COMMONWEALTH OF AUSTRALIA

JOINT COMMITTEE

of

PUBLIC ACCOUNTS

Reference: Review of the Jindalee Operational Radar Network Project

CANBERRA

Friday, 29 November 1996

OFFICIAL HANSARD REPORT

CANBERRA

JOINT COMMITTEE OF PUBLIC ACCOUNTS

Members

Mr Somlyay (Chair)

Senator Crowley	Mr Anthony
Senator Macdonald	Mr Beddall
Senator Mackay	Mr Broadbent
Senator Watson	Mr Laurie Ferguson
Senator Woods	Mr Fitzgibbon
	Mr Georgiou
	Mr Griffin
	Mrs Stone
	Mr Vaile

The matter referred -

Review of reports of the Auditor-General.

WITNESSES

JOINT COMMITTEE OF PUBLIC ACCOUNTS

Jindalee operational radar network (JORN) project

CANBERRA

Friday, 29 November 1996

Present

Mr Somlyay (Chair)

Senator Gibson   Mr Beddall

                      Mr Georgiou

                      Mr Griffin

                      Mrs Stone

Observers

Australian National Audit Office	:	Mr R. McNally
Department of Finance	:	Mr J. Ryan

The committee met at 10.39 a.m.

Mr Somlyay took the chair.

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CHAIR—I now open today's public hearing, which is part of the inquiry being conducted by the Joint Committee of Public Accounts into the Jindalee operational radar network project. The inquiry was initiated in response to a report from the Commonwealth Auditor-General entitled, *Audit Report No. 28, 1995-96—The Jindalee Operational Radar Network Project, Department of Defence*. The report contains concerns about the management of the JORN project by the Department of Finance and the performance of the prime contractor, Telstra Corporation.

Today we will take evidence from a number of individuals and private sector organisations which have participated in the JORN project to some degree. We have as observers Mr Ray McNally, the auditor who conducted the original audit into JORN, and Mr John Ryan from the Department of Finance. When this meeting was arranged, the committee was unaware that the Senate would be sitting. I have been advised that the Senate will be passing a resolution which will retrospectively cover this meeting. The standing orders of the Senate prevent joint committees having public hearings when the Senate is sitting. We are waiting for that resolution to come through from the Senate.

I would like to remind the witnesses that the hearings today are legal proceedings of the parliament and warrant the same respect as the proceedings of the House itself. The giving of false or misleading evidence is a serious matter and may be regarded as a contempt of the parliament. The evidence given today will be recorded by *Hansard* and will attract parliamentary privilege. I refer any members of the press who are present to a committee statement about the broadcasting of proceedings. In particular, I draw the media's attention to the need to report fairly and accurately the proceedings of the committee. Copies of the committee statement are available from secretariat staff present at this hearing.

BARDO, Dr William Stanley, Technical Director, GEC-Marconi, The Grove, Warren Lane, Stanmore, Middlesex, HA7 4LY, United Kingdom

MATHEWS, Mr Raymond Reginald, Major Project Director (JORN), GEC-Marconi Radar and Defence Systems, Eastwood House, Glebe Road, Chelmsford, Essex CM1-1QW, United Kingdom

SHARP, Mr Ian John, General Manager, GEC-Marconi Systems Pty Ltd, Faraday Park, Railway Road, Meadowbank, New South Wales 2114

CHAIR—Welcome. From the committee's perspective, the main purpose of this session is to examine the role GEC-Marconi has played in the JORN project to date and its likely future. Does GEC-Marconi wish to make a brief opening statement to the committee before we proceed?

Mr Sharp—If we could.

CHAIR—Please proceed.

Mr Sharp—As you are aware, I am supported today by Mr Ray Mathews, who is the project director for JORN, and Dr Bill Bardo, the corporate technical director for Marconi, who has had a long involvement on the JORN program and also was instrumental in the development of the technology for this program. On behalf of GEC-Marconi, I would like to thank the committee for providing Marconi with the opportunity of presenting our position on the JORN project and our involvement in the project to date and in the future.

Typically, the JORN project has over the last years had some 400 people working on the project—managers, engineers, technicians and so forth. The balance of this work has been flowing between the UK and Australia, dependent on the work scope of the project at the time. Initial system engineering, in which Marconi was involved, was conducted principally in Australia. We would have had 150-odd people out here in the early parts of the program. The work balance then progressed to the UK, where Marconi was involved in developing specific products such as transmitters and receivers, and this work is just coming to a conclusion at the moment in the UK. Dr Bardo will elaborate in a minute on what we are doing at the moment.

Currently in Australia we have just on 100 engineers and technicians working on the project, developing test equipment and the like, which will allow Marconi to build equipment at the moment and also support the JORN project and technology through its life.

GEC-Marconi Systems Pty Ltd has just recently completed the manufacture of 20 high powered amplifiers for the project, which is essentially the engine to the JORN

program. We are currently gearing up to manufacture a minimum of 200 front-end receivers in country, plus other smaller items. This is all part of Marconi's undertaking to achieve the described level of Australian industry involvements. We are also gearing up at the moment to undertake the installation, integration and testing phase of the program which will commence in earnest in the first part of next year.

Marconi has reviewed the ANAO's report and in our submission we have addressed each of the recommendations as we see it involving the company. I would just like to take the opportunity of acknowledging that recommendation No. 16, in reference to intellectual property, had a direct reference to Marconi. I believe at the moment that Marconi has a proposal in with the Commonwealth where we have agreed the content of licences for the control of intellectual property. I believe there is no further work to be done and the IP issue should be resolved.

I will ask Dr Bardo to address very briefly the technical position on the project at the moment and then Mr Mathews to talk about the project management issues of the project at the moment and how we are moving forward.

Dr Bardo—The technical aspects of the program are extremely demanding. Briefly, the receiver is the best in the world. The Commonwealth is most anxious that the ability of the radar receiver to detect the tiniest signals should not be limited by generation of internal noise. They wanted it to be limited only by the background noise from atmospheric sources et cetera. This has proved most demanding, but we have solved the problem. We believe that the design aspects of that are now concluded and we are just about to put it into production.

The transmitter was required to be extremely flexible to be able to transmit over a wide range of frequencies at will. The beam is steered, so from moment to moment the radar has to choose a frequency—steer to a different direction. In the most extreme cases we are required, in a matter of hundredths of a second, to set the radar up for a new beam direction, a new frequency, a new waveform. We have to be satisfied in those few hundredths of a second that the choice of the parameters is going to be right. It has all proved extremely demanding.

In the process of developing the transmitter we have devised entirely new waveforms that concentrate the energy to an unprecedented degree within a restricted bandwidth to avoid interference with other systems. The characteristics of the waveform are extremely useful for detecting the targets.

We switched, at an early stage in our design, from what is called an analog design to a digital design. The significance of this is that the transmitter is controlled very flexibly by software, giving great freedom of choice in the use of the radar. That design was concluded and, in fact, GEC-Marconi in Sydney has recently manufactured 20 of the high powered amplifiers and we are just finishing off their design for the complex drive

for it.

We are satisfied that the major technical problems have been overcome and all the major contract requirements are met or exceeded, and we are now in the late stages of finishing off the design and, in some cases, going into production.

As part of our risk management we have recently concluded in the UK some tests of a number of the systems operating together to test out this idea of being able to set up the radar very rapidly to give this very flexible operation. It was very successful. The material is now being shipped to Alice Springs for another stage of prototyping. All this is aimed at reducing the risk so that the chance of problems in the system's integration stage in the main radar sites is minimised. As you can imagine, the problems of providing design support at those sites are really quite difficult.

Mr Mathews—I wonder if I might just take two or three more minutes of the committee's time just to give an overview from the project management perspective of the program to date and a little view about what we are doing for the future. Clearly, the JORN program has suffered substantial delays and our part of the program has been part of that delay process. The reasons are varied. Clearly, as Dr Bardo has just described, we do face a remarkably complex and technically challenging development program and almost inevitably some aspects of that program have taken a lot longer than was originally planned. It is regrettable, but seen on many other programs.

We have also suffered other problems which from the management point of view have hindered the progress of the contract, one example of which is the structure of the contract that Marconi formed with Telstra at the beginning of the development contract. It led to the construct that we formulated. It led to a particularly complicated relationship between the two companies with many complex and interdependent interfaces, both technical interfaces and management interfaces. Whilst at the beginning of the program that may have looked very sensible—and indeed it did or else we would not have gone ahead—as time went by the complexity of those interfaces began to interfere with the efficiency of the development process in the project.

Sometime last year it was recognised that that particular mechanism was not helping the program to advance and there was a reorganisation of the relationship between ourselves and Telstra and indeed the work scope that Marconi would perform from then on in. The objective was to simplify substantially the interfaces between Telstra and Marconi and give Marconi a well-bounded, unambiguously defined development and supply task. Essentially, as we refer to in our submission, that was a cradle to grave responsibility. In other words as a result of that reorganisation we were given responsibility for two of the major radar subsystems—the transmit and receive subsystems—from design through to development, production and support. That is what we mean by cradle to grave—total responsibility for those.

That rescoping, the definition of that and the amendment to the subcontract that we have to accommodate that rescoping has actually been the content of discussions with Telstra throughout this year and a lot of progress has been made. We are coming to the close of those discussions and we would anticipate perhaps completing that process in January of 1997. For the moment, that probably is just an overview from us and we would invite you to ask your questions.

CHAIR—In your submission you suggest that the defence requirements in terms of both value and quality of work carried out in Australia cause complexity and tension in the interface between Telstra and GEC-Marconi. What requirements were you referring to?

Mr Mathews—The particular ones we were referring to there was the need quite rightly to retain within Australia high quality technical and managerial work. The contract relationship that we formed with Telstra at that time was aimed at trying to satisfy that requirement. There is nothing wrong with the requirement. Clearly, it is a laudable requirement. Our interpretation of it and the construct that we arrived at—as I said in the opening brief—at the time was clearly judged to be sensible and clearly judged to meet those requirements. In practice however, as the project continued, it did seem to become less and less practical in terms of an efficient working process.

Mr GRIFFIN—Why did it take so long to establish that that in fact was the case?

Mr Mathews—How long it took is a relative thing. Clearly on both sides—both Telstra and Marconi—there was a tremendous commitment to actually making this program work. Clearly there was no intent to work in this rather complex environment come what may. I think the commitment from both companies to actually make that construct work to the benefit of the JORN program was probably the driving force. If it is judged that that caused it to go on too long, then I suspect so be it. But I think there was tremendous effort and commitment just trying to make that work and a lot of lessons for the future.

Mr GRIFFIN—I would bear that in mind, but to look at it in terms of the time frame we are talking about a situation where the first operation of the contract occurred how many years ago now?

Mr Mathews—It was 1991.

Mr GRIFFIN—We are talking about a situation where discussion started to occur in early 1996 around the question of reconstructing it—or was that in late 1995?

Mr Mathews—It was about mid-1995.

Mr GRIFFIN—So we are talking about up to 4½ years before it was established that that was a real problem, and people got their minds around it and started to resolve it.

Mr Mathews—It was three to 3½ years, but not three to 3½ years of just blindly trying to work in that construct. There were several attempts to improve the interfaces between the two companies and there were at least two re-scopes—and I am looking to Bill to confirm that for me. There were two attempts to re-scope the work in order to simplify the process that both companies went through. So it was not a problem that was left for three years, in that sense; it was a problem that was identified by the management teams in both companies and attempts were made to solve it. It was only at the end of the three-year period that it was decided that it was time to stand back and really take a hard, critical look at the construct.

Dr Bardo—If I may comment, I think the recognition began in about 1993. There were some modifications to the share between us to cut down the number of interfaces that were complicating the systems engineering. At the beginning of last year we contemplated a joint venture program between us and undertook a detailed audit at that point. Then it was decided that we would not proceed with a joint venture together, we would retain the prime subrelationship but have a much tidier relationship where we took the responsibility for complete transmitter systems and most of the receiver systems, and we assumed the responsibility that Telstra previously had for the stages of installation, integration and test—a much more satisfactory arrangement.

Mr BEDDALL—How much of a challenge was it that a fair bit of the work on the transmitters in particular had taken place in the UK and the project was here? Was that a contributing factor to the delay? What proportions were done in Australia and in the UK, and what was the relationship between GEC-Marconi Australia and GEC-Marconi UK?

Dr Bardo—In the early years the majority of the design work was conducted in Australia with people from the United Kingdom and people from our company here. What has happened now is that we are moving into the phase of developing the actual hardware and the majority of the effort has switched back to the UK. It will switch back to Australia in the next few months for the installation and integration tests. There has already been the effort in transferring manufacturing operations to Sydney. We have produced 20 of the HPAs and there will be a minimum 200 receivers manufactured in Australia.

Mr GEORGIOU—You have spoken about Marconi and how they will be taking over more responsibilities. What responsibilities did you actually give back to Telstra that you had assumed yourselves in the original contract?

Dr Bardo—We had a complex sharing of the design task and the system responsibility for what is called the surveillance segment, the responsibility for the radar. At one stage we transferred the full responsibility for the control centre work to Telstra. In this latest phase what we have done is concentrate on the two components of the radar, and Telstra assumes the overall design responsibility for the radar, the higher levels of the surveillance segment and the higher level of the full network that constituted the major

share originally.

Mr GEORGIOU—Can you make a judgment about whether or not you are bearing more or less of the burden of the project right now than the one you contracted for?

Dr Bardo—It is a bit difficult to make that judgment. It is a different burden—it is concentrating more on the actual detailed design of the elements of the radar.

Mr GEORGIOU—Was the shift in responsibilities accompanied by any adjustment in price?

Dr Bardo—Yes; there has been quite a shuffling of different work scope from one to the other.

Mr GEORGIOU—Can you tell us about that in terms of money?

Mr Mathews—I would be more than happy to answer the question but I am just slightly worried that we are answering that question in a public forum. We would be delighted to answer it in a private forum. We have explained our reasons to you for having that sensitivity.

CHAIR—We will come back to that issue and maybe we will go in camera.

Mr Mathews—Thank you.

Mr GEORGIOU—You spoke about an equivalent or a very strong commitment shared by yourselves and Telstra to the project. Can you describe how you and Telstra mutually perceived the project when you first entered into the contract, or entered into the work?

Mr Mathews—The perception of the contract when bid and when the development contract was let was clearly of a contract which had technical high risk which was going to be demanding of, as Dr Bardo referred to earlier, innovative techniques to make the solution work. However, there had been sufficient work done to actually make that level of risk acceptable. It is what we would call today a medium to high risk project, which is fine and both Telstra and ourselves were prepared to take on that risk.

We identified those risks as best we could at the beginning. A lot of work was done to try to identify risks, the magnitude of the risks and the likely impact on the program that they would have. In truth, and on other programs as well, it clearly is almost impossible to predict every risk in a program. There were some things that happened that surprised us and surprised Telstra by way of technical problems that we had not anticipated. That came out of the very nature of, as we said earlier, the extremely

demanding technical specification for this particular product.

Mr GEORGIOU—Would you say that in the event Telstra ended up carrying more of the burden than you did from this idealistic beginning, through the project, once you started hitting technical problems and specifications which you found very difficult to meet?

Mr Mathews—I find it very difficult to measure the relative—

Mr GEORGIOU—Give us a feel.

Mr Mathews—Telstra was/is the prime contractor and so the question is more appropriately aimed at them, but I will offer a view. I suspect that because they were the prime contractor for this total network that the burden, however we may define that, for them might have been greater.

Dr Bardo—I do not think they have assumed any more technical risk for the actual development of the radar system. Together we were sharing some risk for the higher levels of the system. But, of course, we were present with them for a long time actually doing a large part of that system design. It is really a tidying up operation. Of course, there was an interest right from the start in having as much of the software effort under Australian control. Hence the construction of the contract with a large amount of the software going into the Telstar organisation.

Mr GEORGIOU—Once you started hitting technical difficulties did Telstra bear more of the financial burden or take more of the responsibility than was jointly assumed at the outset of the project?

Dr Bardo—If you are asking were we turning to Telstra to transfer some of the technical difficulties to them, I do not think that is true.

Mr GEORGIOU—What about financial burdens?

Dr Bardo—That is difficult to answer.

Mr Mathews—I am not sure I understand the question.

Mr GEORGIOU—Dr Bardo does.

Dr Bardo—We are unravelling a quite complicated interrelationship here, trying to make it simpler, and the money follows the work scope.

Mr GEORGIOU—Thank you.

Mr GRIFFIN—With these difficulties around the operation of the contract, did Defence alert you to concerns that they had, or did they make any attempt to try to assist or facilitate any adjustment between Telstra and yourselves with respect to the operation of the contract, or did they have no role at all?

Dr Bardo—From 1993 onwards, I think the three parties recognised that there was a difficulty there. Of course, there was a calculation then of the balance of the advantage: was the balance of advantage in devoting a fair amount of managerial effort in parallel with continuing technical effort to change the scope of the contracts? And would that be worth doing to gain an ultimate advantage? There was a period of debate running in parallel with a continuing action. I think it is worth making the point that the project was envisaged right from the start as involving a fair degree of research and development. It was seen as comparatively high risk and so the construction of a contract was this concept of moving through a cost-sharing arrangement until you hit the ceiling where the contractors then bear the burden.

Mr BEDDALL—In that regard, we talked about it being almost six years before the real problems arose—I mean, the project started in 1987 and you said it was looked at again in 1993. Are you confident that the now completion date of 2001 can be met?

Dr Bardo—Yes, I think so. I think the project actually started in 1991.

Mr BEDDALL—I thought it was 1987 that GEC-Marconi awarded a contract to upgrade equipment.

CHAIR—That was the Jindalee project.

Mrs STONE—You talked about twelve months ago and looking at the contracts and their relationships and so on. In January this year Telstra imposed penalty rates for lateness of delivery, as specified. That is obviously part of a risk management strategy but you said in response to an earlier question that you would have done things differently at the beginning if you had known what you know now about the whole project. What would you have done differently in terms of the project management and the relationships between the various agencies? Would this penalty rate have been something that you would have agreed to earlier on?

Mr Mathews—To answer the first part of your question, 'what would we have done then with what we know now', the simple answer is that we would have done what we have just done in January of this year with Telstra and that is to negotiate a much more sensible and practical share of work for both Marconi and for Telstra. The concept of us now developing two major subsystems, and being responsible for all aspects of those subsystems and everything within it, and their performance totally within Marconi is a much more normal construct within this industry, certainly, and I suspect others. We would clearly now avoid the complex technical, managerial and contractual interfaces that

we set up at the beginning. It was a little ambitious. We at Marconi have suffered that problem since and with one or two other programs in Europe. It is very easy to be wise after the event but the answer to your question is that we would do what we have just done, in order to give this project the maximum chance of succeeding. Incidentally, we firmly believe it will succeed.

Mrs STONE—Was there sufficient information back in 1991 to put the same sort of arrangement in place as you have now? Given the information you had, would you have come to the same conclusion? Or was it only possible to get to this, as you said, more sensible arrangement, after five or six years of work?

Dr Bardo—It would be hard to make judgments about accepting liquidated damages in the state of ignorance you would be in right at the beginning of such a contract. The ideal structure for this sort of risky project is to have some kind of cost-sharing arrangement for a period of time until all parties are satisfied that they understand the risk pretty well, and then negotiate a harder contract, perhaps fixed price or some variance of that, with incentives and penalties when you know the task is relatively straightforward.

The structure of this contract, as I said, was really quite complicated. We produced a pretty complicated structure to deal with the issues of technology transfer and work content. We had to adjust that from time to time. For example, there was a large amount of work content to be done on some complex printed circuit boards for the American processors. That was planned and then had to be aborted because there was not a suitable facility in Australia to make that. We have had to make adjustments by compensating and putting other work here.

No program these days is nice and straightforward in terms of a neat systems engineering solution. There is always a compromise. On our European programs, there is also a penalty to be paid for the cost sharing and the cooperation across Europe. You move away from an ideal systems engineering solution in order to do work in a variety of countries. We have got cases where we have hit engineering problems because a particular piece of work has gone from Britain, to Germany, to Italy, to Spain and back to Britain. There is always a balance. These factors tend to be lost later when programs stretch out in schedule and cost.

In this particular case, it has been clear that people did not want to sacrifice performance for schedule. People would prefer us to struggle on to meet those ultimate requirements at the risk of losing schedule and cost. Of course, ultimately, it is a penalty to the contractor. We have to make a judgment whether we call a halt at some stage and say it is just getting too expensive for us. Had we had penalties imposed earlier, we might have called a halt earlier and said, 'We are struggling, we are taking time, and it is costing us a lot more than we expected, so we will call a halt here.' But we persevered to get the solutions.

Mr GEORGIOU—Were you in any way uncertain about the performance demands of the amplifiers and the receivers? When you engaged in the contract, somehow were the demands that would be made on the amplifiers and the receivers not clear?

Dr Bardo—In a complex program like this, of course, you do not have all the answers until you have done some of the work. It is impossible to do a year or so of preparatory work to make a bid and get all the answers. You actually take several years doing the design, so you have a pretty good idea. Companies survive and prosper or fail on their ability to bid for such complex programs. It is the nature of our business that we are always tackling state-of-the-art requirements. So we had a fairly good idea of what was achievable and what was not. In the end, some areas where we thought we would not encounter too much difficulty proved very difficult. In other areas, we more than exceeded the expectations of the Commonwealth scientists.

Mr GEORGIOU—Could you specify which areas were particularly problematic?

Dr Bardo—Designs for this receiver, as I mentioned, are very demanding. We have pursued several routes and had to retreat and try another technique to ring out the last ounce of performance because we had had to hold down, technically, the phase noise, the production of spurious signals from its internal workings and so on, and that has taken a lot of effort.

Making the high-power amplifiers adjust to the right power levels in, as I mentioned, a few hundredths of a second has proven very demanding. We had to change the output transistors, and obtain them from a different subcontractor at once stage, which has a penalty of some time and cost.

Mr GEORGIOU—Were the amplifiers and receivers the critical reason for the delays in the project?

Dr Bardo—There were difficulties also in actually doing the systems engineering. Systems engineering is an iterative process. You do not have a neat, top-down derivation from the requirements. You also look at what equipment you might have available and you converge on a solution. You have a number of iterations. Quite often, when you are deriving the systems engineering, you discover that you were not aware of all the requirements so you have to go back to your prime contractor and your ultimate customer and say, 'We need to clarify these requirements.'

Senator GIBSON—I have a few questions about the management of the project. They are actually out of the Australian National Audit Office report. On page 12, to do with risk abatement plans, it said:

The contract calls for Telstra to produce Risk Abatement Plans for all high and medium risks. Risk Abatement Plans are the principal management documents arising from the risk management process.

Telstra identified the need for only 14 Risk Abatement Plans, and in the event provided JPO with only three.

Why was this, from your point of view?

Mr Mathews—I am not sure that we can answer that.

Senator GIBSON—But surely, as a prime subcontractor to Telstra, you must have been involved in the management of the project, first of all, in identifying how many abatement plans were required, and apparently only 14 were identified. Why were only three produced?

Mr Mathews—I can try to answer that. The Marconi program had its own risk register which is a document which identifies in some order of priority the risks in the program. So, for the Marconi program, we have that risk register and, at regular periods once a month through the program, we review technically progress against those risks and against the risk abatement plans. We report the results of that risk management process to the prime contractor, to Telstra, once a quarter, and then Telstra will report that on to Defence. That is the process, as I understand it. So our output, which is the result of a review of the risk in the Marconi program, goes to Telstra.

Dr Bardo—May I make a general point: there is an asymmetry here. The Commonwealth and Telstra will have very detailed knowledge of what we do. Because we are a subcontractor, we do not have a full view of Telstra's full scope of work.

Senator GIBSON—I understand that. I just thought that, surely, as a major subcontractor, you would have a view about why these risk abatement plans were not produced.

Mr Mathews—I do not think that we can have that view, to be honest. I suggest that the question is directed better at Telstra.

Senator GIBSON—Okay. Thank you. In the middle of page 27 of the audit office report there are quotations from the project internal technical audit. It says:

This will lead to massive problems during the systems integration and potential failure of JORN to achieve its many performance goals, or require rework of an unknown number of hardware and software CIs.

Is that not signalling basically that there are huge problems still to be overcome to complete this project? Do you agree with that comment?

Dr Bardo—I will make two points: you are, perhaps, assuming that we have this technical audit report. We do not have the full report. We contributed to it but then Telstra decided that it did not want to proceed with the JV that had led to this technical audit.

The full audit report was not issued to us in those circumstances. We had a presentation on the overall aspects of it and, of course, we had some views of it from our people who contributed to the various teams.

Looking at that, we can say that, yes, if you have parts of the systems engineering missing at the top level, there are possibly going to be problems. Indeed, the plan was—and I think still is—from Telstra that with this new contract arrangement constructed, we would provide some people to help them man a team which would do a so-called second systems engineering pass from top to bottom and bottom to top to try to sweep up possible gaps in the systems engineering. At the moment, we are proceeding on the basis that there would not be expected to be very much change to the physical elements we are producing. There might be some changes in interfaces and some software interconnections, but it should not make much difference to our scope of work.

Senator GIBSON—Can I just ask again, there is a quote here, 'massive problems expected during the systems integration phase and potential failure to achieve its many goals'.

Mr Mathews—Can I respond to that. The 'massive problems', it is a sort of judgmental term. Clearly when integrating any complex piece of electronics, and this radar is a complex piece of electronics, as we said before, there are always problems of getting all of those components to work together. The Marconi program, and I can really only talk from the level of the Marconi program, but for both the receive subsystem and the transmit subsystem we recognise that potentially there are problems when we come to put these systems together. So the risk abatement plan, if you like, we are following for this particular risk, because that is what it is, as you rightly identified, is to build completely within the UK, first of all, a complete receive subsystem and a complete transmit subsystem to find out where those problems are. I do not like the term 'massive problems', but there will be technical problems with integration and we will iron out as many of those as we can in the UK before we transit both the transmit and receive subsystem over to Australia for integration at both of the sites here. That is the risk abatement plan and our best known method of reducing the potential problems coming out of that, but I am talking just from the radar level.

Dr Bardo—There are bound to be some system integration problems at our level and above our level. I think this quotation is mainly concerned with the whole operation of tasking the two major radar sites for a particular operational task. We are pretty confident that, although we will hit problems in integrating the physical elements of the radar and commanding them locally, they will function as radars. The next level of difficulty will be tasking two radars separately or together, and I suspect this quotation is about satisfying all of the possible requirements there might be to operate these radars in the various modes.

Mr Mathews—Indeed, the entire network is perhaps where this comment is—

Senator GIBSON—Doesn't this imply that there is still very substantial cost going to be required to complete this integration process?

Mr Mathews—Yes, it is a costly exercise to go through this, not just the integration but the installation of these systems in the designated sites. It is an expensive exercise. We believe that we have planned the program sufficiently well to be able to cope with that.

Senator GIBSON—Do you believe as a subcontractor that you have a firm handle on your costs through to the end of the project?

Mr Mathews—Yes, we do. In terms of our internal planning for costs, we have a program which is a complex program that, if you like, lists every activity we have got to do between now and the end of our part of the program. Alongside that we have resourced costs and manpower, so we believe that our estimating base is adequate for that.

Senator GIBSON—Can I turn to another page of the report, page 35, top of the page, another quotation from the contractor's technical audit report:

Lack of discipline, predominantly within Telstra, in conducting the systems engineering process has led to the network design and its interfaces as well as the management of documents being out of control within the project.

As major subcontractor, what is your comment on that?

Dr Bardo—I think Telstra faced a daunting task. They are not experienced in conducting a military project of this type before. I think that is partly the idea of involving us in some of the previous contractual arrangements. Documentation has been a particular issue. A large number of US military specifications were called up. One thing you have to do with those specs is, at the beginning you have to tailor those, otherwise you get buried in documentation that you are never going to read. Indeed, there has been discussion between us and Telstra and DoD about that issue of a large percentage of engineers' time taken up in producing documentation that we doubted was going to contribute a great deal of value. As a result, there has been a degree of tailoring to reduce that.

I think part of the difficulty with this project is that it is partly a learning experience on a very complex project as well as undertaking the engineering task.

Mrs STONE—A learning experience for whom?

Dr Bardo—A learning experience for Telstra, and to some extent for DoD I think, and in some aspects for us.

Mrs STONE—So you are saying for all parties.

Dr Bardo—Yes.

Mr BEDDALL—Just on the cost of the exercises, just refresh me about what the basis is of payment from Telstra to GEC-Marconi—is it milestones or earned value? How much has been paid to GEC-Marconi and how much is still outstanding?

Mr Mathews—The first part of the question I can answer. We are paid against achievement of milestones in the program. We report cost to Telstra through the standard CS^2 system. As far as how much we have been paid, could I just repeat the request of earlier that we could do that in a private forum. We would appreciate that.

Senator GIBSON—Can I go back on the overall management of the project: again referring to comments in the audit office report on page 18, and not knowing anything much about it personally, I get the impression that what is being really hinted at there is that there is uncertainty as to whether the project can be completed. Secondly, there are queries about when it can be completed, and at what cost.

On behalf of the taxpayers, it seems to me that a lot of the money has been spent—some 80 per cent—and all we can see is 20 per cent of the product, if you like. There is a lot of evidence that there is a hell of a lot more work still to be done and evidence that there is a hell of a lot more software to be written. I had someone quoting to me $500 to $700 per line of software, and some huge number of lines still to go—maybe estimates of many hundreds of millions of dollars still to go. Does this not look like a bit of a financial disaster?

CHAIR—I think we can ask that in camera.

Senator GIBSON—Okay, that is fine.

Mr GEORGIOU—I just want one explanation. On page 2 of your submission, in the second paragraph, you say:

GEC-Marconi agree that the proper and timely analysis and flow down of such requirements to the lower levels is a key factor in the subsequent design work. This task should have been one of the foremost priorities.

It was not. Could you just elaborate on that a bit and start putting names to who should have done this, when it should have been done, why it was not done, and what the consequences of it not having been done were.

Dr Bardo—The prime responsibility for the topmost levels of the project, network level, rests with Telstra. There is a risk, if there is incomplete flow down from those top levels, that some—

Mr GEORGIOU—Can I make a plea for more basic English just for my sake. The top levels, flow down et cetera—can you just break that up for us a bit—unpack it?

Dr Bardo—What the flow down means is that you take the requirements of the topmost level and you derive from logic what the implication is at the lower levels, and you then proceed in more and more detail down to elements of software and hardware that in combination will meet that topmost requirement. As I said, it is not a simple process, it is an iterative process, and you proceed from the bottom as well, taking what you think you have got or you can achieve in terms of hardware performance.

Mr GEORGIOU—So were the topmost specifications from Defence or from Telstra?

Dr Bardo—The way that works is that Defence specifies the capability they want and the prime contractor derives the requirements and parcels those out to various subcontractors. In this case it is bit complicated because there was not a smooth hierarchal flow down from Telstra to another layer to Marconi. Marconi started at a lower level and worked together with Telstra at the lower levels.

I think Telstra have had to satisfy themselves, together with DoD, that those network specifications were actually consistent with specifications that were also provided in their requirement by DoD, referring to equipment to make sure there is no inconsistency between those. I think the reference here is to the fact that that was not complete and is possibly still not complete. This was going to be an important aspect of the second systems engineering review.

Mr GEORGIOU—Can you explain more fully what it is that may still not be complete, because it went right by me?

Dr Bardo—What may not be complete is a recognition of all the implications of the topmost requirements—the way the whole network should function. We are pretty satisfied that we understand how the hardware of the radar and the software for which we are responsible must function to produce the basic operations of transmitting and receiving a signal. What may be missing, if Telstra is not satisfied they have completed the exercise, is every aspect to the topmost requirements in the network—how the whole network will function.

Mr GEORGIOU—Does that mean that we are creating something that we have not really specified—excuse me, because I am now a bit lost—and that we do not know how it will actually function across the range of some expected performance?

Dr Bardo—My expectation is that, with all the work that has gone on, all the major functions are recognised and are being worked on within Telstra and Telstar who are doing a large amount of the network software. But until people have satisfied

themselves they have gone very thoroughly through this whole process, there may be some risk of overlooking some aspects of the requirement.

Mr Mathews—I agree with that. I think probably there has been enough work done. The message here really was that this particular technical task, the flow down of the system requirement as Bill describes it, is really the very first thing that needs to be done on a program like this, or any other program. Until you have adequately and unambiguously defined technically what it is you wish to develop, then there is no point in starting that development.

Mr GEORGIOU—Why did you start it then?

Mr Mathews—I think the modern realisation—and it is a modern realisation, not just in UK or Australia, but in the US as well—is that systems engineering has become a more and more and more important part of every program that we do. I think, to be honest, we have all learnt the hard way. Certainly, Marconi has learnt the hard way on a number of projects by not taking seriously enough this fundamental technical discipline at the beginning of the contract.

I think, as Bill says, enough work was done over a period of time. The lesson to be learned—and it is one of the key lessons to come out of the whole thing—is that that particular discipline, that systems engineering, should be done at the beginning of every single project. It is a valuable lesson to learn. It is one that we leant the hard way and we have applied that rigorously to new projects within the last three to four years. That was really the message we were trying to get over—not that it has not been done, but that it would have been better done as the very first thing.

Mr GEORGIOU—And you lay this inadequate insight at Telstra's door?

Mr Mathews—I do not think I would lay it at Telstra's door in that sense. I could lay this at the door, I suspect, of many, many contractors around the world, including ourselves.

Mr GEORGIOU—I mean in this case. I am not doing an international comparison of contracts!

Mr Sharp—I think in all these contracts, all parties have to recognise that there is involvement between the prime contractor and the subcontractor. We all recognise that there is responsibility on each other's part. It is not solely Telstra.

Mr GEORGIOU—Does that mean you are both responsible for this deficiency? Can you hark back to the earlier days when the thing first took off and you were both very excited by it?

Mr Mathews—I guess we would have to answer that, yes, between Telstra and ourselves—in what proportions I do know about—we both perhaps were guilty, if that is the right word, of not paying sufficient attention to this early enough.

Mrs STONE—What is systems engineering? What does one look like? What is the system of systems engineering that is so important and that you have said you have failed to acknowledge, and so on?

Dr Bardo—The idea of systems engineering is that you take a customer's requirements and you analyse them and decide how you are going to meet his requirements by a particular combination of equipment and software to give him the functions he demands. The ideal model of systems engineering is that you proceed in a series of steps and you do not go past any of those steps unless you are absolutely satisfied that all the requirements have been understood and met.

The difficulty with that is that people are loathe to stop work at a stage and say, 'We must just down tools at this stage until we are absolutely sure that these requirements are met.' In general, you want to proceed with some other work because it is a more complex process than that; you cannot get all the answers at once.

For example, the way system engineering is done is changing all the time. The people who produce models for producing software, which is notoriously prone to over-runs and over-expenditure, have moved from a model which said, 'You have a nice waterfall process of step by step by step,' to one which says, 'It doesn't work like that. You have to have an iterative development. You don't have all the requirements but you need to produce some software and then you modify it reiteratively.' It is a much more messy process than the text books would like.

I think this is what happened here: people were loathe to say, 'We haven't got all this information. We will just down tools and stop until we are absolutely satisfied.' People proceeded on various streams of work, thinking that all these requirements will actually catch up. The difficulty mentioned here is that there was a view in that technical audit that all the top level requirements had not been fully sorted out and that there is a degree of risk that something is being overlooked. I suspect that that risk is not actually high: people have approached the subject from so many different directions that they have probably covered it. But unless you have gone through that process in a fully disciplined way at some stage, you cannot be sure.

Mrs STONE—So the systems engineering that you describe is what we used to call 'working out how to do it', basically, isn't it?

Dr Bardo—Yes.

Mrs STONE—At the same time, does it involve a detailed costing, a cost benefit

analysis, or a benefits costs ratio?

Dr Bardo—Yes, there is a lot of optimisation involved. When you work through the requirements, and you decide that you are going to tackle it in this particular way, you may then proceed to design something, find it is more difficult than you expected and you then have to adjust the degree of pain that falls on that particular bit of the design and transfer it to another.

Indeed, one of the things I did in 1993, my first big involvement in JORN, was to do some rebudgeting of our portion of the work because the demands on some aspects of the receiver were much too high. We were able to achieve the same overall performance, but by doing the design in a different way. And that is characteristic of systems engineering: with a difficult task you go up blind alleys, you retreat, you try another way, you re-optimise.

In terms of costing the budget, you derive a structure that says, 'We're going to give this package of work to him, that package of work to him, it is costed at so much, and the estimate of manpower and materials is this.' You proportion it out as a disciplined project task. The idea being that eventually, when you have done all those, you put them together again and you do the reverse. You add them all up and you integrate them to meet the full requirements.

So you have a symmetrical process in your design. You derive all the little building blocks that you hope, when you put them together again, are going to integrate smoothly and all work together. Typically, when you integrate, you find that you have perhaps missed out some interface connection, a piece of software does not connect with another piece of software, or you have the wrong signal coming out of some box and you have to modify that.

Mrs STONE—If we had taken the ideal—let us call it that now—right from the word go, back in 1989, 1991, 1992, and had used the optimal systems engineering approach, let us say, how long would it have taken before you had got to a stage where you could have said, 'Right, let's stop right here. We know what it is that we are aiming to achieve and this is how we are going to do it'?

Dr Bardo—I suspect that that full system engineering activity would have lasted three years or more. It is an extremely complicated system and, of course, what you are doing in parallel is some of the activities such as designing pieces of equipment and then discovering that you cannot meet all the requirements so you go back and change the system a bit to re-balance, to re-optimise.

Mr BEDDALL—It was explained to us earlier that Telstra is not used to dealing in defence contracts. Certainly Marconi is. In essence there is a client in this: the Department of Defence, represented by the JORN project office. Probably there has been a

fair deal of criticism, not only about this project, but about other projects that the Department of Defence has handled. Do you directly deal with the JORN office at the Department of Defence and, if so, in your experience as an international defence contractor, how does that compare with international standards?

Mr Mathews—Our day to day dealings are, of course, with Telstra, with whom we have the subcontract, but, of course, we come into contact with defence. From my relatively short period on the program, I find that the processes within defence, and the people, are on a par with experience that I have in America and other European countries.

Mr BEDDALL—That perplexes me in the sense that we have a project that is somewhere between 70 per cent and 80 per cent paid for and 10 per cent to 12 per cent delivered, according to the Audit Office. Is that the normal process? There would be a lot of criticisms, particularly when I asked before about milestones, and we can talk about those GEC-Marconi milestones later. There does not seem to have been any milestones set at the outset for this project because payment has been made without reaching milestones.

Mr Mathews—I cannot really comment on that. The audit report claims 80 per cent payment, as you say, from defence to Telstra, but we have no visibility and no involvement at that level of the management of the contract by defence, I am afraid.

Dr Bardo—I have a comment about milestones and earned value because we work to both. In the early parts of a high risk project like this, where you are doing a lot of research, development, initial design, and studies, an earned value milestone can look quite similar to a milestone which demands the delivery of a document in that it is entirely possible to deliver a design and think you have achieved a milestone and only discover later that for reasons of continuing activity with another part of the design that you have to go back and re-do it.

If you plot an earned value graph and then find that you have to repeat some activity for no improvement in earned value, the graph is pretty jagged. It is only when you are getting onto more routine engineering and production that you have a nice smooth progression in milestones or earned value. It is characteristic of that kind of program that it can look very jagged and then smooth out. Quite often it will go jagged again when you hit the systems integration problems.

Mr BEDDALL—Probably the question for us to determine is whether the overall cost benefit to the country is worth those jagged edges, but that is for us to decide.

Dr Bardo—I do not think you have a choice, with respect. All international programs look like this. They vary in severity.

CHAIR—Thank you.

Evidence was then taken in camera—

Committee adjourned at 2.46 p.m.