THE NAVAL ENGINEERING TEST ESTABLISHMENT OF THE CANADIAN NAVY

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ABSTRACT

This article is an introduction to the organization, role and facilities of the Naval Engineering Test Establishment. It also includes a summary of the principal Test and Evaluation programmes in progress.

Introduction

The aim of this article is to outline the role and administrative structure of the Naval Engineering Test Establishment (NETE) and to present an overview of the work that the Establishment performs on behalf of the Canadian Navy.

In many respects, NETE is similar to the Royal Navy's Admiralty Research Establishments. However, because of its overall size and current commitments, the Canadian Navy operates only two test estabishments. Work related to underwater weapons is conducted at the Canadian Forces Maritime Experimental and Test Ranges (CFMETR), which is located on Vancouver Island, British Columbia. NETE, a Government Owned Contractor Operated (GOCO) unit is situated mainly in Montreal, Quebec, and has evolved over four decades to serve as the Navy's principal centre for other aspects of naval Test and Evaluation (T&E).

The development and capabilities of NETE have been affected primarily by national warship acquisition policies and, to a lesser extent, by the overall structure of the Department of National Defence (DND). Consequently, the first part of this article will review the relevant aspects of the political and organizational environment within which NETE operates. This is followed by an outline of the internal administrative arrangements, a description of existing and planned facilities, and by a discussion of the principal areas of expertise. Finally, an account of typical projects, completed and in progress, is provided.

DND Procurement and Organization

The Canadian Navy is in the midst of a long overdue modernization programme. Its fleet of ageing steam powered destroyers, built in the late fifties and early sixties, is scheduled to be replaced over the next five years by 12 Canadian Patrol Frigate (CPF) Class vessels. In addition, the four TRIBAL (TRL) Class gas turbine driven destroyers commissioned in the early seventies, are undergoing a mid-life conversion through the TRIBAL Update and Modernization Program (TRUMP). This level of shipbuilding activity, which is quite remarkable by Canadian standards, will culminate in a complete transformation of all active elements of the Fleet by 1996.

Both CPF and TRUMP ships are under construction by civilian consortia to specifications developed by the Navy. The successful prime contractors, Saint John Shipbuilding Ltd. for the CPF and Litton Systems Ltd. for the TRUMP, have total responsibility for the design, selection and supply of equipment, systems integration, actual construction, the provision of training facilities and spares, and the conduct of trials intended to demonstrate to DND that the new ships meet their generic performance specifications. In essence, the prime contractors are responsible to deliver completely supported ships which meet the prescribed capability requirements.

The contracts for these programmes have been issued by Supply and Services Canada (SSC), the department which oversees and administers all federal government procurement. Supervision of the CPF and TRUMP Major Crown acquisition projects (in excess of $100M CND), is exercised through the respective Project Management Offices (PMOs) which are staffed by DND and SSC personnel. In simple terms, technical issues are handled by the DND representatives as the ultimate users of the deliverable, whereas the SSC group addresses contractual and procurement questions. The PMOs report to the Assistant Deputy Minister (Material) (ADM(Mat)), who is responsible for the procurement and life cycle management of weapon systems within DND.

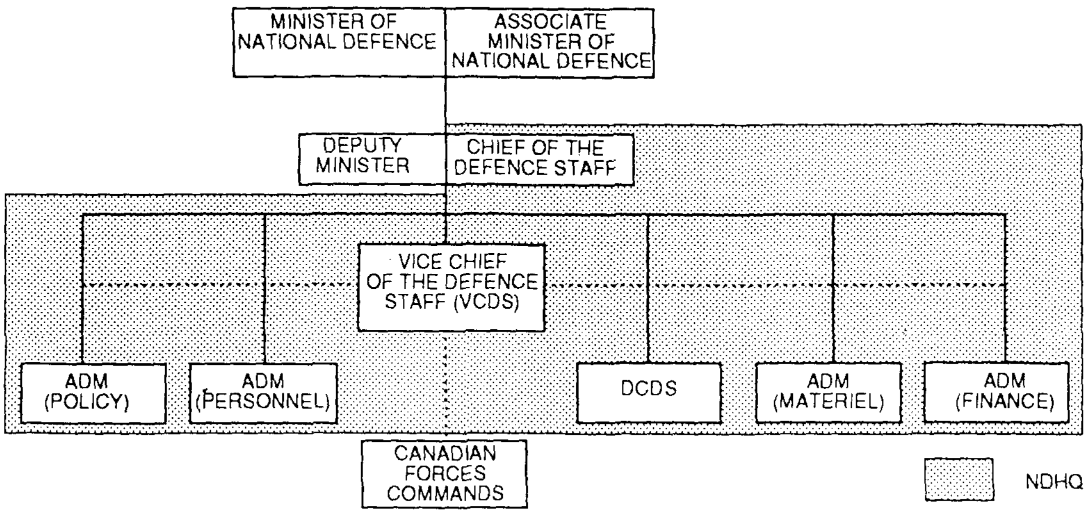

FIG. 1—DEPARTMENT OF NATIONAL DEFENCE ORGANIZATION

ADM: Assistant Deputy Minister
DCDS: Deputy Chief of the Defence Staff
NDHQ: National Defence Headquarters
VCDS: Vice Chief of the Defence Staff

A simplified organigram of the DND and of National Defence Headquarters (NDHQ) is shown in FIG. 1. The Field Commands of the Canadian Forces are linked to NDHQ and the Chief of the Defence Staff (CDS) via the Vice Chief of the Defence Staff (VCDS). Geographically, NDHQ is located in Ottawa, Ontario and the Maritime Command (MARCOM) on the East Coast is stationed about 1,600 km away in Halifax, Nova Scotia. The Maritime Pacific Command (MARPAC) on the West Coast is situated in Esquimalt, British Columbia, a distance of 4,500 km from NDHQ. The Field Commanders and the VCDS are three maple leaf (star equivalent) positions.

The condensed versions of the ADM(Mat) Group and the Chief Engineering and Maintenance (CEM) Branch organizations are depicted in FIG. 2. The Materiel Group is the largest of the five Groups at NDHQ and employs approximately 12,500 people. The Director General Maritime Engineering and Maintenance (DGMEM) is a commodore and is responsible for third level support of naval equipment and systems. In this context, third level support encompasses those activities which are necessary to assure that materiel continues to function to the original or to a modified level of performance throughout its life cycle. Second level support, which is concerned mainly with operational problems, is provided by the Naval Engineering Units (NEUs) which are attached to MARCOM and MARPAC. The DGMEM, through the Director Maritime Engineering Support (DMES), exercises functional and administrative control of CFMETR and NETE.

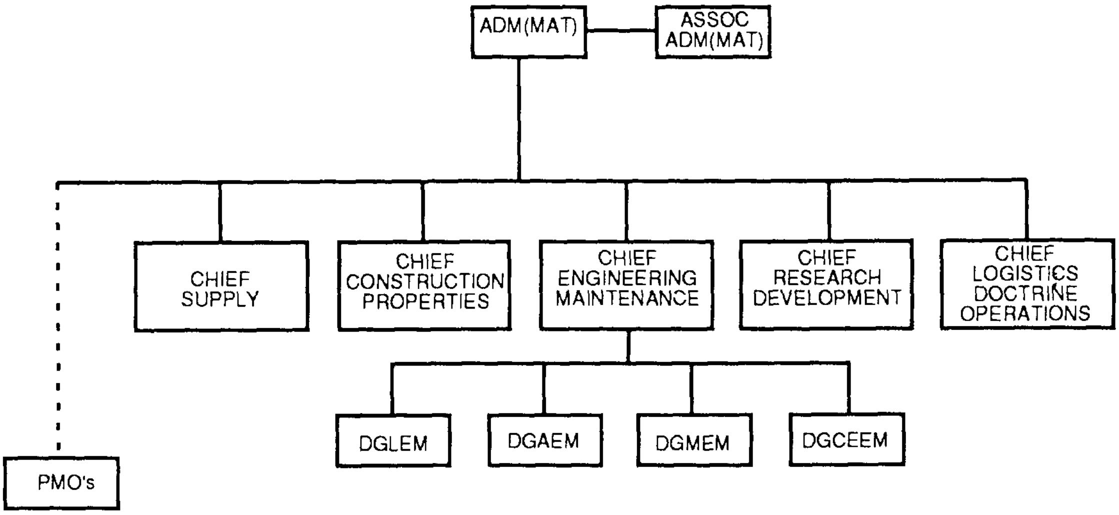

FIG. 2—CONDENSED ORGANIZATIONAL CHART OF THE ASSISTANT DEPUTY MINISTER (MATERIAL) GROUP AND THE CHIEF ENGINEERING AND MAINTENANCE BRANCH

ADM(Mat): Associate Deputy Minister (Material)
DGAEM: Director General Aerospace Engineering and Maintenance
DGCEEM: Director General Communications and Electronics Engineering and Maintenance
DGLEM: Director General Land Engineering and Maintenance
DGMEM: Director General Maritime Engineering and Maintenance
PMOs: Project Management Offices

Historical Background and Mandate

NETE was established in 1952 under a contract from the Department of Defence Production (disbanded in 1968) to Peacock Brothers Ltd. for the installation of appropriate facilities to test the steam and electrical equipment employed in the DDE 205/257/261/265 (now designated ISL, IRE, MKE and ANS) Class destroyers. Upon completion of the necessary modifications to a government-owned building in LaSalle, Quebec, Peacock Inc. was contracted to manage NETE and provide the personnel needed to support naval shipbuilding programmes. In 1968, functional control of NETE was transferred to DND and NETE was constituted as a Field Unit of ADM(Mat) reporting to DGMEM. The GOCO arrangement, where the government owns outright the building and associated plant, but the facility is operated, manned and maintained under successive three-year contracts by a private concern, has been continued since the inception of the Establishment.

The execution of the contract is monitored by the NETE Management Committee which consists of representatives from DND and SSC. NETE taskings are processed through DMES 7 and are submitted directly to the unit Commanding Officer (CO). A detailed accounting of expenditures incurred for each assignment is maintained. Compliance with the terms and conditions of the contract is provided by the CO, who also acts as the liaison between the NETE civilian personnel, other military organizations and foreign government agencies. The CO, a lieutenant-commander, is in fact the on-site DND inspecting and coordinating authority.

The current mandate of NETE is to provide third line T&E services in support of naval equipment for the Canadian Forces. The scope of these services has expanded considerably since the beginning of the Establishment when it was limited to production and environmental qualification testing of steam equipment. The latter type of activity continued for almost twenty years and only began to diminish with the commissioning of the TRL destroyers. After the early 1970s, NETE became actively involved in investigational and maintenance work of marine equipment, it built gas turbine test facilities, pioneered the development of several Equipment Health Monitoring (EHM) techniques and developed capabilities for field measurements and analysis of transient waveforms. More recently, and in keeping with the technology of the CPF and TRUMP, NETE has broadened its activities to include software verification, combat systems support, and reliability studies as they relate to the implementation of the promulgated Reliability Centered Maintenance (RCM) policies.

Today, these in-service support activities account for the major thrust of NETE's total effort. They represent a substantial departure from the routine in-house qualification and production testing which predominated until 1970 and have led to an increased level of interaction with elements of the naval community outside NDHQ. As a result of the changes in direction and scope of work, NETE has instituted a number of Field Service Representative (FSR) positions within the NEU organizations to improve communications with the fleet and has entered into a bilateral Information Exchange Program (IEP) with the U.S. Navy's Naval Ship Systems Engineering Station (NAVSSES) in Philadelphia, Pa.

The last historically relevant event is the NETE Upgrade Plan 1990. The goal of this project, which was initiated in 1986, is to update and modernize the steam-oriented test and evaluation facilities so that the CPF and TRUMP ships may be supported. Highlights of the proposal include a new building and numerous new test capabilities. Details of the planned facilities and services are discussed later in this article.

Organization

The principal NETE site occupies about 8,500 m^2 of land and is located in LaSalle, Quebec, a suburb of Montreal, 200 km from NDHQ. It consists of test installations and office space in a 3,500 m^2 building and of several ancillary annexes. Leased facilities include 400 m^2 of office accommodation about 2 km away and a remote inland body of water to conduct large-scale shock tests.

NETE employs a staff of 130 full-time civilian personnel and a number of part-time consultants for specific non-routine projects. While most of the staff are employed at the main site, about 10% work on long-term assignments either at NDHQ or at HMC Dockyards in Halifax and Esquimalt. Because NETE is a GOCO facility, its internal administrative organization is somewhat unusual. On the military side, the senior officer is the CO. His role is mainly to oversee the execution of the contract, to assign project priorities and to act as the liaison with military units. On the civilian side, the Manager has overall responsibility for the operation of the Establishment. Administrative services such as purchasing, inventory and budget accounting to control expenditures within the approved funding envelop are provided by a staff of eight. It should be pointed out that personnel, accounts payable and auditing services are furnished by Peacock, Inc. as part of their management responsibilities.

FIG. 3 illustrates the reporting and organizational structure for NETE. Internally, the Establishment is constituted along two main streams. The Plant Services group is headed by the Plant Engineer and consists of 41 craftsmen and technicians. This group is responsible for the maintenance, fabrication and operation of all internal and field test installations, as well as property security and general upkeep including minor space renovations and alterations. Available facilities comprise a self-sufficient machine shop, a metal fabrication shop and welding equipment.

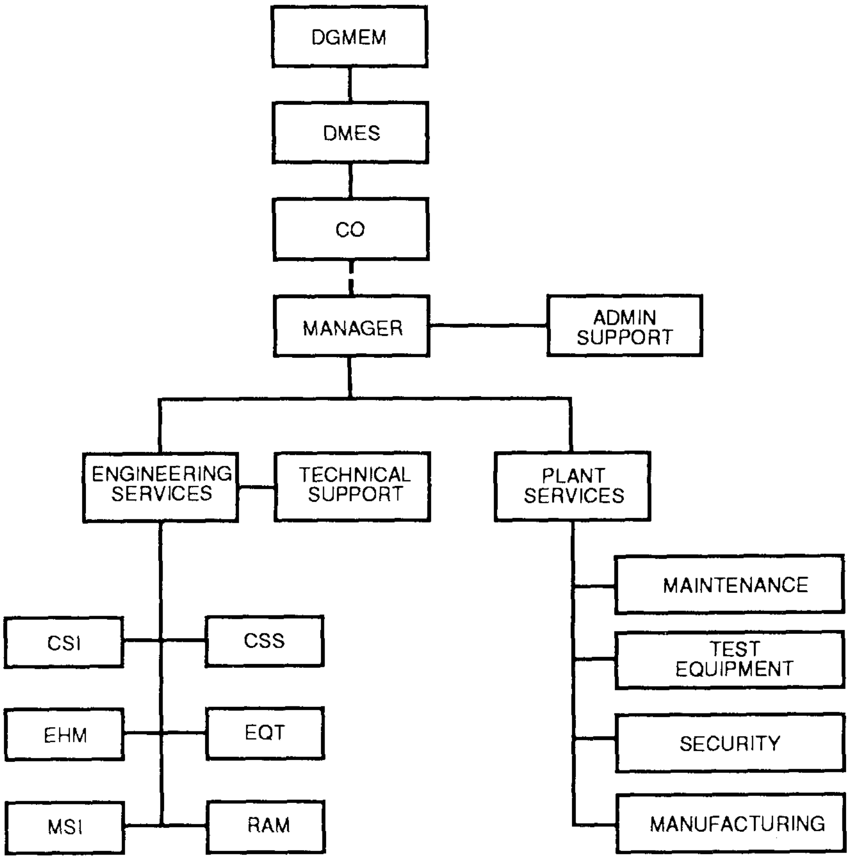

FIG. 3—NETE ORGANIZATIONAL STRUCTURE (1990)

CO: Commanding Officer
CSI: Combat Systems and Instrumentation
CSS: Computer Systems and Software
DGMEM: Director General Maritime Engineering and Maintenance
DMES: Director Maritime Engineering Support
EHM: Equipment Health Monitoring
EQT: Environmental and Qualification Testing
MSI: Marine Systems Investigations
RAM: Reliability, Availability and Maintainability

The Engineering Services group has a staff of 56 engineers, 13 technicians and 12 support personnel. Under the supervision of the Director of Engineering, it is responsible for the execution of all assigned tasks. The group is further subdivided into six major sections, which in a loose manner reflect the nature of technical work undertaken. In order to optimize utilization of resident expertise, a matrix management approach between sections has been adopted. This flexible arrangement fosters collaboration and leads to a more productive and stimulating technical environment.

Existing and Planned Capabilities

Canadian procurement policies for the acquisition of Major Crown Projects place the onus on the supplier to deliver qualified and fully functional naval platforms and associated systems. As a consequence, the T&E programs undertaken by NETE are concerned mainly with the evaluation and development of techniques and the testing of components and pieces of equipment rather than complete systems. This is reflected in the scope of installed facilities which, in general, are versatile to accommodate a range of naval items. Moreover, because of space limitations, only a small part of the installations can be considered permanent. A brief description of generic capabilities is given below.

FIG. 4—MACHINE SHOP, WITH THE ENVIRONMENTAL TESTING AREA IN THE BACKGROUND

Environmental and Qualification. These facilities (FIG. 4) are designed to assess performance of test specimens in either static or dynamic modes in simulated marine or other adverse environments. Modifications may be incorporated to assure that a prescribed performance level is attained. Because of their specialized nature and anchoring requirements, they represent permanent set-ups. Specimens can be subjected to controlled shock, vibration, temperature, humidity, salt-fog and oscillatory motion conditions to the following limits:

- Shock— Lightweight Machine to 115 kg
  Mediumweight Machine (FIG. 5) to 3,400 kg
  Floating Shock Test Platform to 14,500 kg

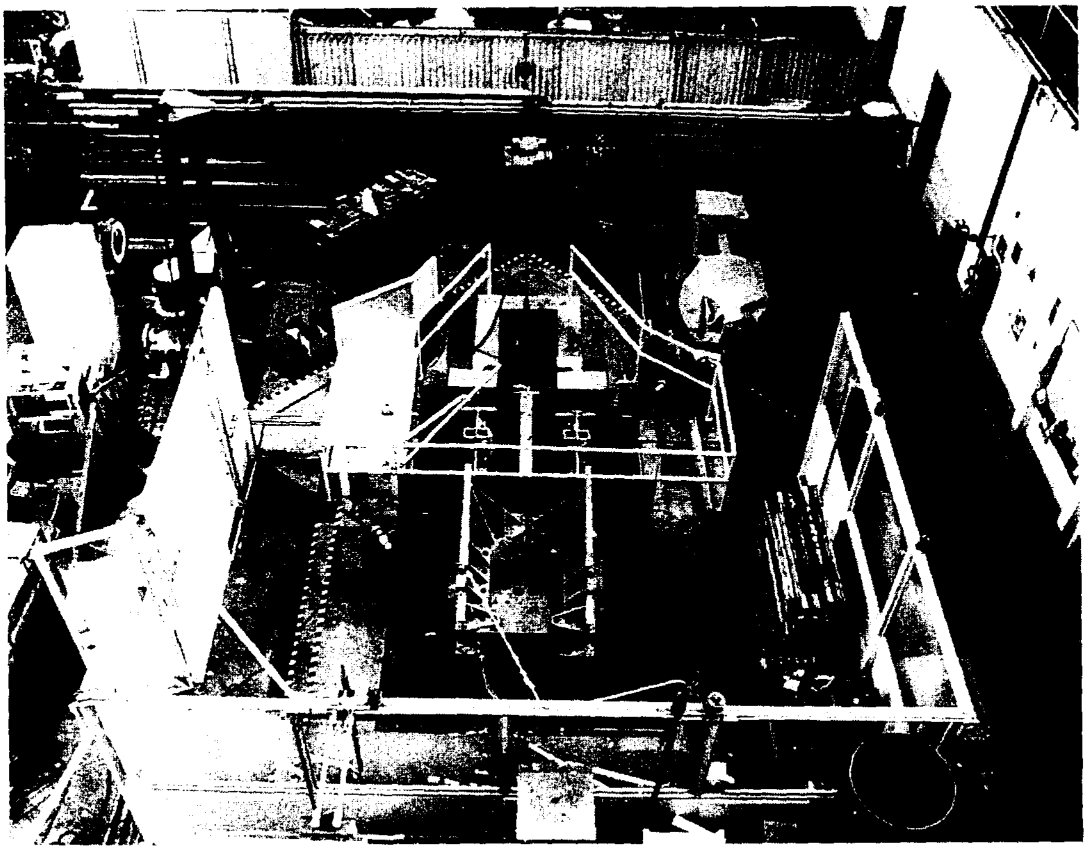

FIG. 5—MEDIUM WEIGHT SHOCK TEST INSTALLATION

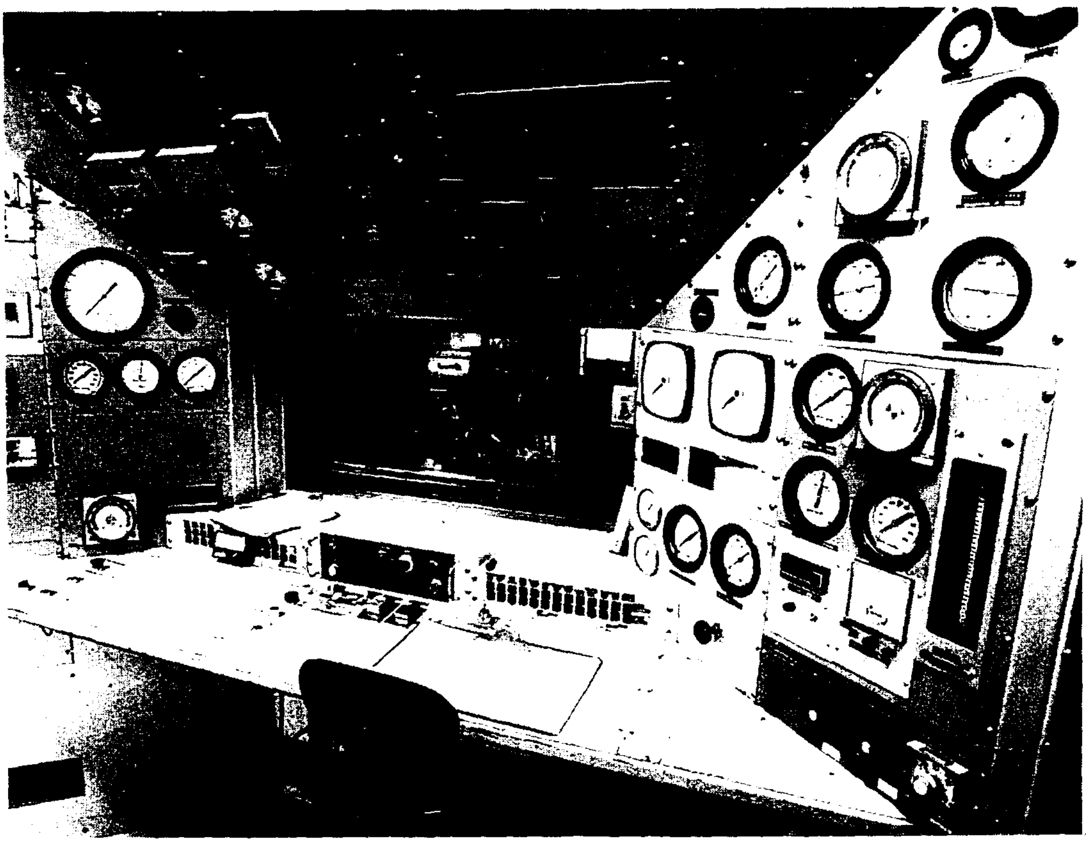

FIG. 6—ENGINE TEST CELL CONTROL ROOM

- Vibration— Mechanical Exciter developing 111,000 N to 60 Hz at 0.35 cm Peak to Peak to 136 kg
  Electrodynamic Exciter developing 26,700 N to 3,500 Hz at 2.54 cm Peak to Peak up to 1,360 kg
  Electrodynamic Exciter developing 66,700 N to 2,500 Hz at 2.54 cm Peak to Peak up to 3,400 kg
- Temp/Humidity— Independently controlled Temperature and Humidity chambers from $-62°C$ to 80°C and from 20% to 95% up to $4 \times 3.5 \times 2.4$ m high
- Salt-Fog— Chamber Enclosure $3 \times 3 \times 2.4$ m high up to 35°C
- Oscillatory Motion—Platforms to $\pm 45°$ with periods from 8 to 20 s up to 1,350 kg, along one or two axes

Engine Cell. Prime mover evaluations are performed in a fully instrumented test cell (FIG. 6) constructed to accommodate gas turbines up to 5,220 kW and diesel engines up to 3,000 kW.

Test Circuits. These quasi-permanent installations encompass a broad spectrum of test circuits designed to accommodate evaluation and performance testing of pumps (FIG. 7), compressors, generators, heat exchangers, instrumentation sensors, motors and steam equipment (FIG. 8). Principal testing capacities are:

- Electrical— 1.3 MW at 550 V, 3P at 60 Hz complete with step down transformers for 440, 220 and 110 V
  5 kW at 120 V, 3P at 400 Hz
  3 kW at 270 and 110 VDC
- Cooling water— 11.4 m^3/min, 3.2×10^{10} J/hr
- Steam Supply— 10,900 kg/hr, 4.14 MPa at 427°C
  2,250 kg/hr, 4.14 MPa at 427°C
  140 kg/hr, 4.14 MPa at 440°C

Chemical Laboratory. The chemical laboratory is equipped to handle a wide range of chemical analyses to ASTM Standards and has developed automated procedures for the analysis of exhaust gasses, fluid contaminants and quantitative determinations of oil quality.

Computer Facilities. The computational environment for office automation, management information processing and engineering applications, consists of a cluster network incorporating a MICROVAX II, a MICROVAX III and a VAX 6410. The network is supported by 64 MB RAM memory and 3.7 GB disk storage, and serves 65 terminals, 17 PC workstations and 15 hard copy output devices A high speed 32 channel Analogue to Digital Converter (ADC) (FIG. 9) is interfaced to the 6410 for on-line acquisition of transient signals. Other peripherals include a 386 33 MHz Tempest PC, a 12.5 MIPS stand-alone workstation and a two-terminal CAD system.

Photographic Facilities. The photography unit is equipped to process and develop a diverse variety of colour still exposures including microphotographs, and to produce standard as well as high speed video recordings up to 6,000 frames per second.

Planned Capabilities

The upcoming deployment of the CPF and TRUMP ships will be accompanied by several technological challenges. The new destroyers incorporate powerful electrical generation and distribution systems, employ distributed digital machinery control concepts, rely on integrated communication and fire control systems, employ sophisticated computer and data bus technology and will be maintained through progressive refits of the major components.

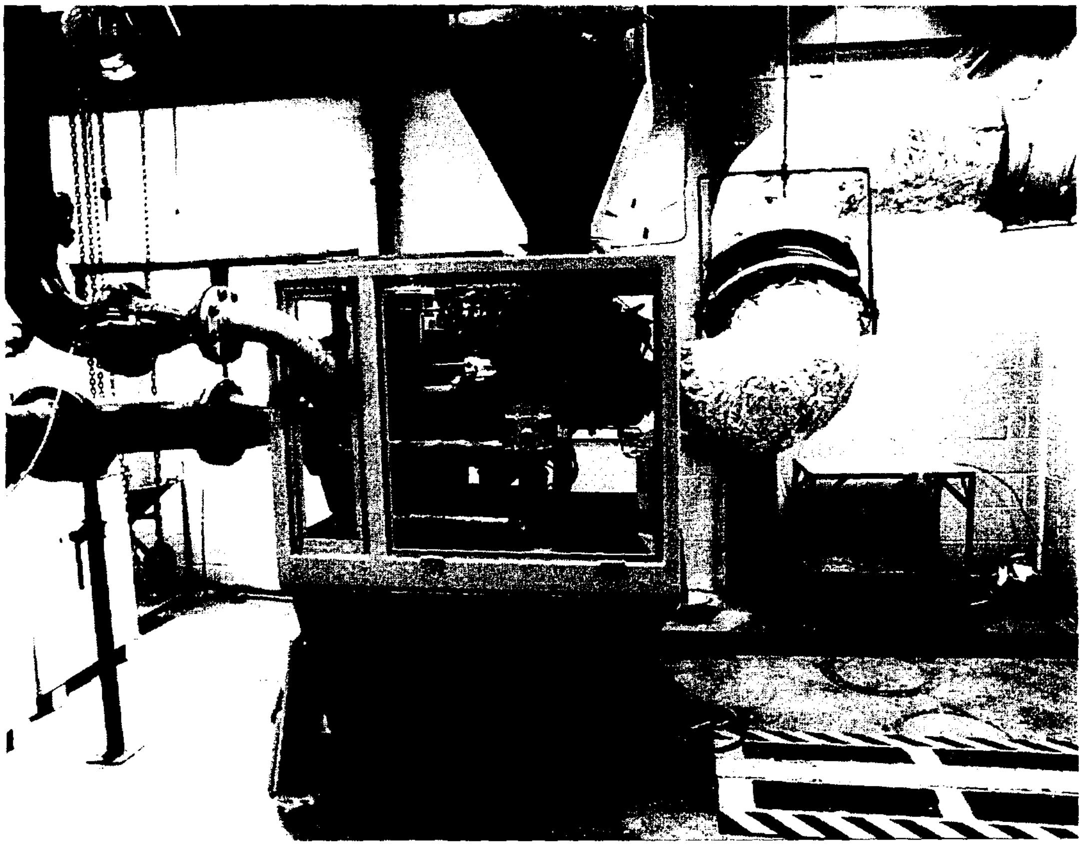

FIG. 7—THE TRUMP FIRE AND PREWET GAS TURBINE PUMP TEST SITE

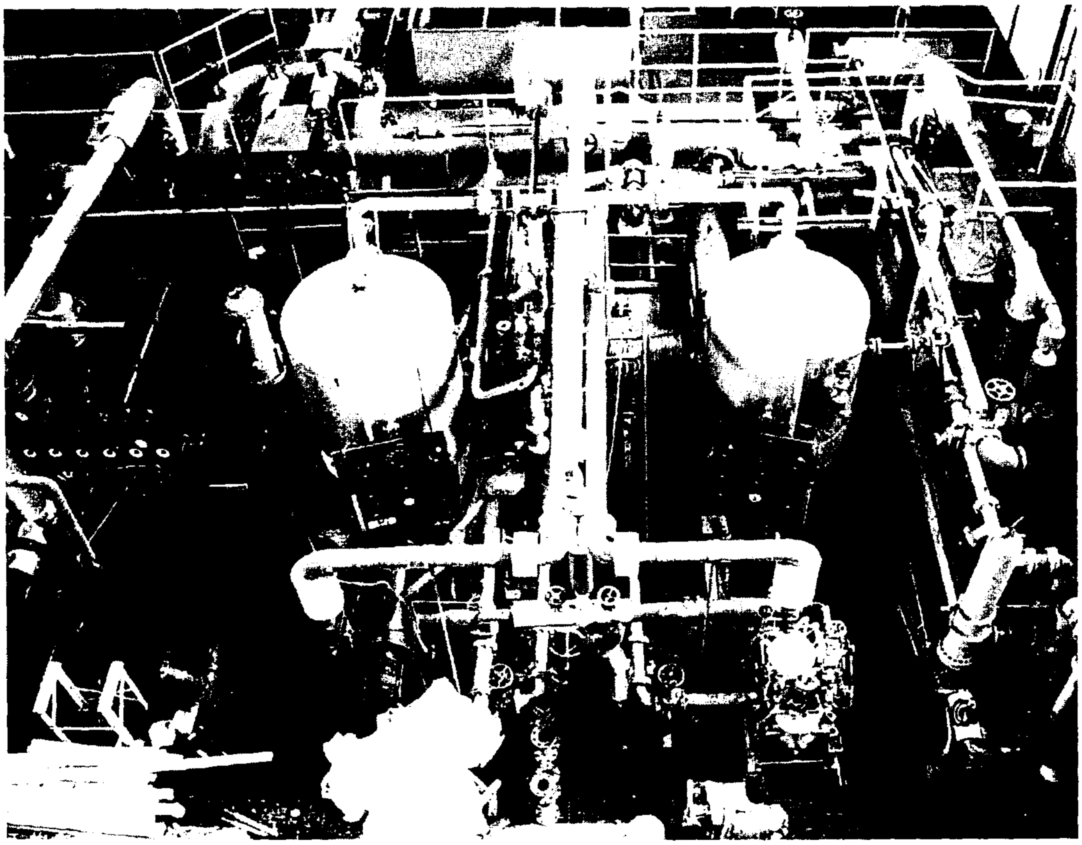

FIG. 8—STEAM EQUIPMENT PERFORMANCE TESTING AREA

FIG. 9—COMPUTER ROOM WITH HIGH SPEED 32-CHANNEL ANALOGUE DIGITAL CONVERTER

The support requirements for the next decade, coupled with the rapidly increasing awareness to control environmental pollution, are the primary reasons for the augmentation and expansion of NETE's capabilities. Under the NETE Upgrade Plan 1990, over a three year period starting in 1993, the Establishment, in addition to a general modernization of existing plant and a new building, will acquire the following facilities:

- Chamber for combined Temperature, Humidity and Vibration testing
- Programmable Shock Signal Generator & 400 kN Exciter
- Shielded Chamber for EMI/EMC evaluation
- Shielded Computer Room for Tempest installation
- Solid & Waste Water Environmental testing facility
- Engine Test Cells up to 22,500 kW
- Structural Material Testing capabilities

Concurrent with the projected facility enhancements, there are consonant increases in personnel to manage the implementation of new policies and provide specialist services during the introduction of the new elements of the Fleet.

Active Taskings

The role of NETE is to act as the T&E agency for the Navy's Design Authority. In this capacity, NETE is expected to make recommendations to NDHQ and has no implementation powers. During the 1989/90 calendar year, NETE published 110 reports and began the 1990/91 fiscal year with 300 active projects of varying magnitude and complexity. A number of these tasks involve co-ordination of existing naval programmes and as such, are of an on-going nature. However, the majority of the projects assigned to NETE deal with specific investigations, evaluations of feasibility studies and are of finite duration. The principal current activities of the six engineering sections are summarized below.

Combat Systems and Instrumentation (CSI)

The CSI Section is responsible for projects in the areas of combat system electronics, digital controls and instrumentation. Normally in a supporting role, the section designs and assembles instrumentation packages to acquire, record and reduce a number of dynamic engineering signals. Examples of the waveforms typically processed include shock, vibration, noise, strain, torque and pressure.

Current active projects comprise investigation of electronic noise experienced in fitted sonar receivers, definition of input/output parameters of the 750 kW gas turbine generator controller which is to be interfaced to the TRUMP Integrated Machinery Control System (IMCS) and the site installation and operation of instrumentation modules to acquire data during the HULVUL tests. The latter activity is in support of the Canadian participation in the series of underwater blast and airborne tests conducted by the RN on a decommissioned LEANDER Class frigate.

Computer Systems and Software (CSS)

This section manages the internal computational facilities and undertakes taskings in the domains of computer systems and software with emphasis on Independent Verification and Validation (IV&V), review of documentation and evaluation of computer related products.

Active projects include participation in the development of the computer-controlled and laser-guided helicopter Recovery Assist Securing & Traversing (RAST) Mk. III landing system, the Canadian Towed Array Sonar System (CANTASS), and the prototype version of the computerized shipboard Naval Maintenance Management System (NaMMS), evaluation of commercial hardware for shipboard applications, feasibility studies into the use of Computer Aided Software Engineering (CASE) tools, and general support to capital projects.

Equipment Health Monitoring (EHM)

The EHM Section administers projects associated with the development and application of EHM techniques to marine equipment and tests machinery units refurbished by repair and overhaul agencies to verify that specified performance levels are attained. EHM entails the assessment of machinery condition via non-intrusive methods and is broadly equivalent to the RN's Condition Based Maintenance (CBM) appellation.

The principal activities of the section are the introduction of the automated vibration data collector (Data Trap) as the field measurement instrument, the co-ordination and monitoring of the Oil and Coolant Condition Analysis Program (OCCAP), development of the Shipboard Machinery Performance Testing (SHMaPT) programme and continuing support of the NaMMS non-tactical local area network presently in sea trials in H.M.C.S. *Huron*.

Environmental and Qualification Testing (EQT)

This section provides testing services to qualify equipment to MIL and other appropriate standards, modifies components and units to satisfy qualification requirements, and conducts measurements of transient time records generated during a variety of field trials intended to assess the structural integrity of naval designs and systems.

In addition to routine environmental testing, recent assignments included the re-design and re-packaging of commercial reverse osmosis desalination plants for submarines and surface ships, participation in the nuclear blast simulations conducted at the U.S. White Sands Missile Range and extensive digital data acquisition during different phases of the RN's HULVUL project.

Marine Systems Investigations (MSI)

The MSI Section handles engineering investigations of marine components and complete systems.

Presently, the section is attempting to define exercise and failure analysis guidelines in order to generate performance status reports for the existing stocks of torpedoes, is assessing the implications of environmental protection legislation in naval ships, is evaluating available liquid and solid waste handling equipment for possible shipboard deployment, is pursuing resolution of malfunctions encountered in fuel and lubricating oil circuits, and is conducting material tests on products identified for use in proposed noise reduction programmes.

Reliability Availability and Maintainability (RAM)

This cell is mandated to support the implementation of RCM policies with respect to new, as well as, existing elements of the fleet and to continuously assess the relevance of naval maintenance plans. Although the RAM Section has recommended several revisions to the promulgated preventive maintenance schedules, the major thrust of its work concerns the development of policies, methodologies and tools which are necessary to introduce RCM concepts in the upkeep of naval equipment.

Summary

In view of its overall operational commitments, size and existing national constraints, the Canadian Navy has evolved a rather unique structure to accomplish its limited T&E objectives. The role of NETE in meeting these objectives and the distinct arrangement under which the Establishment is constituted, have been the subject of this article. The article also outlined the internal organization and the available facilities, services and engineering capabilities. An overview of active projects has been included to give the reader an appreciation of NETE's contributions in providing the Canadian Navy with reliable, dependable and affordable equipment.

Recent diminutions in world tensions presage a declining prominence for Defence-related expenditures. The expected re-alignment of national priorities augurs inevitable reductions in funding and resources allocated to the acquisition and modernization of future naval platforms. The Canadian Navy is in a somewhat fortunate position in that its major capital refurbishment programmes are entering the delivery stage and are not likely to be affected in the immediate future. As a result, NETE is looking forward to the challenge of participating in the integration and in-service support of the technologically advanced CPF and TRUMP destroyers.