CHAPTER VI: DEFENCE RESEARCH AND DEVELOPMENT ORGANISATION

6.1 Qualitative Requirements based projects at Naval DRDO laboratories

Scrutiny of 24 projects aimed at achieving indigenisation, undertaken by Navy affiliated DRDO laboratories at a cost of ₹731.51 crore revealed that 21 projects i.e. 87 *per cent*, did not adhere to the original timeframe for completion. Seven projects witnessed cost overruns ranging from 38 to 348 *per cent*. Scrutiny of 12 projects related to critical naval technologies showed delays, technological obsolescence, difference of perceptions between Navy and DRDO on success criteria, delayed communication of QRs and frequent changes in QRs by Navy contributing to failure in actual induction of indigenously developed capability.

6.1.1 Introduction

Research and Development activities need to be dynamic in order to cope with the highly complex and technology intensive requirements of the Navy. The development of equipment, sonar systems, underwater weapons and materials for naval platforms such as ships, submarines and aircrafts require incorporation and integration of multi-disciplinary technologies. To achieve this, the Directorate of Naval Research & Development (DNRD) at DRDO HQ acts as the interface and facilitates effective interaction between Indian Navy and DRDO Labs. The Directorate deals with technologies in areas such as underwater Weapons, underwater Sensors, Naval Materials and Marine Biology, underwater Ranges, Oceanography, Ship Hydrodynamics and Structure, and Fuel Cell and Marine Stealth.

DRDO has a network of three naval laboratories, *viz.* Naval Material Research Laboratory (NMRL), Ambernath with competency in metallurgy, polymer science and technology; Naval Physical and Oceanographic Laboratory (NPOL), Kochi engaged in the design and development of underwater

surveillance systems and Naval Science and Technological Laboratory (NSTL), Visakhapatnam, dedicated to the design and development of underwater weapons and associated systems for the Navy.

6.1.2 Project formulation and the Financial Powers

Like other DRDO laboratories, Naval Laboratories also take up Mission Mode (MM)/Staff projects, Technology Demonstration projects (TD)/Research and Development projects (R&D)/Science and Technology (S&T) and Infrastructure Facility (IF) projects. Selection of a DRDO project involves a process of conducting a feasibility study, planning and peer review. After completion of the peer review, the project proposal is submitted for sanction to the competent authority as per the delegated financial powers vested with the respective authority. A brief description of various types of projects and the procedures required for approval is as under:

6.1.2.1 Mission Mode (MM)/Staff projects

These projects involve deliverables for the services within a specified time frame for induction. These projects are usually referred to DRDO by concerned Staff (Army, Navy & Air Force), in the form of General Staff Qualitative Requirement (GSQR)/Naval Staff Qualitative Requirement (NSQR). Based on SQR submitted, DRDO conducts pre-project or feasibility studies and offers its expert comments on the project to the initiating Staff, after which the project is finalised, modified or dropped by the initiating Staff. The procedures for various activities for project management are conceptualisation, feasibility studies, peer reviews, sanctioning, monitoring and reviews, closure of projects and transfer of technologies.

6.1.2.2 Technology Demonstration (TD) projects

These projects are normally initiated by DRDO as feeder technologies for future or imminent Staff projects. These are funded and controlled by DRDO with modest or limited user inputs. The purpose of this type of project is to develop, test and demonstrate a particular technology. Modules of this may be developed by industry and design/analysis packages by academia.

6.1.2.3 Science and Technology (S&T) projects

These are low level projects funded solely at the Lab level with loose alignment to future technological needs. S&T projects are normally taken up with academia involvement and include a quantum of analysis and simulation modules.

6.1.2.4 Infrastructure Facility (IF) projects

These are for setting up infrastructure facilities**.** The Competent Authority for sanctioning of the project and the cost limits are as under:-

Amount in ₹

Sl. No.	AUTHORITY	FINANCIAL POWERS	FINANCIAL POWERS (with financial concurrence)
1.	Laboratory Director	Up to 10 lakh	Up to 5 crore (with IFA concurrence)
2.	Chief Controller	-	5 crore to 25 crore (with IFA concurrence)
3.	DG	-	25 crore to 50 crore (with IFA concurrence)
4.	Secy Def(R&D)	-	50 crore to 60 crore (with JS & Add FA concurrence) 60 crore to 75 crore [(with FA(DS)/Secy Def(Fin) concurrence)]
5.	Raksha Mantri	75 crore to 500 crore	-
6.	Finance Minister	500 crore to 1000 crore	-
7.	Cabinet Committee on Security(CCS)	Beyond 1000 crore	-

6.1.3 Scope of Audit

The present audit focuses on the MM, TD and R&D projects with emphasis on meeting the user's requirement based on the Qualitative Requirements

{[1]Outline/Preliminary/Definite Naval Staff Qualitative Requirements (NSQR)}. The QR expresses the user's requirements in terms of capability desired with minimum required verifiable functional characteristics at the same time to ensure that formulation does not prejudice the technical choices by being narrow and tailor made. The SQR is drafted by the user directorate at Service Headquarters. The existence of a QR indicates that Navy had some plans of acquisition or at least a felt need. Therefore, projects with QRs were selected for audit scrutiny. Completed projects and projects which witnessed time overruns were subjected to detailed audit scrutiny. In the case of on-going projects, except for the analysis of reasons of time and cost overruns, a detailed assessment was not attempted, as evaluation of achievements with reference to definite deliverables, would be premature.

Audit covered twenty four projects with QRs, sanctioned during the period 1991 to 2010 at a total cost of ₹731.51 crore and examined whether the deliverables anticipated in these projects were achieved within the projected time and cost framework.

6.1.4 Criteria to determine success of project

MM/Staff projects are high priority projects taken up by the DRDO based on well defined user requirements in terms of QR, deliverables and time frame. Successful projects involve technology transfer and post-project production activities. A project can be considered successful only if the deliverables in terms of equipments and systems are accepted by the users for induction into service after satisfactory users' trials, thereby, leading to their productionisation and induction in the Indian Navy. Similarly, the success in the case of TD and R&D projects leads to an MM/Staff project, which in turn leads to induction of the realised system/technology in the service. Based on the above, the audit criteria are:

(i) Whether TD/R&D project led to an MM/Staff project and

(ii) Whether the Staff/MM project led to induction in service.

[1] SQR's lay down user's requirements in a comprehensive, structured and concrete manner. Staff Equipment Policy Committee in the Service Headquarters finally approves the SQR's. Prior to finalization and approval of SQR's, these are called Outline/Preliminary/Draft QRs.

6.1.5 Audit Methodology

Audit was taken up at the three Naval DRDO laboratories and DRDO Headquarters during July 2012 to November 2012. Audit methodology was based on examination of records, documents and issue of audit queries and observations. Draft Audit Report was issued to the Ministry in May 2013. Ministry's reply was received in September 2013 which has been suitably incorporated wherever necessary.

6.1.6 Audit Objective

The audit objective was to ascertain the outcome of projects having a QR undertaken by the Naval Laboratories in terms of productionisation and induction of equipment/system in the Navy. In relation to TD/R&D projects, the audit objective was to ascertain whether these in turn led to a Staff/MM project.

6.1.7 Measurement of the effective management of the MM/Staff projects/TD and R&D projects.

The success of any project primarily depends upon its timely completion within the sanctioned cost of the project. We undertook an analysis of time and cost overrun of the projects. The results are as under:

6.1.7.1 Time Overrun Projects

An analysis of the 24 projects showed that out of 24 projects sanctioned during 1991 to 2010 at a cost of ₹ 731.51 crore, 21 projects (i.e. 87 *per cent*) did not adhere to the original time schedule. The delay ranged between six months to nine and a half years, as detailed below:

Sl. No.	Project No.	Project Name	Date of sanction	Original PDC	Last PDC	No. of exten-sions granted	Time overrun (in Years/ Months)
1.	NCM-221	Weld consumable (DMR249A)	18.1.05	17.7.06	17.1.07	1	6 Months
2.	NCM-223	Weld consumable (DMR249B)	12.9.06	11.3.08	31.12.08	1	9 Months

3.	NPL-217	USHUS-I	16.2.04	16.2.06	31.3.09	4	03 Years 01 Month
4.	NPL-220	HUMSA NG	8.9.06	8.9.09	31.3.11	1	01 Year 07 Months
5.	NPL-221	DDSK	29.11.06	31.5.08	28.5.11	2	03 Years
6.	NPL-206	NAGAN	23.6.98	23.6.02	31.12.11	7	09 Years 06 Months
7.	NPL-214	LFDS	12.3.03	12.3.05	30.6.12	6	07 Years 03 Months.
8.	NPL-215	SBA	26.3.03	26.3.05	31.3.10	3	05 Years
9.	NPL-216	MAARECH	18.6.03	17.6.05	31.12.13	5	08 Years 06 Months
10.	NST-161	WGT	14.6.91	June 95	June'99	2	04 Years
11.	NST-168	UWR, Goa	20.6.95	19.10.98	6.7.08	7	09 Years 06 Months
12.	NST-171	SHAKTHI	16.5.96	15.5.00	30.11.02	4	02 Years 06 Months
13.	NST-179	DISHA	02.5.00	01.5.03	31.5.05	1	02 Years 01 Month
14.	NST-188	VARUNASTRA	5.8.02	04.8.06	31.5.13	5	06 Years 10 Months
15.	NST-189	AET	14.11.02	13.11.05	13.11.06	1	01 Year
16.	NST-194	MAREECH	29.8.03	28.8.06	31.12.13	5	07 Years 04 Months
17.	NST-195	AEM	31.10.03	30.4.05	31.12.07	2	02 Years 08 Months
18.	NST-201	LWM	19.8.04	18.8.06	31.12.07	1	01 Year 04 Months
19.	NST-205	EAST	6.3.07	5.3.12	5.3.14	1	02 Years
20.	NST-208	ALWT	12.2.08	14.8.13	31.12.15	1	2 Years 04 Months
21.	NST-213	MIGM	30.4.10	30.4.12	31.12.13	1	01 Year 08 Months

NOTE: **NCM: NMRL, Ambernath**
NPL : NPOL, Kochi
NST : NSTL, Visakhapatnam

The reasons attributed (September 2012) by the DRDO for the time overrun were delay in completion of trials, non-availability of the platform and

changes in the design and QRs. Delay in completion of these projects may have an adverse impact on the capabilities of the Navy, as some of these projects have been sanctioned with definite QRs or with Outline Requirements so that the system developed can be put to best use before the onset of technological obsolescence of the developed items.

6.1.7.2 Cost Overrun

We observed (July 2012 to November 2012) cost overrun ranging between 38 and 348 *per cent* in seven out of 24 projects as detailed below:

₹ in Lakh

Sl. No.	Project No.	Project Name	Original cost	Revised cost	Cost overrun (in *per cent*)
1.	NPL-206	NAGAN	3000	6415	114
2.	NPL-214	LFDS	1171	2465	111
3.	NPL-216	MAAREECH*	1315	5889	348
4.	NST-194	MAAREECH*	1740	4073	134
5.	NST-161	WGT	1732	2382	38
6.	NST-168	UWR, Goa	1841	3743	103
7.	NST-188	VARUNASTRA	4850	7450	54

* NPL-216 (Maareech) was undertaken by NPOL, Kochi for development of Anti Torpedo Decoy System. NST-194 (Maareech) was undertaken by NSTL, Visakhapatnam for development of expendable decoys and fire control system. Both projects were complementary to each other. NPOL, Kochi was the leading lab for Project Maareech as a whole.

The cost overrun of 38 to 348 *per cent* indicated in the Table above, was attributed (September 2013) by the DRDO to increase in cost of materials/stores, change of platform for conducting trials involving removal of the system under trial from one ship and installation onboard another ship, non-availability of nominated aircraft for the trials, variation in exchange rates, change in requirement of stores for the project and requirement of additional Design & Engineering (D&E) models. Clearly, the cost estimates were not prepared with due diligence and did not account for project exigencies correctly.

In its reply, Ministry of Defence (DRDO) stated (September 2013) in relation to project at Sl. No. 3 above that the cost and time overrun was due to addition of two production grade systems and change of trial platform. Ministry also accepted that they had no control over availability of ships, submarines and aircraft for trials. They also stated that productionisation required Research and Development, customized engineering and vendor development.

The reply only confirms that initial cost estimation did not factor in these critical requirements which in turn also impacted the timely completion of projects.

6.1.7.3 Status of QR based Naval DRDO projects

We examined the R&D, TD and Mission Mode (Staff) projects undertaken by three laboratories[2] wherein Qualitative Requirements were formulated by the user either as a draft QR, preliminary QR, Outline QR or in a few projects, by a definite NSQR.

We noticed (July 2012 to November 2012) that out of 24 projects, four projects of NSTL[3] and two projects each of NMRL[4] and NPOL[5] were successfully completed. Of the remaining 16 projects executed by NSTL and NPOL, four projects were still in progress whereas twelve projects (five by NPOL and seven by NSTL) could not meet the objectives of user acceptance, productionisation and induction in service.

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[2] The three laboratories are: Naval Materials Research Laboratory (NMRL), Ambernath, Naval Science and Technological Laboratory (NSTL), Visakhapatnam Naval Physical and Oceanographic Laboratory (NPOL), Kochi.

[3] NSTL: (1) Setting up of underwater range (UWR)(NST-168) (2) Advanced Modular Fire Control System (NST-168) (3) AET (NST 189) (4) EEM (NST 195)

[4] NMRL: (1) Weld consumables for Steel DMR-249A(NCM-221) (2) Weld consumables for Steel DMR-249B(NCM-223)

[5] NPOL: (1) USHUS-1 (NPL-217), (2) USHUS Training Simulator (NPL-226)

Ministry of Defence (DRDO) stated (September 2013) that estimated PDC did not include system engineering documentation and TOT. The reply did not take into account the objective of actual productionisation and induction which would have to necessarily include the estimation of system engineering, documentation and TOT.

Each of these twelve projects is discussed below in detail:

Projects undertaken by NPOL

(a) Development of Active cum Passive Towed Array Sonar (Project NAGAN)

Sonar (originally an acronym for Sound Navigation and Ranging) is a technique that uses sound propagation to navigate, communicate with or detect objects such as other vessels on or under the surface of water. There are two types of "sonar". Passive sonar essentially listens for the sound made by vessels; active sonar emits pulses of sounds and listens for echoes.

Towed Array Sonar plays an important role in Anti-Submarine Warfare (ASW) operations and is the sonar for warships to locate very silent submarines capable of launching high speed torpedoes. The Passive Towed Array Sonar (PTAS) technology was developed by NPOL, Kochi through a Technology Demonstration project in the nineties. Earlier, PTAS could meet the requirement of detection of a submarine at long range due to low frequency operations of the sonar and reduced self-noise effect of operating platform. However, new submarines had become quieter due to incorporation of stealth technology and passive detection. Therefore, Navy projected the requirement of an Active cum Passive towed array sonar system for fitment on its frontline warships. Subsequently, based on an NSQR formulated in August 1997, NPOL took up development of "Active" cum Passive Towed Array Sonar" (Project NAGAN, NPL-206), a user driven Mission Mode Project sanctioned by the Government in June 1998 at an estimated cost of ₹30 crore and PDC of June 2002.

Mention was made in C&AG of India Report No. 5 of 2007 regarding time and cost overrun of Project NAGAN and the consequential non-availability of

the technology for Indian Navy, resulting in commissioning of its four frontline warships without Sonar capability between January 2001 and April 2004. In their Action Taken Note, Ministry had indicated (June 2009) that as a remedial measure, Decision Aid for Technology (DATE) analysis would be undertaken in all future mission mode staff projects to project realistic time frame and funds before obtaining sanction.

Our further examination revealed (October 2012) that the project underwent three further revisions of PDC (March 2008, March 2009 and finally till December 2011) as also cost revision upto ₹64.14 crore from the originally sanctioned amount of ₹30 crore. NPOL attributed the time and cost overrun to delays in commissioning of chilled air circulator system, power supplies and intercoms by Navy, non-conduct of trials due to monsoon/rough sea, refit of trial ship, shift in the basis of user acceptance[6] leading to unanticipated purchase of two sets of wet end system; inaccurate estimates on the requirement of spares and lack of understanding of the engineering complexities of the project.

The system which was refurbished (April 2012) after carrying out the re-engineering works was termed as "Re-engineered NAGAN". DRDO stated (May 2012) that NAGAN RE was undertaken for the upgradation of NAGAN as per the NSQRs and the initial trials in April 2012 with user participation had shown encouraging results. Extensive evaluations of NAGAN RE capability would be continued, wherein, DRDO was expected to demonstrate the total capability of NAGAN. However, Navy viewed (March 2009) that NAGAN was far from meeting its primary requirements of even detecting a dived submarine and that the performance of NAGAN was even inferior to the medium frequency HUMSA sonar.

The delay in the project coupled with the non-achievement of the parameters of even detecting a dived submarine, compelled the Navy to consider the project as unsuccessful in February 2010 after incurring ₹48.51 crore, and eventually reduced the status of the project from MM to TD. As a result, a

[6] Unlike in the earlier sonar projects of NPOL i.e. HUMSA and Panchendriya; in NAGAN, Navy expected the NPOL prototype to be functional like a production model proved for extreme operational conditions and not only meeting the technical requirements.

new NSQR was framed in November 2010 enhancing the performance requirements and in April 2012, a fresh MM project 'Advanced Light Towed Array Sonar' (ALTAS) (NPL-232) was sanctioned by Ministry of Defence at an estimated cost of ₹114.42 crore with PDC of April 2016.

NPOL, however, did not agree (September 2012) with the Navy's views on the project as unsuccessful. DRDO stated that Project ALTAS had enhanced performance parameters incorporated in NSQR to meet present and futuristic requirement of the Navy and that Project NAGAN would continue as a TD project facilitating inputs to the design and testing of project ALTAS.

Thus, a project conceived in 1998 with a definite requirement projected by Navy could not be completed conclusively by the DRDO even after time overrun of nine and half years and cost overrun of ₹34.15 crore. NPOL cited (September 2012) the outdated QRs of 1998 as one of the reasons for non-acceptance of the developed system by the Navy. In addition, Navy opined (November 2012) that rapid advancements in technologies available worldwide made the system obsolete.

Due to continuous delays in completion of sonar NAGAN, Defence Acquisition Council (DAC) in 2008 approved procurement of ATAS (Advanced) for Delhi and Talwar class ships. Thus, due to prolonged delays and non-fructification of sonar NAGAN, project ALTAS had to be sanctioned at a cost of ₹114.42 crore, besides resorting to import.

Our scrutiny (October 2012) also brought out differences in perception between the DRDO and Navy regarding the project; while DRDO held that User Acceptance Trials (UAT) were conclusive and the system was ready for User Evaluation Trials (UET), Navy did not agree with this on the ground that certain key technologies/capabilities were yet to be proved.

The audit scrutiny revealed that while DRDO claimed success, Navy opined (April 2009) that NAGAN was based on obsolete technology, did not show enhanced passive detection and was not comparable even with the 1980s' technology. Navy further opined that that NPOL did not represent a realistic situation regarding the project at various fora such as Steering Committee,

Apex Committee Meetings and Chief of Naval Staff/Vice Chief of Naval Staff reviews.

In reply to the Draft Audit Paragraph, Ministry of Defence (DRDO) stated (September 2013) that the Navy had recommended a major change in QR after the conclusion of the UETs in February 2010, which could not be absorbed in the system, rendering NAGAN as virtually a non-inductable system. Further, with regard to Navy's views on capabilities of NAGAN system, it was stated that the Navy did not give DRDO an opportunity to test efficacy of the capability of NAGAN. The Ministry of Defence (DRDO) also stated that the Navy had no intention of continuing with User Evaluation Trials (UETs) post June 2010 due to trial platform ship (INS Sharda) entering refit which would make the trial ship unavailable for conducting further trials.

The reply is however not acceptable as considerable delay in the project had rendered the NSQR outdated.

(b) Development of Anti Torpedo Defence System (ATDS). (Project Maareech)

Navy had a requirement for an Anti Torpedo Detection System (ATDS), capable of detecting, confusing, decoying and destroying incoming torpedoes. Based on a Preliminary QR formulated by Navy and a project proposal initiated by NPOL, Kochi, in October 2002, Ministry in June 2003 sanctioned a 'mission mode' project ATDS (Project No. NPL-216, Project Name MAAREECH) to NPOL at an estimated cost of ₹13.15 crore, with PDC of 24 months (June 2005). While NPOL was responsible to develop the ATDS and the Towed Acoustic Decoy (TAD), a supplementary project for developing a set of counter measures (expendable decoy and fire control system) was allotted to NSTL, Visakhapatnam. This project titled 'Anti Torpedo Decoy System' (MAAREECH) (Project No. NST-194) was sanctioned in August 2003 at an estimated cost of ₹17.40 crore with a PDC of 24 months (August 2005). The system to be developed by NSTL was to be integrated with the ATDS being developed by NPOL. ATDS Maareech was planned to be fitted on a total of 38 ships and a truncated version consisting of only expendable decoy launcher was to be fitted in eight ships.

We observed (September 2012) considerable time and cost overruns in the project. The PDC of the project was extended six times upto December 2013 and cost was upwardly revised twice to ₹14.89 crore and ₹58.89 crore. Similarly, the PDC of NSTL's project was revised five times upto December 2013 and cost was revised once to ₹40.73 crore. As of November 2012, further trials were to be conducted under both the projects for evaluating its acceptance. It was also noticed that the preliminary QR was not converted in to a definite NSQR by the Navy. Reasons for not formulating a definite NSQR were called for (April 2013) from the Navy. Their reply was awaited (December 2013).

DRDO attributed (May 2005) the reasons for the delay of seven and a half years in both the project to *ab initio* development of new hardware architecture for ATDS, non-availability/withdrawal/decommissioning of trial ship, technical problems, onset of monsoon and trials extending to more than two seasons.

We also noticed (September 2012) that there was a clear divergence in views of DRDO and Navy with regard to availability of platform for trials, reasons for delay, availability of ready systems for fitment of the prototype and methodology for UET itself and lastly, even difference of opinion with regard to whether performance of the system was documented correctly during evaluation, as discussed below:

- While the NPOL cited (February 2008) non-availability of platform for trials from the Navy as a major cause for the delay, Navy maintained (November 2012) that they had provided trial platforms. Navy further added that the mutually agreed timelines were always adhered to by them and were factored in while planning the deployment of ships for operational commitment. Navy also pointed out that it was in fact the non-availability of the system for trials on the scheduled dates, and change/additional/late intimation regarding requirements by the DRDO which contributed to the delay.
- NPOL stated (January 2011) that they had insisted upon that the UETs should be conducted against a UET document only. A draft UET

document was prepared by NPOL and sent to Navy for their comments and vetting, but the trials were not conducted as per any specific document or methodology. According to NPOL, improper conduct of trials resulted in inconclusive trials. However, Navy stated that the UETs were conducted in accordance with the Trial Directive approved by the competent authority and that all procedures as per practice torpedo firing were observed and all data were recorded which were later forwarded for analysis to Weapon Analysis Unit.

- While the Navy held (November 2012) that the system developed by the DRDO failed to perform as per promulgated NSQRs in both the UETs**,** NPOL attributed (September 2012) Navy's non-acceptance of the system to its insistence on tactical performance instead of system functionality during trials.

We observed (September 2012) that lack of coordination between Navy and DRDO regarding adherence to timelines fixed for making the system available for trials by the DRDO and the platform for conduct of trials by the Navy, documentation of outcome of trials in an undisputed manner and arriving at the mutually accepted criterion for user acceptance led to the delay in the projects.

Thus, due to delay, DRDO could not meet its requirements resulting in a critical capability gap in Navy's operational preparedness. In order to overcome this, procurement of 'A' number torpedoes at a cost of ₹600 crore, was approved by the Defence Acquisition Council in January 2011.

In response, Ministry of Defence (DRDO) stated (September 2013) that the Navy had never agreed to mutually accepted test schedule or acceptance criteria during 2007-2010. They further stated that the capabilities of Mareech were comparable to NTDS, the imported system being processed by the Navy. They opined that Project Mareech ought to be subjected to the same acceptance criteria and number of trials as agreed for the imported torpedoes. Regarding time overrun, DRDO reiterated that it was due to Navy's insistence on the changed hardware architecture and to the extension in PDC to carry out sea evaluation trials and user acceptance. Further, with regard to the cost escalation, the DRDO stated that the development cost of four systems was less as compared to the cost of one imported NTDS.

The above contention of the Ministry of Defence (DRDO) thus strengthens the audit observation that there was lack of coordination between the DRDO and the Navy in conducting trials and in formulating mutually agreed criteria for user acceptance. Further, the comparison of cost of the imported systems with that of the DRDO developed ones is hypothetical at this stage, as the developed system is yet to be accepted by the Navy.

(c) Low Frequency Dunking Sonar (LFDS)

Low Frequency Dunking Sonar (LFDS) is a sensor for detection of submarines and is used for Anti Submarine Warfare (ASW) operation.

In January 2003 Indian Navy projected the requirement of LFDS with an assured detection range of 15 Km. Accordingly, DRDO proposed (January 2003) to design and develop dunking sonar with better range and detection capabilities. Govt of India, Ministry of Defence sanctioned the Mission Mode project LFDS in March 2003 without an NSQR, to be carried out by NPOL at an estimated cost of ₹11.71 crore with the PDC as March 2005. The sanction of an MM project without a QR rendered the DRDO unclear about the actual requirement of Navy. The objective of the project was to design and develop a LFDS optimized with long range detection capability to be fitted on helicopters (in service/due for induction) like Advanced Lightweight Helicopter (ALH). As NPOL had earlier completed a dunking sonar, the DRDO claimed that part of the technology of MIHIR and another Sonar project NAGAN could effectively be used in this project. Preliminary NSQR with necessity as "OPERATIONAL IMMEDIATE" was sent to NPOL for compliance by Navy in January 2004. However PDC for the project was extended six times till June 2012. The major reason attributed by DRDO (September 2011) for the extension of PDC was the revision of technical issues including use of state of the art technology instead of the available technology, requirement of additional funds for procurement of additional electronics hardware, installation activities of the LFDS on the nominated platform, issues relating to airworthiness of platform, non-availability of the nominated aircraft ALH and the conduct of Phase-3, Phase-4, Phase-5 flight trials.

We observed (September 2012) that the main reason for the time overruns was attributable to the DRDO, in meeting the revised technical requirements as envisaged by the Navy. In all, five phases of trials were concluded and in the Phase-5 trial conducted (April-May 2012), deficiencies in design were noticed by Navy. However, according to the Navy, the Phase-5 trial conducted (April-May 2012) to assess the maximum ranges attainable with LFDS and prove the performance of the system, revealed deficiencies.

In addition to the revision in PDC till June 2012, the cost of the project was also revised thrice (first revision to ₹14 crore, second revision to ₹20.337 crore and lastly to ₹24.65 crore) against the original sanctioned cost of ₹11.71 crore. The increase in cost was mainly due to requirement of additional funds in the conduct of Phase-3, Phase-4 & Phase-5 trials and for procurement of additional new electronics hardware. Since there were no definite guidelines/inputs from the Navy, the project was considered (December 2012) for closure by the DRDO who also proposed (December 2012) for productionisation of the system for eventual fitment on an operational platform.

However Navy opined (December 2012) that prolonged development timelines and NSQR non compliance had resulted in 'obsolescence' in the LFDS system and approximately 30 *per cent* of the verifiable technical characteristics could not be complied. Navy further stated that the QRs of LFDS were diluted to enable fitment on ALH helicopter for conducting trials. However, LFDS in its present form was not suitable for fitment on any ASW helicopter. Navy further added that prolonged development time lines had led to purchase of foreign sonar systems.

In reply (September 2013) to the Draft Audit Paragraph, Ministry of Defence (DRDO) admitted that the deficiencies noticed during Phase-5 trials could be made good only in Phase-6 trials. They further added that LFDS does not face any component obsolescence and that certain features (Active Buoy and Bathy Buoy) could not be demonstrated due to the Navy not having these items in their inventory. The Ministry of Defence (DRDO) attributed the change in QRs to Navy's choice of ALH for trials which was not an ASW platform. It was also stated that the airworthiness for the LFDS was granted in 2008-09

and hoped that the Navy would give a go ahead for exploitation of LFDS on an operational platform.

Thus, besides time and cost overrun, the development of the system remained unfruitful.

(d) Sea Bed Arrays

Sea Bed Arrays (SBA) technology consists of passive acoustic hydrophones, connected through cables, placed on the seabed to continuously monitor the movement of submarines and surface ships by way of detection, localisation, classification and tracking. Navy forwarded draft staff requirements for the project to NPOL in August 2001.

Indian Navy planned to use the seabed array technology to monitor the strategic locations at sea on continuous basis. Ministry of Defence sanctioned the project as a Technology Demonstration (TD) project in March 2003 at an estimated cost of ₹13.17 crore with the PDC of 24 months (i.e. March 2005). PDC for the project was revised twice i.e. in March 2007 and June 2008 to cater for design changes suggested by the Critical Design Review (CDR) Committee constituted by the Director NPOL in December 2006, in areas of data acquisition, telemetry, ocean deployment and retrieval technologies and also to accommodate delays on the development and evaluation of RF telemetry systems and its trials. Thereafter the non-availability of the trial platform INS Nireekshak further delayed the project which was finally closed in March 2009 after incurring an expenditure of ₹9.98 crore.

Subsequently, Navy was asked (August 2010) to examine the conceptual requirement of the SBA based on a decision[7] taken in the 32nd Steering Committee on Underwater Sensors (SCUWS) (January 2010), i.e. nine months after completion of the project. In the meantime, Directorate of Staff Requirements of IHQ MoD (Navy) and NPOL decided (February 2012) to identify areas of its usage and sought comments from all Commands and the Directorate of Naval Operations (DNO). In April 2012, all but Command

[7] The decision taken was to examine the conceptual requirement of Sea Bed Array system by 30th September 2010.

Headquarters (SNC, Kochi) and the DNO of IHQ MoD (Navy) opined that the system could not be accepted for operational deployment.

In reply to the Draft Audit Paragraph, Ministry of Defence (DRDO) stated (September 2013) that the SBA project was completed successfully in the presence of naval representatives at Karwar in May 2009. DRDO HQrs also stated that in January 2013, the Navy had shown keen interest in the project which highlighted the need for the project.

However, the fact remains that the Navy did not accept the system for operational deployment. Further, documentary evidence in support of Navy's continued interest in the system was not provided to Audit (December 2013).

Thus the project was to be undertaken by the DRDO at the instance of Navy even though the latter was unclear about the project's functional utility. Eventually, the Navy found that the system could not be deployed, after incurring an expenditure of ₹9.98 crore by DRDO.

(e) Diver Deterrence Sonar for Karwar

Diver Deterrence Sonar (DDS) deters divers from approaching a harbour/installation from the sea. In 2001, it was decided by the Navy that DDS may be introduced in all harbours as an 'OPERATIONAL IMMEDIATE' requirement and accordingly, in November 2004, a decision was taken to undertake a 'Mission Mode' project for development of DDS for Karwar. Navy promulgated NSQR for DDS in August 2005. In November 2006, Government of India, Ministry of Defence sanctioned the project to NPOL, Kochi to design and develop an engineered DDS with remote controls using Radio Frequency (RF) system at an estimated cost of ₹7 crore with an anticipated completion within 18 months (May 2008).

The PDC for the project was extended three times due to critical changes in design, feasibility study on deterrence and constraints on the range parameters before the project was finally closed in May 2011. Prior to the closure of the project, the Steering Committee on Under Water Sensors (SCUWS) suggested (July 2010) that Navy and NPOL explore the world market to identify the

existence of similar system and its capabilities. However, as no such system was found available, Navy accorded approval (October 2010) for the closure of the project and DRDO closed the project (May 2011) stating that the project met all the QRs as defined in the NSQR. However we observed (December 2012) that the system developed by the NPOL was not accepted by the Navy for the reason that the instantaneous deterrence of divers could not be achieved apart from the fact that it caused acute physiological discomfort to the crew of submarines and its adverse influence on submarine equipment. The Navy had also concluded (September 2012) that the NSQR formulated was not achievable and any reduction in its parameters would not create the requisite deterrence. As a result, the Navy did not clear the DDS for production. Since instantaneous deterrence could not be achieved Defence Acquisition Council accorded (October 2012) an AoN for the procurement of 78 Portable Diver Detection System in addition to a contract concluded in June 2012 for the procurement of Integrated Underwater Harbour Defence and Surveillance System (IUHDSS) for four naval harbours.

In reply to the Draft Audit Paragraph, Ministry of Defence (DRDO) stated (September 2013) that by not accepting the system at Karwar, the Navy lost an opportunity to energise an unmanned deterrent mechanism, to supplement other means of diver deterrence and that the decision to buy Diver Detection Sonar was independent of the non-induction of DDS. They further stated that the expenditure incurred on the project was not entirely infructuous, since all hardware bought for DDS had many other applications in the Lab (power amplifier, transducer). The Ministry of Defence (DRDO) also stated that the objective of Diver Deterrence Sonar was not ill-conceived, and would be used in areas where own divers are not required to operate.

The contention of the Ministry of Defence (DRDO) that the hardware bought for DDS has many other applications in the Lab is not acceptable as the project was primarily envisaged for the requirement of Diver Deterrence Sonar, which was not achieved.

The sequence of events clearly indicates that the objective of deterrence of underwater saboteurs envisaged by the NSQRs was ill-conceived which led to

non induction of the deterrence based systems and rendered the expenditure of ₹5.09 crore incurred on the project as unproductive.

Projects of NSTL, Visakhapatnam

(a) Development of Wire Guided Torpedo

As the existing torpedoes of the submarines of the Indian Navy were either anti-ship or anti-submarine, Navy planned to widen the role of the submarines by introducing new torpedoes which had a dual operation.

Accordingly, as a sequel to a Research & Development (R&D) Project[8] sanctioned at a cost of ₹4.755 crore in 1982, a project for "Development of Wire Guided Torpedo" (WGT) was sanctioned by the Government of India to NSTL, Visakhapatnam in June 1991 at an estimated cost of ₹17.32 crore, later revised to ₹23.82 crore with PDC of four years (June 1995). The project was sanctioned as a Technology Demonstration (TD) project based on a Draft QR approved by the Navy in April 1988. The weapon was to be developed for X_1 submarines and was also expected to be compatible for use by X_2 submarines. The project was to be executed in three phases. In the first phase, completion of total development work, integration of subsystems and Lab proving trials was envisaged. In the second phase, Transfer of Technology to M/s BEL, Bangalore and delivery of production models by them was envisaged. Acceptance by the user was planned in the third phase. PDC was revised twice till June 1999. Meanwhile, Navy in 1994 approved the Outline Staff Requirements (OSRs) for WGT and identified X_2 submarine as the platform in place of X_1 submarine designated originally. On completion of phase-I of the TD project, Government in November 2001 sanctioned its closure with effect from June 1999 after incurring an expenditure of ₹23.81 crore without completing the second and third phases, as the Navy had declared that the torpedo developed by the DRDO did not meet the envisaged QRs. Reasons for not completing the second and third phases of the project were called for from the Navy. Their reply was awaited (November 2013). Our scrutiny

[8] Development of Wire Guided Torpedoes was initiated by NSTL in 1977 and an R&D project was sanctioned for the purpose in 1982 at a cost of ₹4.755 crore. The torpedo developed was found to be unsuitable for induction.

revealed (December 2012) that the project could not reach its desired objective mainly due to Navy's inconsistent policies as discussed in the subsequent paragraphs.

Although the Navy had decided (1997) to close the project as TD it, however, continued with the trials. For this purpose, a project 'Evaluation Trials for WGT' at a cost of ₹4.80 crore was sanctioned to NSTL in October 2001 with PDC as April 2004. In the meantime, in June 2002, the Navy decided to convert the submarine WGT to a ship WGT, naming it "Takshak". This project was successfully completed in April 2004 at a cost of ₹4.47 crore and eventually paved way for the development of pre-production models and conducting user acceptance trials for induction into service. For this purpose, in August 2004, Ministry of Defence sanctioned the project "Development and Evaluation Trials of Heavy Weight Ship Launch Torpedo [(TAKSHAK (NST-200)] at an estimated cost ₹22.25 crore. Under this, five D&E torpedoes were to be developed and produced under ToT.

The Navy finally decided in July 2005 not to induct WGT in their inventory on the ground that the NSQRs were outdated and instead preferred 'Varunastra' (High Speed Heavy Weight Ship Launch Torpedo), a new project that had been sanctioned in August 2002 at a cost of ₹48.50 crore. The Navy, thus, recommended (July 2005) to stage-close the project Takshak.

We noticed (July 2012 to November 2012) that NSTL had in its closure report of the project WGT stated (February 2001) that they had developed the WGT indigenously with the infrastructure established within the country. Various critical and state of the art technologies had been established which would be used in ongoing and future projects and that WGT could replace a torpedo in the Navy, if required in the near future. However, Navy had then stated (June 2001) that WGT would be inducted into service when proved to their satisfaction. According to the Navy, the development of indigenous torpedo technology was in keeping with their long term goal of total self-reliance in armaments. We, however, observed (December 2012) that the project could not achieve this ultimate objective even after a decade since its closure and the outcome of WGT evaluation trials was limited to successful technology

demonstration and establishment of processes and products in the areas of both ship launch and submarine launch heavy weight torpedoes.

Ministry of Defence (DRDO) in its reply (September 2013) agreed that frequent changes in the QR, especially at the end of the project proved to be a hindrance for the DRDO to bring the project to any logical conclusion. They added that though the Navy had procured torpedoes rendering the DRDO's efforts unfruitful, the expertise accumulated had been kept alive as the technology was relevant and could be required in future.

To sum up, the process started in 1991 with a definite requirement to develop and induct a Submarine launch WGT did not reach its logical conclusion of induction into service even after passage of two decades and an expenditure of ₹28.33 crore (₹23.81 crore on WGT, ₹4.47 crore on its trials and ₹5.05 lakh on TAKSHAK). Citing obsolete technology, another project VARUNASTRA has been taken up in August 2002 at a cost of ₹48.50 crore. The sequence of events of the development of WGT shows that frequent changes given by the user led to the non-achievement of the objective of the project and an expenditure of ₹28.33 crore incurred on the development of Wire Guided Torpedo has largely been rendered unfruitful.

(b) Design and development of High Speed Heavy Weight Ship Launched Torpedo (VARUNASTRA)

Varunastra is an electrically propelled Heavy Weight Ship Launch Torpedo for Anti submarine operations. Varunastra was sought to be developed with state of the art features in control, homing and recovery aspects and with the best propulsion technology that could be achieved in the country. The torpedo was designated for existing 'R' class ships, 'D' class ships and also future ASW ships, capable of firing Heavy Weight Torpedoes. The torpedo was to be made compatible to the launchers available onboard of the ships and to the Fire Control System (FCS).

Based on the experience gained by NSTL, Visakhapatnam in the development of Advanced Experimental Torpedo (AET) and Wire Guided Torpedo (WGT)), Navy in March 2002 requested DRDO to undertake a project to develop a torpedo to meet the operational needs of enhanced homing

performance, higher speed, range and low self noise. The anticipated requirement of the torpedo for the Navy, was more than 'Z' numbers.

Based on a project proposal submitted by NSTL and Outline Staff Requirements (OSRs) formulated by Navy in March 2002, the Government of India, Ministry of Defence in August 2002 sanctioned the project to NSTL, initially as an R&D project, at an estimated cost of ₹48.50 crore with PDC of four years (August 2006). The OSR were later translated into NSQR in August 2005 with higher-end specifications. The aim of the project was to design, develop, fabricate, test and prove at sea all the technologies and systems required for an Advanced Heavy Weight Torpedo for launch from the designated classes of ships. Ten prototypes were proposed to be developed; out of which four would be R&D models and six to be D&E models.

The project underwent six revisions in PDC, last revision being December 2013, and two revisions of cost to ₹74.50 crore. So far (September 2013), three R&D torpedoes and eight D&E torpedoes were developed in association with the production agency, M/s BDL, Hyderabad, of which two D&E and one R&D torpedoes were lost during trials at sea. User Evaluation Trials (UETs) were in progress and an amount of ₹70.87 crore had been incurred on the project (November 2012).

Absence of a firm QR at the outset impacted the completion of the project. NSTL stated (October 2011) to DRDO Headquarter that the OSRs, based on which the project was sanctioned, were found (October 2011) not feasible for realisation with the available technology in the country, particularly in respect of battery and motor, but Navy had urged (October 2011) DRDO to pursue the project. Thereafter, it took another three years i.e. from April 2002 to August 2005 for the Navy to come up with an approved NSQR with realisable requirements. In the NSQR, Navy enhanced the features of Varunastra and altered the specifications. To accommodate the changed specifications, the Lab had to re-start the whole development and the design which entailed extension of PDC. A significant span of three years was lost in the process. The remaining delay was attributed, *inter alia*, to the time taken in identifying and engaging the production agency and delay in conduct of trials. The cost overrun was due to introduction of production agency (M/s BDL and

M/s BEL), transfer of technology and procurement/integration of torpedoes for User Evaluation Trials (UETs).

Navy, however, disagreed (June 2013) with the DRDO's contention and stated, inter alia, that:-

(i) OSRs of March 2002 were promulgated after prolonged consultations with NSTL and after scaling down the 'staff targets' promulgated in May 2000. The Lab had confirmed (January 2002) that it would meet these requirements.

(ii) The formulation of final NSQRs was delayed due to delay by the DRDO (2 ½ years) in preparation of the Project Definition Document (PDD) Version 3. NSQRs were formulated within six months of receipt of the draft PDD Version 3.

(iii) There was no enhancement of features and the features/specifications were mutually defined.

(iv) The contention of DRDO that the whole development of Varunastra was restarted after August 2005, was not correct as the trials of Varunastra had started in December 2005.

(v) As regards cost overrun due to introduction of production agency, the OSR itself had envisaged concurrent engineering approach which was accepted by NSTL and at no stage, NSTL had highlighted any problems in this regard.

Our scrutiny, (November 2012), however, revealed that the final NSQRs were at variance with the OSR in the parameters of length, weight, range, operating depth and crushing depth of the torpedo. The changed specifications contributed to the delay. Thus, while Navy was responsible for the delay due to changes made in the NSQRs, the DRDO delayed the preparation of PDD Version 3, and caused further delay in identification of production agency and in conduct of trials.

Thus, the project sought to be completed by August 2006 had not been completed (September 2013) even after time overrun of six years and cost overrun of ₹26 crore.

(c) Design and development of Thermal Propulsion System for Heavy Weight Torpedo (Project Shakti).

NSTL, Visakhapatnam in February 1995 proposed to design, develop, test and prove a thermal propulsion system using Otto fuel and Hydroxyl Ammonium Perchlorate (HAP) to power a heavy weight torpedo at a higher speed for use by the Navy at the turn of the century. It was also felt that the technology involved was representative of state of the art engines of advanced weapon systems being inducted into service and would not be available from any external agency. It was, therefore, important to start developing such engines indigenously.

Based on NSQR promulgated by Navy in March 1996, the Government of India, Ministry of Defence in May 1996 sanctioned the project "Design and Development of Thermal Propulsion System for Heavy Weight Torpedo (SHAKTI)" (NST-171) as a Technology Demonstrator (TD) to be carried out by NSTL at an estimated cost of ₹16 crore with PDC of four years (May 2000).

PDC of the project was revised four times, till November 2002 on the reason that the turbine had to be re-designed for higher inlet temperatures, delay in realising improvement in hardware, delay in manufacture and testing of pump stack and in completing the integrated trials for proving integrated engine performance, design modifications, and completion of integrated and endurance trials. The project was successfully completed in November 2002 after incurring an expenditure of ₹15.86 crore.

In November 2003, the Government of India, Ministry of Defence sanctioned another TD project to NSTL for "Packaging, Integration, and Proving of Thermal Torpedo including Technical trials at an estimated cost of ₹34.04 crore with date of completion as May 2007, and also merged it with another project on Technical Co-operation between NSTL and a foreign firm for "Development of Thermal Torpedo". The latter project was not based on

QR and its scope was to manufacture, assemble and integrate thermal torpedo test vehicle and check for the functional performance trials. The project was completed in March 2010 after three revisions of PDC for various technical reasons relating to trials, development of turbine rotors etc. NSTL stated (January 2012) that upon successful demonstration of the project, the Lab had expressed their desire to take up a MM project for Development of Thermal torpedo. However, Navy did not respond to formulate a revised NSQR for the development of Thermal Torpedo.

Even though NSTL had claimed that the TD project was successful, Navy did not agree. When audit sought to know (March 2013) the reasons for the delay in taking up the project on development of Thermal Torpedo, Navy stated (June 2013) that culmination of a TD project into an MM project is possible only when DRDO demonstrates its capability to develop component technology in a TD project. Since the objectives of the TD project were not met and developmental capability not demonstrated, the project was not pursued further.

Thus, the objective of the TD project could not be met by the DRDO and the expenditure of ₹47.68 crore incurred on the two TD projects (₹15.86 crore on Project Shakti and ₹31.82 crore on its integration and trials) did not benefit either the Navy or the DRDO.

(d) Design and Development of Light Weight Mine (LWM)

Based on a project proposal from NSTL and NSQR from Navy, the Government of India, Ministry of Defence, Department of Defence Research & Development accorded sanction in August 2004 for the Project titled "Design and Development of Light Weight Mine (LWM)" at an estimated cost of ₹2.86 crore with PDC as of August 2006. Preliminary NSQR of December 2002 was modified in May 2003 and in August 2005.

The main objective of the project was the design and development of shallow water Light Weight Mine (LWM) for the Indian Navy. The project was to be undertaken in two phases: (i) Design, development and proving of ship launched version and (ii) Design and Development of air launched version.

The project was extended till December 2007 due to changes in QR and eventual design changes. Besides, change in the platform for mine laying from aircraft 'D' to aircraft 'I' and also the technical requirements such as ship countermeasure settings, MCM logic, acoustic telemetry and integration of all sub-systems added to the delay.

We observed (November 2012) that the User Evaluation Trials concluded between January 2010 & October 2011 were unsuccessful due to non-compliance of the QRs. Consequently, the induction of LWM was awaited (October 2012) subject to successful compliance of the UETs.

Thus, though the project commenced with a definite QR in 2004 and was planned to be completed by August 2006, it was extended till December 2007. Further, UETs were still (November 2012) under progress. In November 2012, Navy stated that there was considerable gap in their mining capability due to delay in realisation of the project and the existing mines stock catered only partially to the total requirement. The compliance to NSQR post UET in October 2012 was sought (March 2013) by us from the Navy and the DRDO and was awaited (November 2013).

In response (September 2013) to the Draft Audit Paragraph, Ministry of Defence (DRDO), however, accepted our findings and stated that the change in QR led to fresh design, different specifications, infrastructure and finally to time and cost overrun.

Conclusions

Our review of 24 projects which had a QR and were undertaken by three naval laboratories, viz. NMRL, NPOL and NSTL showed that 21 (87 *per cent*) out of 24 projects witnessed time over runs of six months to nine and a half years and six projects witnessed cost over run ranging from 38 to 348 *per cent*.

A further examination of nine projects with significant time overruns showed that the desired outcome i.e. productionisation and ultimately induction of the system/ technology could not be realised. Existence of QRs indicated that Navy either had a definite requirement or at least a felt need of the capability.

Recurrent cost and time overruns raised questions on the ability of the laboratory to deliver the systems / technologies as promised, at initially sanctioned cost and within the PDC. The time overruns in 87 *per cent* of the projects could lead to a situation where originally envisaged PDC being viewed as indicative only, with every possibility of extension of the project at the sanction stage itself.

Specifically, this study has brought out that:

- There were differences of opinion between the Laboratory and the Navy regarding whether a project was successful or not. While the Laboratories viewed the outcome based on the conformity of the technology / system to the QRs, Navy measured success based on its ability to perform in an operational situation. The differences also extended to what methodology be used in evaluation and whether all the results of evaluation were documented properly (Projects Nagan/Maareech). This indicated the need for a more rigorous approach to determine the success criteria and an agreed methodology for evaluating the same.
- The delays in completion of DRDO projects resulted in the projects facing a constant threat of obsolescence. By the time the systems were ready for evaluations, they were found to be obsolete *vis a vis* the contemporary technology. This led to sanction of new projects with stiffer parameters for the same deliverable (Project Nagan, LFDS, WGT, LWM). Clearly, there was a need to spell out the time frames realistically, taking into account parameters like time required for evaluations, contingencies, technological challenges, non-availability of platforms for evaluations.
- Some of the projects suffered due to inefficiencies in framing and communicating the QRs timely, or due to changes in QRs midway. While Project Nagan was a case of obsolescence, the Navy did not

improve and communicate revised NSQRs. Only on completion of the Project did the Navy communicate the outcome as obsolete. Similarly, in Project Mareech, though the Navy had a definite need, it did not communicate NSQRs to the DRDO in this MM/Staff project. In the case of Project LFDS, Navy initially diluted the NSQRs but on completion of the project, held the developed system obsolete and not fit for induction. For Project WGT, the platform was changed from submarine launched to ship launched midway of the project. This project was closed and a new Research & Development Project Varunastra was launched with OSRs that were found to be unrealizable by the DRDO. NSQRs for this project were framed three years later and further enhanced thereafter. In Project Shakti, Navy was yet (September 2013) to come up with a Staff/MM NSQRs. Project LWM also witnessed changes in NSQRs. Clearly, timely formulation and communication of appropriate QRs require to be far more robust than those available at present.

- Two projects namely Diver Deterrence Sonar and SBA were ill-conceived. In the case of former, such technology did not exist elsewhere as admitted by the Navy. Similarly, with regard to SBA, the project did not suit Indian conditions. The projects were closed only after DRDO had spent considerable resources.

Ministry of Defence (DRDO) stated (September 2013) that the projects are successful regardless of the technology developed being utilised or not and that the non-acceptance of the user cannot be termed as failure in Research and Development.

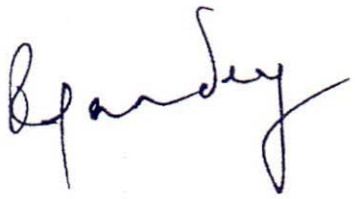
While the Ministry's contention that R&D projects cannot be termed as failure is partially acceptable, however, the fact remains that projects with a QR indicate that the Navy had a specific need for the equipment and such projects would, therefore, definitely need to be completed successfully, which in many cases as has been brought out in review, was not done. Similarly, a successful R&D and TD project should lead to a MM/Staff project, eventually leading to productionisation. However, this was not the case.

Ministry of Defence (DRDO) while broadly agreeing to the audit conclusions, stated, *inter alia*, (September 2013), that all these projects were first time development of products with *ab initio* development of necessary technology and hence were time consuming. Technology Development processes are difficult and therefore, time and cost estimates for such projects are at the best 'approximate'. Sometimes, the user is forced to seek changes in NSQRs due to changing technological scenario and any change in NSQR had time and/or cost penalty; and in some cases when a sub-assembly is developed in the lab, it becomes difficult to find suitable vendor. They also stated that various measures have been taken to mitigate the pitfalls in the execution of projects: concurrent development of technology, commissioning of a series of TD projects to develop technologies to keep them ready to meet product requirement of the user; development of well defined UET schedules with quantiative success criteria by mutual negotiations with the users to address the ambiguity and conflicts and involvement of the user from the beginning of the project and not at the trial stage.

Recommendations

- There is a need to re-visit comprehensively the existing project planning and management, particularly in terms of the probable date of completion (PDC) being projected. The PDC should be more realistic and also include sufficient time for user evaluation and user trials, availability of platforms, time required for modifications to platforms and development of prototypes etc.
- To overcome the different perceptions over success criteria for a project, there is a need to further refine and document the success criteria and test conditions etc. in addition to the QRs, at the time of project sanction itself, to ensure greater clarity.
- Navy needs to formulate and communicate mature QRs quickly to DRDO. In case, it is not feasible to formulate QRs, the fact should be communicated to the DRDO as early as possible. In those cases where owing to the technology obsolescence, existing QRs require a change, the revised QRs should also be communicated promptly to the DRDO.

- There is also a need for the Navy to introduce greater rigour in formulating QRs and ensure that QRs reflect the appropriate and deployable technology.
- DRDO should be more pro-active in timely completion of existing projects. Where the projects are beyond current capability of the DRDO, this should be communicated early to the user service.



New Delhi **(RAJIV KUMAR PANDEY)**
Dated: **Principal Director of Audit**
Air Force

Countersigned

New Delhi **(SHASHI KANT SHARMA)**
Dated: **Comptroller and Auditor General of India**