taylor Wood

12. A list of witnesses who gave evidence at the public hearing is at Appendix A. The Committee's proceedings will be printed as Minutes of Evidence.

BACKGROUND

DSTO

13. After the CSIRO, DSTO is the second-largest government research organisation in Australia. It has about 2600 employees, half of whom are professional researchers. DSTO receives an annual appropriation of just above $200m; in the 1994/95 budget the amount was $219.1m.

Role of DSTO

14. The 1993 Strategic Review identified a number of key capabilities which rely heavily on aircraft and related airborne ordnance. The Strategic Review also re-affirmed Australia's defence posture to be one of self-reliance to a greater extent than in the past, coupled with closer regional engagement. In this strategic and operational context the responsibility for scientific and technological support of military aviation falls primarily on

DSTO in close collaboration with Australian industry and overseas suppliers of equipment where necessary.

15. DSTOs objective statement is to give advice on the application of science and technology that is best suited to Australia's defence and security needs. This is achieved by:

- participating in national security policy formulation through the provision of scientific and technological advice to Defence and other Government agencies involved in that process
- contributing to new defence capability through the provision of scientific and technological advice and assistant in relation to new or enhanced capabilities, including the development and evaluation of technology demonstrators to meet special Australian defence requirements
- contributing to existing defence capability through scientific and technological investigations to extend the life of platforms and equipment and to solve operational problems associated with deficiencies in-service equipment and operational procedures
- facilitating the timely transfer of the results of defence research to industry, and providing access to industry and other agencies to the research facilities and expertise of DSTO.

Location

16. AMRL is located at two sites in Melbourne - Maribyrnong and Fishermens Bend. The Fishermens Bend site is owned by the Commonwealth and comprises 12.3 ha.

Facilities at Fishermens Bend

17. In 1990 the Committee recommended that the redevelopment of the Fishermens Bend site should proceed at an estimated cost $17.5m. The Committee concluded that many of the buildings were inadequate for their current use and that the site should be redeveloped. *(Committee's report relating to the redevelopment of the Aeronautical Research Laboratory site, Fishermens Bend, Vic - Committee's 10th report of 1990 - Parliamentary Paper 378/1990.)* The Committee was advised that Phase A of the redevelopment was completed in 1993 and Phase B is planned to commence

in 1994. This substantial investment in addition to works undertaken between 1987-90 costing $11.95m, is ample evidence of a commitment to the continuation of Defence research at Fishermens Bend.

18. During the 1980s DSTO developed what were described to the Committee as 'very capable structural and propulsion test facilities'.During the inspection of AMRL the Committee was able to see an example of structural testing about to commence as part of a bilateral study involving Canada and Australia. This project, designated the International Follow on Structural Testing Project, will involve AMRL scientists and engineers subjecting the aft fuselage and wings of an F/A 18 Hornet aircraft to various tests the results of which will be critical in determining if or what structural modifications will be required to enable the aircraft to continue to fly in the next century.

19. Whilst this project reflects the sophistication of structural test facilities, the ability of AMRL to undertake research into aerodynamics, especially in the transonic range, is limited by the capacity of wind tunnels available.

Wind tunnels

20. Wind tunnels have been in use since the early 1900s to obtain aerodynamic data about aircraft, components of aircraft such as wings and flaps, and the behaviour of stores carried onboard aircraft. It is possible to test actual aircraft and the behaviour of stores to determine their aerodynamic behaviour, but this has been found to be expensive, potentially hazardous and the subject of many sources of error.

21. Before any actual test flights occur aircraft designs or components are subjected to many hours of intensive testing in wind tunnels in order to evaluate their aerodynamic behaviour. Aircraft or airborne stores experience a variety of aerodynamic forces as their move through the air. A 'Lift force' supports the aircraft in flight, 'drag force' resists the motion of the aircraft and 'control forces' allow the aircraft to manoeuvre. In order to predict flight behaviour and performance these forces must be known. A further complication occurs when an aircraft is fitted with external stores such as fuel tanks, bombs or missiles. In this situation more complex interactions between aircraft and stores occur which may cause unexpected behaviour of both aircraft and store during carriage and release; this includes the possibility of inadvertent contact, which can have disastrous results.

22. Designs studied in wind tunnels comprise stationary geometrically detailed sub-scale models and air, at various velocities, is driven past them to simulate flight conditions. The use of stationary models greatly facilitates forces and pressures generated by the air flow and the measurements obtained can be used to predict the characteristics of full scale aircraft in flight. Of special interest to DSTO engineers and scientists are air velocities which approach the speed of sound. It is here that shock waves appear and the flow of air over the surfaces becomes very complex. Furthermore, it is in the transonic area that most air combat aircraft operate and store releases occur. Therefore, in order to predict the behaviour of an aircraft as it approaches and crosses the speed of sound, it is necessary to test models at velocities from well below the speed of sound to somewhat in excess. A typical transonic wind tunnel has a capability to operate in the ranges of Mach 0.4 to Mach 1.4.

Description of wind tunnel

23. A typical transonic wind tunnel consists of a large closed circuit duct, generally constructed from steel, which contains a high-powered fan to drive air around the duct an instrumented test section containing the model. The shape of the duct is designed to minimise the power required and to provide a uniform air flow past the model. A cooler is located in the duct to remove energy added to the circulating air by the fan. Turning vanes and flow straighteners are provided to improve the quality of air flow past the model. Auxiliary plant such as air compressors and air drying equipment are required for effective tunnel operation.

An Australian transonic wind tunnel

24. The majority of military aircraft operations occur in the transonic speed range; this will continue for the foreseeable future. Defence advised that Australian defence related requirements for transonic data include:

- determination of detailed aerodynamic load distributions on combat aircraft through the entire range of operational conditions they are likely to encounter; this data is required to determine the expected life and life extension of defence force aircraft

- investigations into the safe carriage and release of airborne stores, including explosive ordnance; Defence believe this is an important aspect of self reliance – without an independent capability the operational options could be limited and dictated by overseas aircraft and armament manufacturers

- investigations into the effect of release disturbances and free stream aerodynamics on aiming point accuracy of free fall stores; this allows data used by weapon computer systems in defence force aircraft to be refined, resulting in increased accuracy

- determination of the aerodynamic behaviour of defence aircraft to facilitate flight dynamic and combat modelling in support of aircraft operations; this information minimises the potential for loss of aircraft during operations and reduces the cost of flight trials.

- an independent transonic aerodynamic assessment capability to support procurement

- the capability to provide information to prospective equipment suppliers to support procurement

- opportunities for research and development with regional countries, most of which do not possess transonic wind tunnels.

THE NEED

25. Defence believes there is a need for the transonic wind tunnel at Fishermens Bend to be upgraded to enhance the DSTO capability and to complement the existing world class facilities available for structural and propulsion testing.

26. The Committee questioned DSTO about the status of Australian aerodynamic research capabilities compared with other countries. In response a senior DSTO scientist advised the Committee:

> The intellectual capability of our aerodynamic scientists is as good as anywhere else in the world. That is reflected in the reputation that we enjoy, and the relationship we have with universities both in Australia and overseas that we maintain through membership of international associations and professional disciplines. Our facilities are not acknowledged as the best in the world...But in capability to understand aerodynamics, the ability to use data, the ability to interpret and provide that information in a system sense to our customers, DSTO scientists are as good as anybody else in the world.[1]

Fishermens Bend wind tunnel

27. DSTO operates four significant wind tunnels which cover velocities from zero to Mach 5. Two of these tunnels, the transonic tunnel at Fishermens Bend and the S-1 tunnel at Salisbury, SA, have transonic capabilities. The transonic tunnel at Fishermens Bend was built in the mid-1940s as a high pressure, low speed, research tunnel. A number of modifications were made to it through the 1950s and early 1960s to enable it to operate at transonic speeds and to improve its efficiency.

28. It has a test section 530 mm wide by 810 mm high. Closed circuit air is reticulated by an axial flow compressor driven by a 1.7 MW electric motor. The tunnel has a heat exchanger to cool the air in the circuit and two screens upstream from a contraction ahead of the test section to improve flow uniformity and to reduce turbulence.

29. To achieve Mach numbers above 0.6, the pressure of the air in the tunnel must be reduced below atmospheric pressure because there is insufficient power to operate at higher pressures. Operating pressure in the wind tunnel can be varied from one-tenth of an atmosphere to two atmospheres.

30. Defence advised the Committee that the tunnel has two major deficiencies - its low Reynolds number and its small test section size. The Reynolds number is a parameter which indicates the ability of the tunnel to simulate fullscale flight correctly. Defence advised the Committee that the test Reynolds number required to adequately predict the operational behaviour and performance of combat aircraft has steadily increased over recent years. Defence believe the situation has now been reached where reliable extrapolations of AMRL transonic tunnel data to flight conditions is often impossible. For reasonably confident prediction of flight characteristics of present aircraft at transonic speeds a Reynolds number of greater than one-tenth of the full scale flight value is normally required. The Reynolds number capability of a transonic wind tunnel depend mainly on the test section dimensions and the operating pressure. Defence therefore

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[1]Transcript, p. 40.

believe there is a need to increase the test section dimensions of the Fishermens Bend tunnel and to increase the operating pressure to give an operating Reynolds number approximately seven times greater than the current tunnel capability. In practical terms, this means that tests on combat aircraft models in the upgraded tunnel match more closely conditions experienced in real life with a consequent increase in the confidence and usefulness of the data.

31. The second major disadvantage of the Fishermens Bends transonic tunnel is its small test section size. Defence advised the Committee that small models accommodated by the existing test section are difficult and frequently impossible to manufacture to the required accuracy. Defence advised the Committee that small models accommodated by the existing test section are difficult, and hence very expensive, to manufacture to the required accuracy. This severely restricts the range of models that can be made readily available. The resulting long manufacturing time and high cost of models severely restricts productivity. The small model scale also makes it difficult to provide manually adjustable control surfaces and impossible to provide onboard control surface actuators. It is also difficult to provide the necessary internal space to accommodate on-board instrumentation such as force balances and pressure transducers. These restrictions not only extend greatly the time to undertake most test programs, but also mean that some types of test, for example dynamic tests, cannot be undertaken at all.

Salisbury wind tunnel

32. The S-1 wind tunnel at Salisbury was built during the period 1952-55. It was commissioned in 1957 to provide a supersonic aerodynamic test facility in Australia to support the guided missile testing program then being conducted at the Woomera Range.

33. The tunnel is powered by a 3 MW variable-speed induction motor driving a modified 'Nene' centrifugal compressor. It was designed originally to operate at a variable-pressure supersonic facility in the Mach range of 1.6 to 2.8 with a nominal working section size of 380mm wide by 380mm high.

34. In the early 1960s the tunnel's speed range was extended downwards to Mach 1.4 and in 1965 further modifications were made enabling the tunnel to operate in the Mach 0.3 to 0.95 range.

35. Defence pointed out that the test section dimensions are about 60% of those of the Fishermens Bend tunnel and the problems with small scale

apply even more to the S-1 tunnel. Defence also advised that the S-1 tunnel has a similar test Reynolds number to the Fishermens Bend tunnel in the transonic range.

Attempts to remedy deficiencies

36. Attempts to overcome the problems at Fishermens Bend have had a tortuous progress. It was already evident in the mid 1970s that the tunnel did not have the capability to continue to meet the increasingly complex demands posed by newer generations of aircraft and stores.

37. The Australian Science and Technology Council (ASTEC) (1977-78) and the DSTO External Review (1980) drew attention to the inadequacies and obsolescence of DSTO wind tunnels. A recommendation by ASTEC resulted in Cabinet directing that Defence develop a detailed long term plan for upgrading and extending facilities for research and development in aeronautics and aerospace. A study of facility requirements was undertaken as a result of this direction. The resultant study identified transonic wind tunnel testing as the area of greatest deficiency and a proposal to acquire a major transonic wind tunnel was subsequently developed. The new wind tunnel project developed covered the period 1982-92 and culminated in the completion of detailed design documentation for a new tunnel at an indicative cost in excess of $50m. The proposal failed to get approval due to Defence programming pressures and the lack of Defence support for the substantial investment.

38. DSTO subsequently undertook a fundamental reassessment of requirements which concluded that the majority of high priority requirements could be met by comparatively minor upgrading of an existing wind tunnel in combination with developing capabilities in Computational Fluid Dynamics (CFD). The need for the wind tunnel upgrade therefore results from the advantages of this option over other options examined.

39. Other options examined but found to be unsatisfactory for providing the required transonic aerodynamic data are discussed in the following paragraphs.

Continue with present facilities

40. During 1982-92 independent studies into transonic testing requirements were undertaken and extensive consultations were held with users of the data - the RAAF, RAN, Army and Australian industry. All

agreed that existing facilities to be obsolete and incapable of meeting current and future Defence requirements.

Rely on Computational Fluid Dynamics

41. The use of CFD involves solving basic equations of fluid motion on digital computers. It is a discipline which is advancing steadily and has established a complementary relationship with wind tunnel testing. Defence advised the Committee that there is nevertheless general agreement that CFD will not replace transonic wind tunnel testing until well into the next century - if ever. Recent major investments in new and upgraded wind tunnels in the USA support this view. CFD techniques are used at AMRL and can be used to extend tunnel productivity and to enable wind tunnel results to be used more effectively to predict full scale flight conditions. Defence believe CFD will not remove the need for wind tunnels.

Test overseas

42. Many countries with a significant independent air defence capability have acquired their own transonic wind tunnels. A number of benefits stem from maintaining an independent in-country capability:

- the achievement of greater self-reliance by the development of the national technology base and the ability to respond effectively in an emergency. Overseas testing would severely erode the in-country technology base.

- the security of information for military and commercial reasons. Overseas testing could compromise security.

- wind tunnel investigations are exploratory and often test programs are strongly influenced by results as they come to hand and further tests are required at short notice. Overseas wind tunnels are often booked out for months and sometimes years ahead. Overseas testing would impose severe restrictions on the responsiveness to Australian needs.

- overseas testing would be insufficient by itself to maintain and develop local expertise. Without local expertise, overseas test programs are unlikely to be well specified and supervised. Further, results are unlikely to be correctly interpreted and applied.

- international experience has been that it is difficult to recruit and retain capable engineers and scientists in circumstances where the major experimental facilities are not in-country. Efforts at developing skills through the attachment of personnel overseas often result in the best personnel remaining overseas and not returning. Even if personnel were to return, they would be unable to maintain and develop their acquired expertise which would be gradually eroded.

Use overseas data

43. Many Australian aircraft and store combinations, store arrangements and operational requirements are unique and are not shared by other countries operating with the same aircraft. Therefore, much of the aerodynamic data required is not directly available from aircraft manufacturers. To obtain data for Australian requirements would consequently require tests to be carried out in overseas wind tunnels. This arrangement would lead to deficiencies already discussed.

44. Defence advised that experience has been that overseas manufacturers tend to charge a high premium for such data when they perceive an inability to produce it locally. Experience with Mirage IIIO, F-111C and more recently F/A 18 aircraft has been that manufacturers and parent operating services are reluctant to provide the aerodynamic data they possess. The difficulty that has been experienced in obtaining data from a number of different aircraft manufacturers and foreign defence agencies over the years indicates that this is due to basic policy. Defence believe that this is hardly surprising because it is recognised that success in combat is achieved by the operator who has superior knowledge of his equipment, and who can emphasise its strengths and minimise the impact of its weaknesses.

45. Ultimately the aerodynamic data that gives this greater understanding of operational effectiveness is therefore a very valuable and sensitive commodity.

Committee's Conclusions

46. For Australia to continue its self-reliant defence policy it is necessary for capabilities relying on aircraft and related airborne ordnance to be maintained and further developed.

47. To maintain and develop these capabilities it is essential for Australia to have a modern transonic wind tunnel to provide data on aerodynamic loads of aircraft and stores, such as missiles, to permit their more efficient deployment and life extension.

48. DSTO scientists and engineers and support personnel have the skills and expertise necessary to undertake aerodynamic research at international standards.

49. Reliance on testing overseas would compromise local expertise and security.

50. The existing transonic wind tunnel at Fishermens Bend suffers from small test section dimensions and inadequate flow simulation capability.

51. Construction of a new and much larger wind tunnel to replace the existing facility would be expensive.

52. Costs of providing a facility which is adequate for defence requirements would be reduced by the upgrading of the existing transonic wind tunnel at Fishermens Bend with complementary advances in computational fluid dynamics.

53. There is a need for the transonic wind tunnel at Fishermens Bend to be upgraded by enlarging the test section and providing enhanced flow generation systems.

THE PROPOSAL

Outline

54. The proposal involves the upgrading of the transonic wind tunnel at Fishermens Bend to the minimum extent necessary to meet current and foreseen Defence needs. The proposal involves retaining a substantial part of the existing wind tunnel facility and associated buildings to minimise costs.

Development of the proposal

55. Early in 1992, following the realisation that the $50m wind tunnel concept was unlikely to proceed, DSTO undertook a reassessment of its requirements. The reassessment revealed that developments in CFD over the previous decade had made it possible for the majority of the ADF

transonic data requirements to be met by upgrading one of the existing DSTO wind tunnels in conjunction with developing CFD capabilities.

56. In February 1993 proposals were sought from international wind tunnel design consultants for the development of options to upgrade an existing tunnel. The successful tenderer submitted an interim report in June 1993 which concluded that is was feasible to upgrade to existing Fishermens Bend tunnel to meet the majority of current and future ADF requirements. The report also concluded that it was not cost effective to upgrade the Salisbury tunnel. The consultant estimated the cost of the upgrade for the Fishermens Bend tunnel to be of the order of $11m.

57. The consultant's interim report was accepted following extensive consultation within DSTO. The consultant was requested to proceed to develop different levels of upgrades in more detail to enable a limited cost capability tradeoff to be made. The consultant's final report, received by DSTO in January 1994, identified three levels of upgrades and provided a cost estimate for each. Following further consultation within DSTO and the wider Defence community, it was decided that the option which replaced the tunnel drive compressor, which is more than 40 years old and approaching the end of its economic life, was the most cost effective.

58. Defence believe this option offers greatly reduced technical risk, lower operating costs through higher energy efficiency and lower maintenance, and slightly higher performance than the other options put forward but for a modest increase in cost. The proposal put to the Committee reflects this option. Components of the tunnel which will be upgraded or replaced are described in the following paragraphs.

Drive system

59. The existing drive system for the main compressor will be replaced with a 5.3 MW variable speed electric motor and ancillaries with characteristics that match the requirements of the tunnel. The increase in power from the current 1.7 MW will produce a major increase in the ability of the tunnel to accurately simulate full scale flight. The motor and drive system will be installed in the existing motor room which is unlikely to require extension. The new drive system will be equipped with a closed loop control system to hold the desired test Mach number to very high accuracy.

Compressor

60. The main drive compressor fan, which circulates the air around the tunnel, will be replaced with a purpose designed and built machine. It will be optimised to match the characteristics of the modified tunnel and absorb the increased drive power. The compressor, combined with the increased drive power, will enable the tunnel to be operated at stagnation pressures up to two atmospheres at airspeeds up to Mach 1. This will provide a major increase in test capability by increasing the Reynolds number, a measure of the similarity of the flow over a model compared with full scale conditions, by a factor of about 4.

Test section

61. The test section region of the tunnel circuit, which contains the model under test, will be replaced to give an increase in test section area of approximately 50 per cent. This will permit the use of models 50 per cent larger in cross section and will result in a considerable increase in testing capability. Ventilated walls will be provided to reduce shock interaction effects and improve performance.

Plenum evacuation system

62. A plenum evacuation system, will be installed. This system will permit the fine adjustment of Mach number, improve the tunnel energy efficiency and flow quality, and extend the operating Mach number range. This system will also be used to pressurise the tunnel up to two atmospheres and reduce the pressure to about one-quarter of an atmosphere to enable high transonic Mach numbers to be achieved. The motor, compressor, and ancillary equipment associated with this system, will be housed in an existing room alongside the tunnel circuit.

Nozzle

63. A removable nozzle will be provided just upstream of the test section to facilitate operation at high transonic Mach numbers.

Tunnel circuit air cooling system

64. An upgraded circuit air cooling system will be provided. As the air is circulated around the tunnel, it increases in temperature due to the energy added to it as it passes through the compressor. The continuous circulation

of the air can lead to a large increase in temperature which will reduce the test capability, be detrimental to the integrity of the model under test, and cause problems with other equipment. A new heat exchanger will be installed in the contraction upstream of the test section to keep the air within the required temperature limits. Associated components will also be upgraded.

Tunnel control system

65. A new control desk will be provided to house the controls for the motor drive system, the plenum evacuation system, the model support systems, and controls for other minor plant, together with monitors for setting up and monitoring the tests. Appropriate safety equipment and interlocks will also be provided to ensure all systems operate safely. Control systems will be linked to the tunnel data acquisition system which will be retained.

66. Of significance from an occupational health and safety point of view, will be the provision of a sound insulated enclosure for tunnel operating staff and the control desk.

Main model support

67. The model support holds the model in the test section. The existing model support has a very limited control capability which severely limits productivity. A new main model support system will therefore be provided to enable the orientation of the model in relation to the airflow to be set and changed remotely while air is flowing over the model.

Store support

68. A specialised multi degree-of-freedom store support will be acquired to enable aircraft-store interaction tests to be carried out. The existing tunnel is not equipped with a suitable store support mechanism.

Sidewall model turntables

69. New sidewall turntables will be provided to set the attitude of special 'half' models mounted on the sidewall of the test section and to allow two dimensional model tests to be made. The existing sidewall turntables are not suitable for the new larger test section.

Model support control system

70. A computer based control system for the three model and store supports will be acquired. This system will communicate with the main tunnel data system and will also be operable in a stand-alone mode for setup and checkout purposes.

Force balances

71. Suitable force balances to facilitate the calibration of the wind tunnel will be acquired.

Building works

72. An upgrade of the existing wind tunnel building will be undertaken. The upgrade will cater for the new tunnel components. An extension will be made to the existing building entrance foyer to provide a reception and display area. The services in the building will also be upgraded to suit the new plant. New foundations and flooring will be provided for the major items of equipment.

Adequacy

73. The Committee questioned Defence about the adequacy of the enhanced capabilities which the upgrading of the wind tunnel will achieve. Defence advised the Committee:

> I think we are confident...One reason we are confident is that we have got some good advice on it, we think, from our consultants. We have got our own expertise which is able to evaluate that advice. We have got a number of clients in the air force with a keen interest in this and they are of the view that this will do the job. So we think it is the right way to go.[2]

Site and master planning

74. The location of the building to house the upgraded wind tunnel is in accordance with the master plan for the Fishermens Bend site.

[2]Transcript, p. 53.

75. The Fishermens Bend area is zoned as General Industrial and currently there are no plans for rezoning by planning authorities. The nearest houses are at least a kilometre away.

Fire protection

76. The Committee was advised that fire protection systems will be upgraded to ensure compliance with the Building Code of Australia (BCA). A risk assessment is to be undertaken during the design phase to determine the appropriate level of fire protection in consideration of the value of the new asset. The design is to be assessed by the Melbourne Metropolitan Fire Brigade (MFB).

77. The Commonwealth Fire Board (CFB) raised a number of matters concerning the special attention which will need to be given to the new compressor, heat exchangers and oil store, risk assessment, the consultative process and certification of the design. The CFB commended Defence for intending to consult the MFB on the design. This will allow the MFB to be familiar with the facility, its functions and its fire dangers and to ensure that facilities needed to meet operational requirements are provided.

78. Defence advised the Committee that the functional design brief requires that the upgrading of the building and services is to be carried out in accordance with relevant fire safety standards, codes and advisory bodies including the BCA, the MFB and the Insurance Council of Australia.

79. Assessment of risk during the design phase to determine the appropriate level of fire protection, will include the CFB recommendation that special attention be given to the new compressor, heat exchanger and oil store.

80. Defence also advised that the design of the building will be certified by the design consultant to ensure the design complies with relevant codes and regulations. Any departure from building regulations will be referred back to relevant areas in Defence which will seek further technical advice.

Energy efficiency

81. Defence advised the Committee that power consumption costs, based on estimated operating hours at various operating load, will be $165 000 per annum.

82. The functional design brief will require a design which maximises energy efficiency and calls for consideration of materials, energy efficient components, equipment, load matching of the compressor and motor and energy systems which will maximise energy efficiency and economies on a life cycle costing basis.

83. The major part of the upgrading will involve the installation of new equipment and the upgrading of existing components. Only minor modifications and extensions will be required to the existing building and requirements for new services will be minimal. During the design phase the energy efficiency potential of the building envelope and systems will be addressed. The building is currently connected to the site Building Management System which monitors and records electricity consumption and remotely monitors and controls the operation of the airconditioning system. This system will be retained to ensure that the energy efficiency of the building is maintained.

84. Defence advised the Committee that investigation was undertaken into the possibility of using cogeneration technology to provide power. The initial indications were that it would not be a cost-effective approach. Tunnel operations require short duration bursts of high load, and not a base continuous load. One of the advantages of cogeneration is that heat produced by cogeneration could be made available for heating. Defence advised that the is not any use for this heat at the Fishermens Bend site required by the activities undertaken there.

Support for the proposal

85. The Committee received submissions giving strong support to the proposed upgrading from the Returned and Services League of Australia (RSL), the Association of Australian Aerospace Industries (AAAI) and the Australian Division of the Royal Aeronautical Society (RAeS).

86. The RSL submitted that it is vital that Australia maintain its own capability across the range of wind tunnel facilities needed to support its military aviation industry and urged the Committee to recommend that the upgrading should proceed.

87. The AAAI is the industry body which represents and promotes companies which design, manufacture and service systems related to the aerospace industry. It has over 40 members all involved in some way with the engineering aspects of flight. In their capacity as contractors and

suppliers to Defence, AAAI members welcomed the prospect of an enhanced indigenous transonic wind tunnel capability. This enhancement will provide opportunities for the Australian aerospace industry to be given access to the facilities on commercial terms. The AAAI believes the scope of the proposed work will be sufficient when complemented with a strong capability in fluid dynamics. The AAAI also believes that in terms of the more rapid production of higher quality aerodynamic data, the enhanced capability would represent a satisfactory return on the investment proposed. In terms of the location of the enhanced facility at Fishermens Bend, the AAAI pointed to a number of factors favouring this location:

- a large proportion of the aviation and aerospace industrial capacity being located in Victoria, with much of it at Fishermens Bend

- the recent move of the Department of Aerospace Engineering of the Royal Melbourne Institute of Technology to a nearby site at Fishermens Bend

- the recent opening of the Aerospace Industry Training Centre at Broadmeadows.

88. The RAeS is the multi-discipline professional institution supporting the aerospace profession in Australia. The Society seeks to ensure that development of Australian aerospace activities is adequately supported by education, training, research and other infrastructure. Such development must be sufficiently integrated to facilitate the efficient and effective generation of a skilled aerospace workforce. It must be applied to achieve Australian advantage in the international aerospace market. The RAeS has contributed to developing cooperation within sectors of aerospace activities in Australia. This need for cooperation is driven by the realisation that the future requires harnessing of local talents and assets to create and exploit strengths attractive to the marketplace.

89. In these contexts, the RAeS indicated strong support for the proposal by providing a further opportunity for a coordinated approach for the following reasons:

- the upgraded transonic wind tunnel will be an important element of the national research and development infrastructure capable of being utilised by many users

- it will form an essential part of a range of wind tunnels covering the full range of airspeeds, and Mach and Reynolds numbers

- it will fill a vital gap in the national capability in the transonic range, especially in its Reynolds number range

- it will fill a vital Defence need - which has been designed to meet

- it has obvious use as a training facility and access should be made available to universities on appropriate terms

- CFD is an additional research tool complementing wind tunnels and not replacing them

- the upgrade will result in the establishment of a Defence and national asset and its cost can be justified on that basis.

90. Defence confirmed that the Australian aerospace industry as a potential user of the facility on a full cost recovery basis.

Committee's Conclusions

91. Expert advice obtained by DSTO confirmed the feasibility and practicalities of upgrading the transonic wind tunnel at Fishermens Bend.

92. The extent of the upgrading of various components of the wind tunnel has been the subject of extensive studies and consultation by DSTO.

93. DSTO is confident that the enhanced capabilities which the upgraded transonic wind tunnel will achieve are adequate for the longer term.

94. The design and certification of fire protection measures will be undertaken in accordance and consultation with relevant codes and authorities.

95. The proposed upgrading has the support of the Australian aerospace industry and the Australian Division of the Royal Aeronautical Society.

96. There is scope for the upgraded wind tunnel to be made available to the aerospace industry for research on a full cost recovery basis.

CLOSURE OF SALISBURY WIND TUNNEL

Consolidation of aerodynamic resources

97. Implementation of the upgrading of the Fishermens Bend transonic wind tunnel will facilitate the closure of the Salisbury S-1 tunnel and consolidate aerodynamic resources at Fishermens Bend. Defence believe this rationalisation will result in substantial reductions in aerodynamic research and development costs as follows:

- a reduction of ten professional and technical support positions in the aerodynamic area - saving annually $0.5m

- a reduction in contract electricity costs at Salisbury - saving annually $0.3m

- a reduction in maintenance costs associated with the Salisbury tunnels - saving annually $0.1m.

98. When questioned further about the rationale for closing the Salisbury tunnel, Chief of DSTO's Air Operations Division advised the Committee that DSTO do not believe that it can afford to maintain two transonic wind tunnels with associated infrastructure and staffing. DSTO acknowledged that the Salisbury tunnel has over the years done a sterling job in delivering a product which the consumer is highly appreciative of - undertaking research into how bombs, missiles and fuel tanks separate from aircraft in the transonic region. The stores separation work has been undertaken at Salisbury because of the inherent capabilities there.

99. DSTO argued that the proposed upgrading of the Fishermens Bend tunnel will provide a capability to undertake the same store separation work which is being done at Salisbury at an enhanced level of efficiency. DSTO pointed out that the Salisbury tunnel suffers a number of disadvantages which ruled it out following studies into which of the two wind tunnels should be upgraded. A prime factor which ruled out the upgrading of the Salisbury tunnel is its limited scale. The size of models which can be studied in the Melbourne transonic tunnel is larger than Salisbury. This translates into a number of efficiencies and improvements in accuracy in the data obtained and the inferences which can be drawn from the data.

Reactions to Salisbury closure

100. Representatives of professional and trade associations, with membership employed at the Salisbury facility, presented strong arguments to the Committee for the Salisbury tunnel to be retained, and not closed. A number of arguments were advanced in written submissions and at the public hearing in Melbourne by representatives of these groups. In summary the case put to the Committee was as follows:

- the Salisbury S-1 wind tunnel represents the repository of store release wind tunnel testing expertise in this country
- the Salisbury S-1 wind tunnel is Australia's only test facility capable of providing supersonic aerodynamic data in missiles, projectiles etc to the standard required for predicting their flight performance
- other methods of providing supersonic aerodynamic data to a similar standard (notably computational methods) are not yet proven or available in Australia
- the S-1 tunnel has demonstrated that it is well suited to stores related work which forms 70 per cent of Australia's wind tunnel workload.

Cost savings

101. The associations do not agree with figures produced by Defence showing cost savings in relation to labour, maintenance, and power. In a supplementary submission to the Committee the associations indicate that annual maintenance and minor development costs at Salisbury would be $182 500. The lower cost of power would be obtained by running the tunnel at night, during off-peak periods. Defence advised the Committee that the annual cost to operate and maintain the Salisbury tunnel is $715 000, which includes staff costs, maintenance and power charges. To operate the Fishermens Bend tunnel costs $340 000 which also includes staff costs, maintenance and power.

102. DSTO indicated they do not believe it logical to conduct some transonic testing in an inferior facility after the upgraded tunnel becomes available, particularly when the upgraded tunnel will have the capacity for all of the testing needed. DSTO believes it can ill afford to retain two

operating transonic tunnels; even if the Salisbury tunnel were in Melbourne it would be closed and even if it were possible to maintain the operation of the Salisbury tunnel for $182 500 per annum, it would be an unnecessary additional cost.

Committee consideration

103. It may be that there will be some financial savings to the aerodynamic research area of DSTO by closing down the Salisbury wind tunnel. However, the magnitude of the savings, if any, may be transferred to other areas of the organisation as additional charges. In this context the savings may well be illusory.

104. The Committee was impressed by the work being undertaken at the Salisbury wind tunnel and by the evidence presented at the public hearing by representatives of associations with members working there. There has been experience in recent years that often facilities are closed down prematurely and opportunities are missed when decisions are taken merely on the basis of savings. Apart from later regretting the loss of capabilities stemming from the deactivation of specialist facilities, other losses could occur which may also be later regretted - corporate knowledge, experience and expertise. These losses are not reflected on any balance sheet.

105. On the basis of the evidence presented to it the Committee is unable to endorse the deactivation of the Salisbury wind tunnel nor is it convinced that it should continue to operate. The Committee therefore believes the matter deserves to be considered further by independent experts in the fields of aerodynamics, engineering and financial analysis. The Committee is mindful of the stimulus provided to the development of an Australian defence aerodynamic research capability by ASTEC. An independent study, under the auspices of ASTEC, into the desirability of deactivating the Salisbury wind tunnel would allay any reservations which the Committee has.

Committee's Recommendation

106. An independent study of the desirability of deactivating the Salisbury S-1 wind tunnel should be carried out under the auspices of the Australian Science and Technology Council. Membership of the study panel should include experts in the fields of aerodynamics, engineering and financial analysis.

ENVIRONMENTAL AND SOCIAL IMPACT

Construction impact

107. Construction will be carried out on the AMRL site and Defence believes construction activity will not be disruptive to the local community. The upgrading of the facility is expected to generate short term employment within the Melbourne area because Defence envisage that a significant proportion of the cost of facilities will be expended locally.

Environmental

108. The AMRL site has no natural grassland, bushland or wildlife habitat. The soil profile comprises one metre of fill over natural silty sand. During the AMRL redevelopment project, examined by the Committee in 1990, some soil contamination was encountered at former CSIRO building locations. The Committee was assured by Defence that the environmental consequences of this contamination were subsequently addressed to the satisfaction of the Department of Health and the Environmental Protection Authority.

109. Defence also believe that since the proposal involves upgrading an existing facility, excavation required will be minimal and that contamination of the site should not be a hazard during construction. Should excavation be required, Defence propose to monitor all excavations for organic and inorganic chemical contaminants and radioactive contaminants in accordance with existing management plans.

110. Defence advised the Committee that blue asbestos was previously removed from the building but trace amounts may still exist. If asbestos is identified during the proposed works, it will be removed by licensed contractors in accordance with the requirements of the State Occupational Health and Safety Authority and in accordance with the Commonwealth Occupational Health and Safety (OH&S) Code of Practice. Defence should advise the Committee of the extent of any additional costs associated with removal of any residual asbestos discovered.

111. No hazardous substances will be generated by the wind tunnel during operations. Defence advised the Committee that an Environmental Certificate of Compliance has been issued for the proposed work with the following conditions applying:

- the refurbishment of the transonic wind tunnel will comply with Victorian Environment Protection Agency (EPA) noise guidelines
- the refurbishment is to comply with the Victorian Occupational Health and Safety Regulations.

112. Defence assured the Committee that the design of the facility and tunnel operating procedures will; ensure that noise levels conform with all EPA and OH&S requirements.

Heritage

113. There are no heritage classified buildings on the AMRL site nor is the site on Commonwealth or State heritage registers.

Child care

114. The Committee's report into the redevelopment of the Aeronautical Research Laboratory (ARL) site (10th report of 1990) recommended that ARL examine the need for and costs and benefits of providing a child care facility for its employees at Fishermens Bend.

115. In evidence to the present inquiry Defence advised the Committee that the study was concluded in 1991. Discussions with adjacent organisations revealed that there was no interest in establishing joint child care facilities. Investigation of the possibility of AMRL contributing to the operating costs of local council childcare facilities in consideration for additional priority places for the children of AMRL staff resulted in a negative response from staff. Staff considered their existing childcare arrangements preferable to those provided in nearby privately operated child minding centres due to cost.

CONSULTATIONS

116. Adjacent property owners, and organisations with an interest in the Fishermens Bend area were briefed on the project by Defence; these organisations included the City of Melbourne, the State Electricity Commission and the Port of Melbourne Authority.

117. Defence indicated that wind tunnel and other related DSTO staff at Melbourne and Salisbury were kept fully informed throughout the development of the upgrade proposal.

COST AND TIMING

Cost

118. The Limit of Cost estimate for the proposal is $12.7m at December 1993 prices.

Timing

119. Subject to required approvals it is planned that construction will commence in March 1995 with completion in September 1996.

Committee's Recommendation

120. The Committee recommends the upgrading of the transonic wind tunnel at the Defence Science and Technology Organisation's Aeronautical and Maritime Research Laboratory, Fishermens Bend, at a Limit of Cost estimate of $12.7 million at December 1993 prices.

CONCLUSIONS AND RECOMMENDATIONS

121. The Committee's conclusions and recommendations and the paragraph in the report to which each refers are set out below:

		Paragraph
1.	**For Australia to continue its self-reliant defence policy it is necessary for capabilities relying on aircraft and related airborne ordnance to be maintained and further developed.**	46
2.	**To maintain and develop these capabilities it is essential for Australia to have a modern transonic wind tunnel to provide data on aerodynamic loads of aircraft and stores, such as missiles, to permit their more efficient deployment and life extension.**	47
3.	**DSTO scientists and engineers and support personnel have the skills and expertise necessary to undertake aerodynamic research at international standards.**	48
4.	**Reliance on testing overseas would compromise local expertise and security.**	49
5.	**The existing transonic wind tunnel at Fishermens Bend suffers from small test section dimensions and inadequate flow simulation capability.**	50
6.	**Construction of a new and much larger wind tunnel to replace the existing facility would be expensive.**	51
7.	**Costs of providing a facility which is adequate for defence requirements would be reduced by the upgrading of the existing transonic wind tunnel at Fishermens Bend with complementary advances in computational fluid dynamics.**	52

8. There is a need for the transonic wind tunnel at Fishermens Bend to be upgraded by enlarging the test section and providing enhanced flow generation systems. 53

9. Expert advice obtained by DSTO confirmed the feasibility and practicalities of upgrading the transonic wind tunnel at Fishermens Bend. 91

10. The extent of the upgrading of various components of the wind tunnel has been the subject of extensive studies and consultation by DSTO. 92

11. DSTO is confident that the enhanced capabilities which the upgraded transonic wind tunnel will achieve are adequate for the longer term. 93

12. The design and certification of fire protection measures will be undertaken in accordance and consultation with relevant codes and authorities. 94

13. The proposed upgrading has the support of the Australian aerospace industry and the Australian Division of the Royal Aeronautical Society. 95

14. There is scope for the upgraded wind tunnel to be made available to the aerospace industry for research on a full cost recovery basis. 96

15. An independent study of the desirability of deactivating the Salisbury S-1 wind tunnel should be carried out under the auspices of the Australian Science and Technology Council. Membership of the study panel should include experts in the fields of aerodynamics, engineering and financial analysis. 106

16. **The Committee recommends the upgrading of the transonic wind tunnel at the Defence Science and Technology Organisation's Aeronautical and Maritime Research Laboratory, Fishermens Bend, at a Limit of Cost estimate of $12.7 million at December 1993 prices.** 120

Colin Hollis MP
Chairman

20 October 1994

APPENDIX A

WITNESSES

ACTON, Mr Stephen Joseph, Assistant Secretary, Automotive, Food, Metals and Engineering Union, 229 Greenhill Road, Dulwich, South Australia

HANCOCK, Mr Neil Ronald, Manager, Facilities and Property, Aeronautical and Maritime Research Laboratory, Defence Science and Technology Organisation, Department of Defence, 506 Lorimer Street, Fishermens Bend, Victoria

JERMEY, Mr Christopher, Delegate, Association of Professional Engineers, Scientists and Managers Australia, 11 Bagot Street, North Adelaide, South Australia

LOUGH, Dr Roger, Acting Director and Chief of Air Operations Division, Aeronautical and Maritime Research Laboratory, Defence Science and Technology Organisation, Department of Defence, 506 Lorimer Street, Fishermens Bend, Victoria

MARSH, Ms Roslyn Marion, Industrial Officer, Association of Professional Engineers, Scientists and Managers Australia, 11 Bagot Street, North Adelaide, South Australia

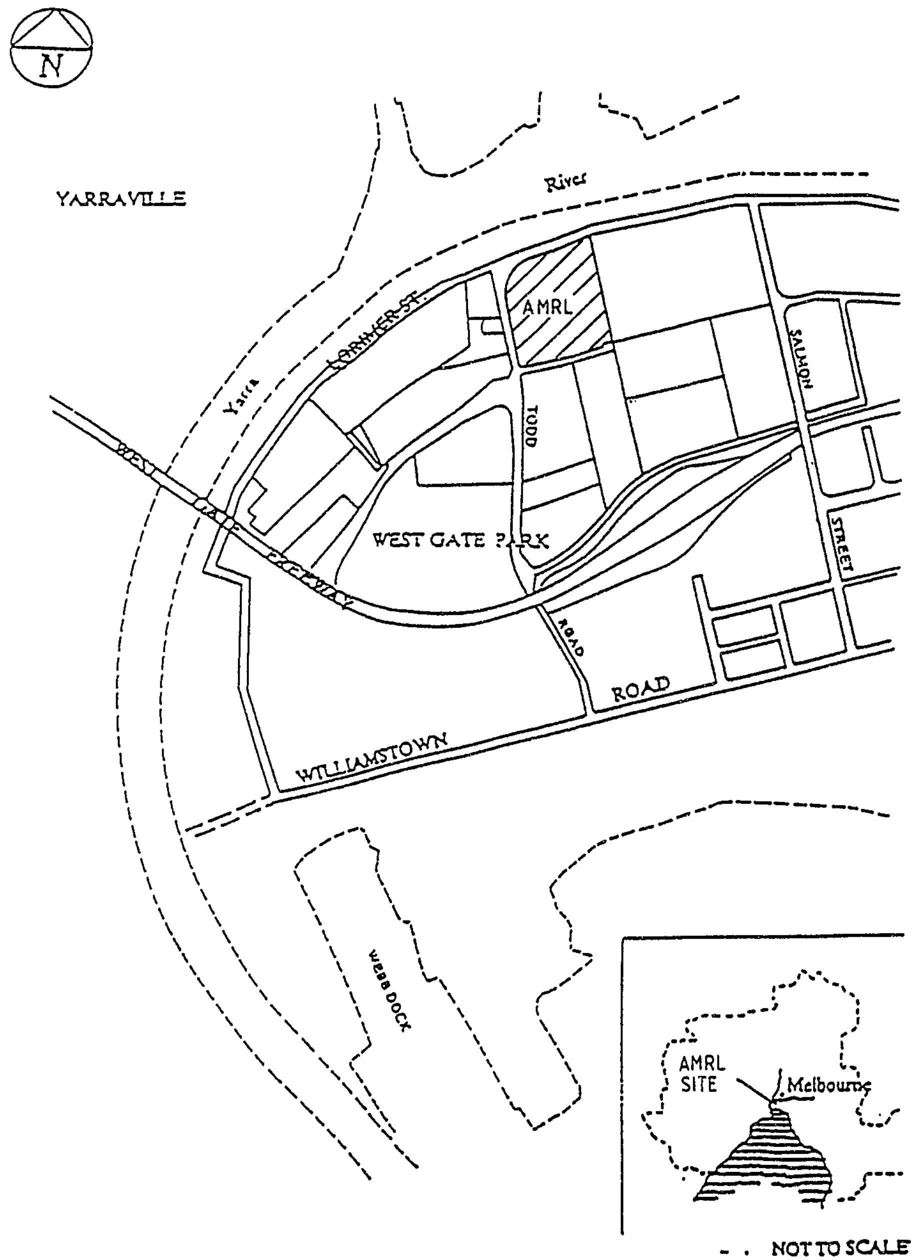
SHARP, Mr Peter Kenneth, Assistant Secretary, Science Corporate Management, Defence Science and Technology Organisation, Department of Defence, Anzac Park West Offices, Canberra, Australian Capital Territory

SPENCER, Jeffrey Mark Barnett, Delegate, Association of Professional Engineers, Scientists and Managers Australia, 11 Bagot Street, North Adelaide, South Australia

APPENDIX B

SITE LOCATION AND SCHEMATIC DIAGRAMS

Page



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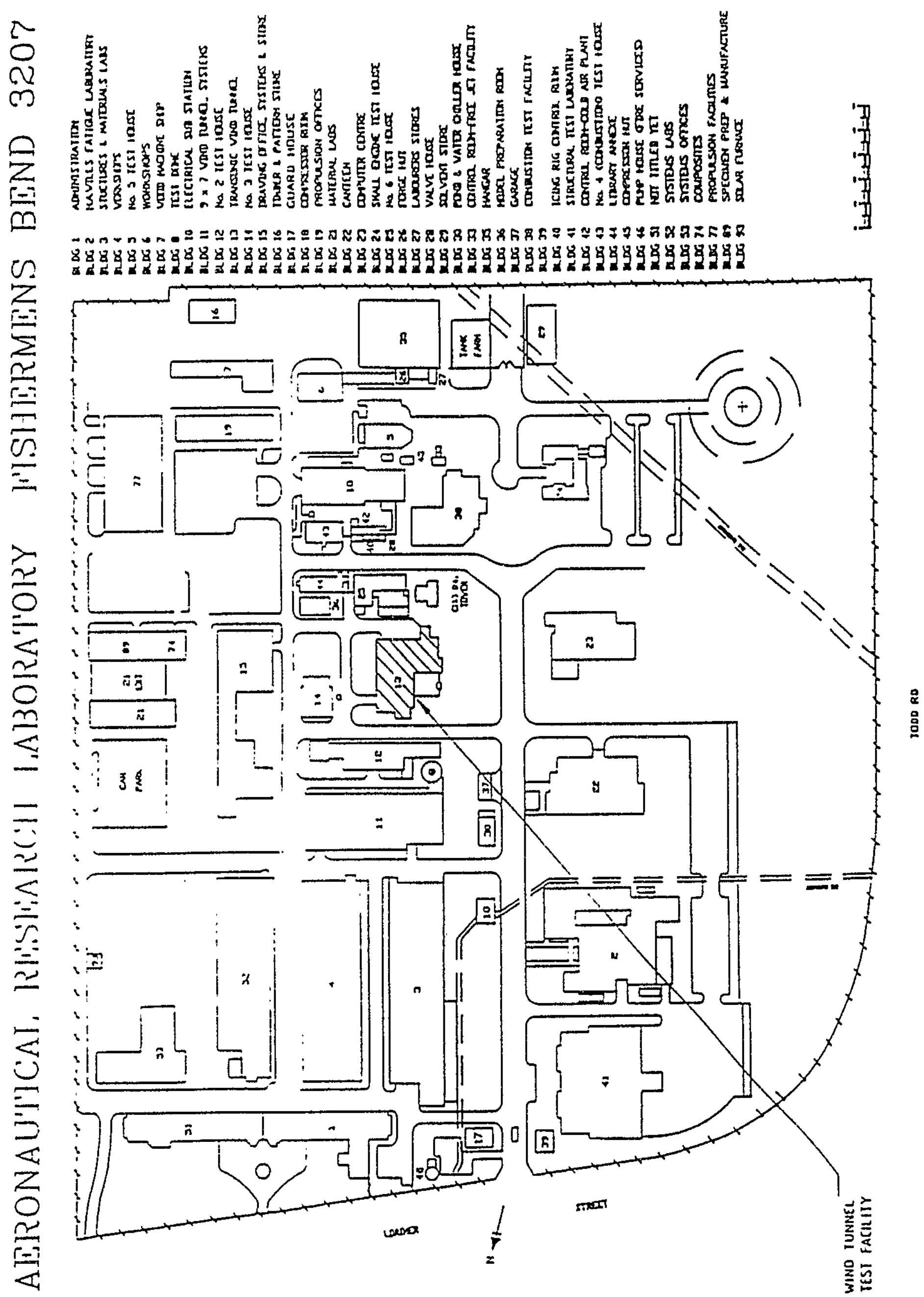
AMRL TRANSONIC WIND TUNNEL UPGRADE
SITE LOCATION DETAIL 1

B - 1



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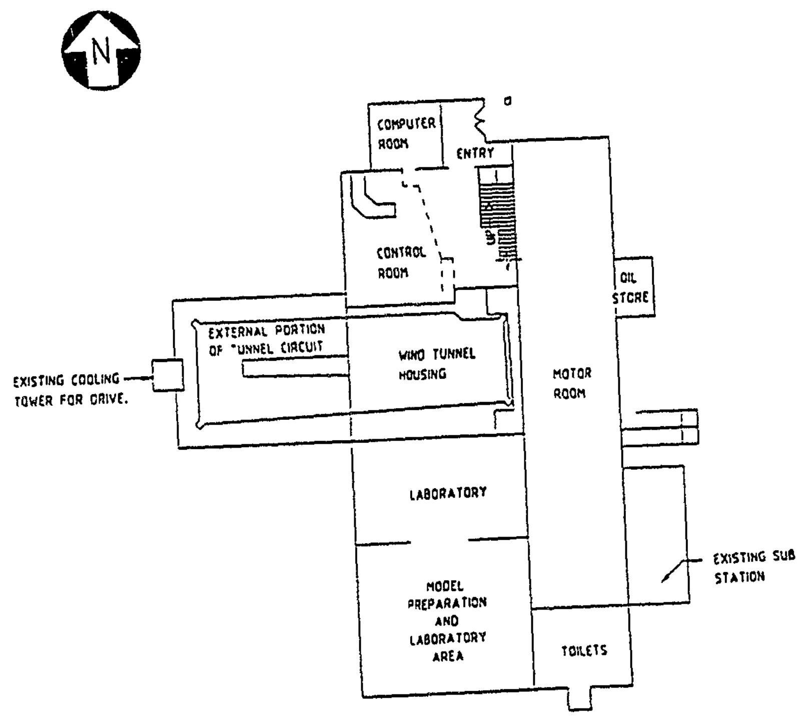
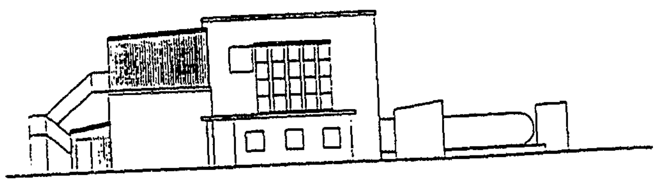
SITE LOCATION DETAIL 2

B - 2



LAYOUT OF EXISTING BUILDING CONTAINING THE TRANSONIC TUNNEL.



EXISTING NORTH ELEVATION

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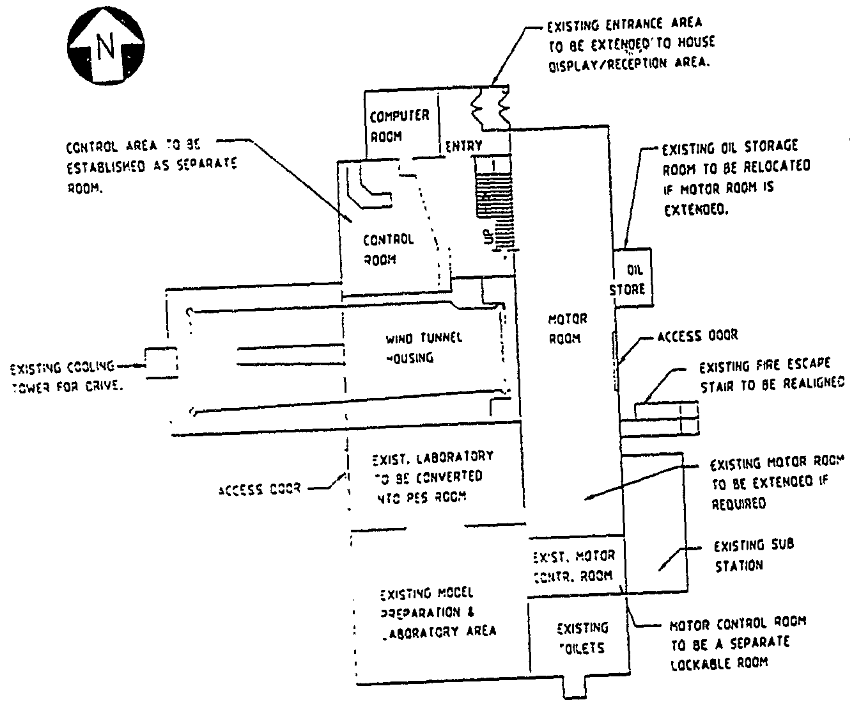
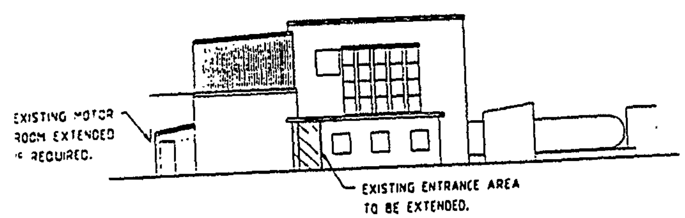


LAYOUT OF MODIFICATIONS TO BUILDING TO CONTAIN THE UPGRADED TRANSONIC TUNNEL



NORTH ELEVATION

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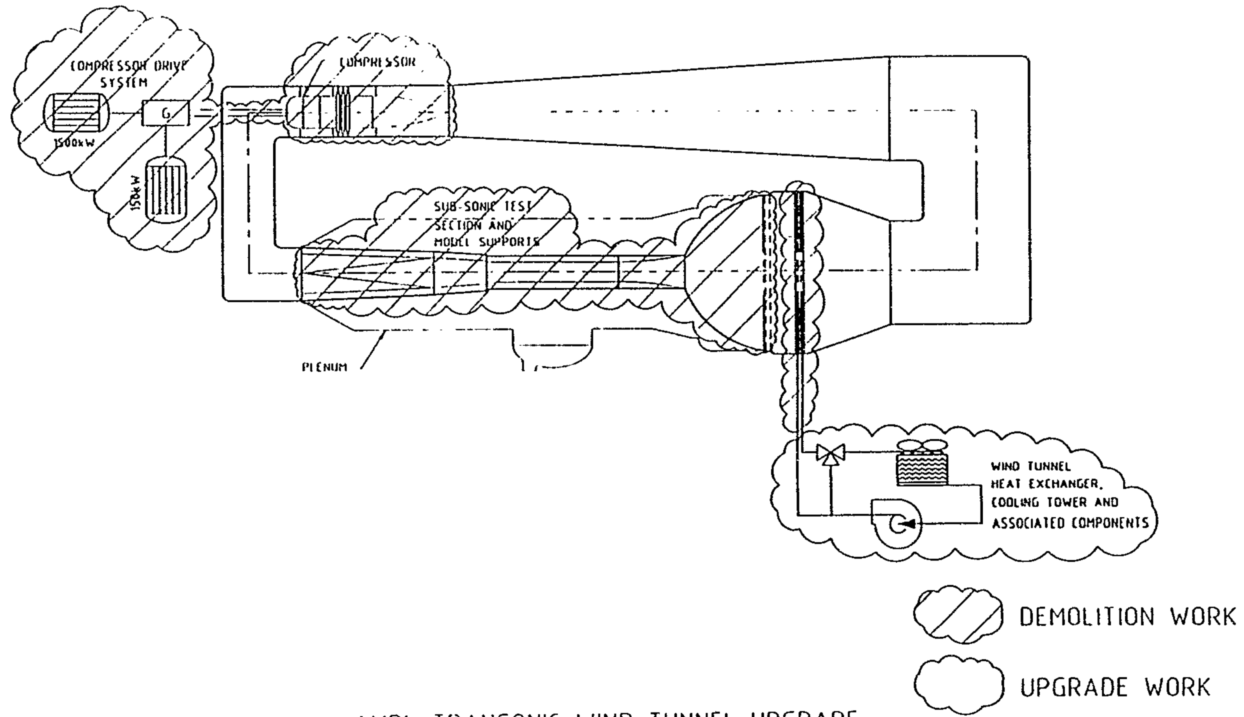
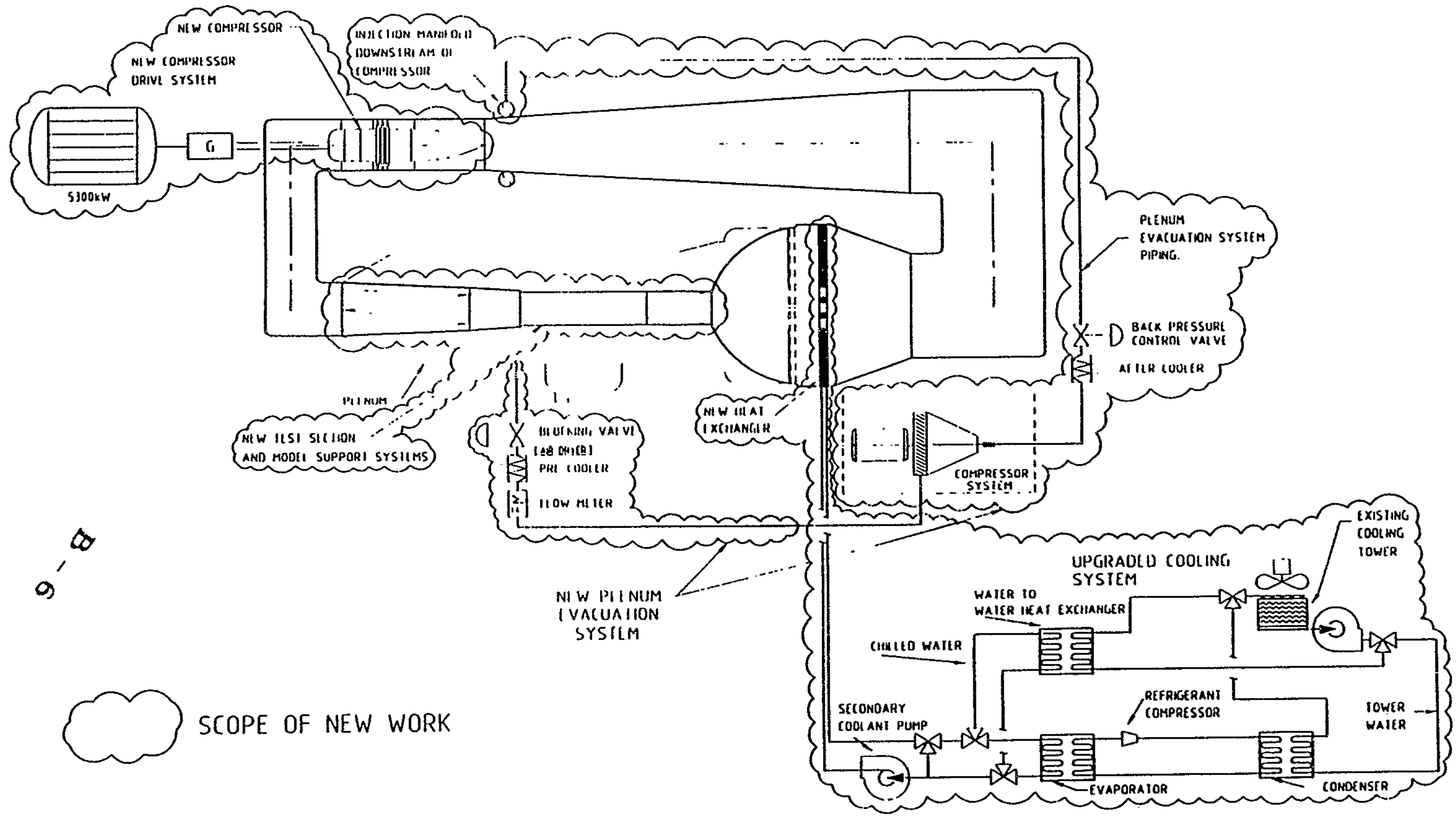


AMRI TRANSONIC WIND TUNNEL UPGRADE
BASIC SCOPE OF DEMOLITION WORK FOR THE MAIN COMPONENTS

29 06 94 14 53



AMRI TRANSONIC WIND TUNNEL UPGRADE
BASIC SCOPE OF PROPOSED UPGRADE WORK FOR THE MAIN TEST COMPONENTS

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