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TURNING THE TIDE: THE NAVAL ENGINEERING OFFICER'S FUTURE

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JCSP 41

Exercise *Solo Flight*

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TURNING THE TIDE: THE NAVAL ENGINEERING OFFICER'S FUTURE

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INTRODUCTION

The Royal Canadian Navy (RCN) now finds itself on a much needed journey of fleet renewal. A journey that started with the Halifax Class Modernization project and will end with the delivery of the Canadian Surface Combatant. Along the way, two other classes of ship will be introduced; namely, the Harry DeWolf Artic Offshore Patrol class and Queenstown Auxiliary Oiler Replenishment class, the latter replacing the now decommissioned Protecteur class. A journey that will also result in new approaches to Naval Material Support. Approaches that will employ a Naval Material Regulatory framework based on risk management. Approaches that will see the decreased use of traditional maintenance methods and the increased use of contracted services – a situation not unlike the one that unfolded in both the Royal Air Force (RAF) and the Royal Australian Navy (RAN). Approaches that will considerably change the onboard maintenance organization dynamic – both the RAF and RAN found that in heavily contracted environments, where there is limited maintenance done by military technicians, the competence of the military technical staff deteriorates significantly to the point where it impacts combat effectiveness.[1, 2] As such, a crucial role within all new RCN approaches will be the central role of the onboard Engineering Officer.[3]

In an effort to align future Engineering Officer training and development along a path that is conducive to the above new approaches, this paper will endeavour to highlight the key roles of a sea-going Engineering Officer as they relate to the "current"

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[1] Haddon-Cave, Charles., Great Britain., Parliament., House of Commons., *The Nimrod Review : An Independent Review into the Broader Issues Surrounding the Loss of the RAF Nimrod MR2 Aircraft XV230 in Afghanistan in 2006*. Report (London: TSO, 2009).

[2] Paul J. Rizzo, *Plan to Reform Support Ship Repair and Management Practices* (Canberra: Ministerial and Executive Coordination and Communication Division, Department of Defence, Australia, 2011).

[3] Unless stated otherwise, the term Engineering Officer is a generic term that refers to both the Combat Systems Engineering Officer and Marine System Engineering Officer which are currently employed onboard major warships within the Royal Canadian Navy.

operating environment, attempt to highlight key factors of the future environment that will impact these roles and conclude with recommendations that will hope to enhance an Engineering Officer's ability to operate within the future environment. This task will be accomplished in three steps: an examination of key documents that detail the roles and responsibilities of the Engineering Officer; a detailed discussion on the factors that will modify the future environment; and conclude with recommendations drawn from the author's understanding and personal experience.

UNDERSTANDING THE ENVIRONMENT (PRE-2013)

Sea-going Engineering Officers have many different roles and responsibilities onboard an HMC Ship. First there is the slew of essential secondary duties that are required to be done to ensure the smooth operation of the platform: Ammunition Officer, Signature Management Officer, Environmental Officer, Damage Control Officer and Noise Control Officer are but a select subset of these assigned duties.[4] Second as a Head of Department, they are responsible to the Executive Officer for the administration of the department and their divisional duties. Finally, as the onboard technical authority they are responsible to the Commanding Officer for the technical readiness and safe operation of the equipment and systems in their charge.[5] Associated with each of these roles, there is a network of personnel that must be kept up to date and aware of the ship's technical and manning state: N37 Engineering Operations, the ship's assigned Fleet Maintenance Facility Project Leader, the Fleet Technical Authority, Formation Safety and Environment, and the Formation Technical Authority to list a few.

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[4] Department of National Defence, *SSO AL9CH2, Ship's Standing Orders* (Halifax: DND Canada, 2014), 662.

[5] Department of National Defence, C-03-005-033/AA-000, *Naval Engineering Manual* (Ottawa: DND Canada, 2012), 284.

Despite the number of different roles and various reporting chains, the past 20 years have seen Engineering Officers successfully handling complex technical situations and achieving great success – the Maritime Engineering Journal contains numerous articles about these successes.[6] Successes that are predicated on three key factors: sound training backed by at-sea experience, competent and experienced onboard technical staff and trusted connections with experts ashore.

Sound Training

The training required to be a qualified sea-going Engineering Officer is one of the most demanding programs within the Canadian Forces. On top of having an accredited Engineering Degree, completing Naval Environmental Training Plan Officers (NETPO) and getting certified as an Officer of the Day (OOD), the sea-going Engineering Officer is required to complete three additional courses (Naval Engineering Indoctrination, Basic Officer Qualification Ashore and Naval Engineering Common), two years on a ship (Basic Officer Qualification Afloat and Head of Department Afloat) and successfully challenge three oral qualification boards[7] - a process from beginning to end that generally takes seven years to complete.

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[6] LCdr Sean Williams, "*This is Africa — The Challenges of Making Emergency Diesel Generator Repairs While Deployed*," Maritime Engineering Journal, no. 65 (Fall 2009/Winter 2010): 5-9.
[7] Department of National Defence, A-PD-055-002/PP-001, *Canadian Forces Manual of Military Occupation Structure - Volume 2 Part 1 - Job Based Occupational Specification for Naval Combat Systems Engineering Officer* (Ottawa: DND Canada, Amended 2010), 20.

Sound Staff

Equally important, and arguably more qualified, is the onboard technical staff. Similar to the Engineering Officer, technician training is a blend of in-class academics and at-sea experience. This blend typically results in the average technician having two to three years of in-class training supported by one to two years of at sea-experience upon them attaining their journeymen qualification. This knowledge is then typically solidified over the next five to six years by extensive at-sea experience where they perform first and second line (and at times third line) maintenance within their respective fields. This hands-on technical experience is then capped by another round of in-class academics (Qualification Level 6) and at-sea experience focused on engineering and personnel management. Often intermixed within this cycle is time spent at the Navy's second (and third) level Fleet Maintenance Facility, which introduces the third component of the Engineering Officer's shipboard maintenance equation – the extended family.

Sound Connections

In addition to the Fleet Maintenance Facility (FMF), the Engineering Officer's extended family consist of four other entities; namely, Engineering Operations (N37), Fleet Technical Authority (N42), Fleet Technical Officer (FTO) and Life Cycle Material Managers within Director General Maritime Equipment Program Management (DGMEPM). Each of these five entities influence the Engineering Officer's daily efforts in one fashion or another. FMF is the main naval engineering and maintenance service delivery organization.[8] Additionally, contained within its engineering departments are key technical subject matter experts that can be engaged on short notice with little more

[8] Department of National Defence, C-03-005-012/AM-001, *Naval Materiel Management System Manual* (Ottawa: DND Canada, 2013), 85.

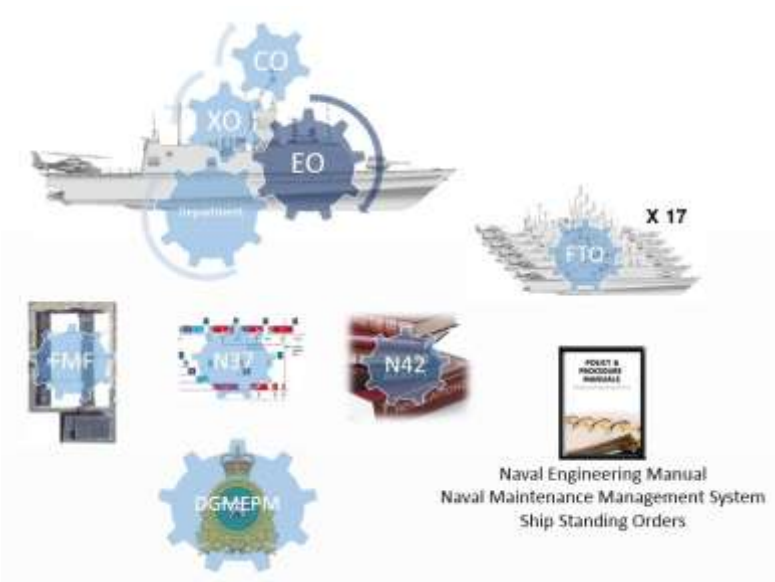

Figure 1: Formation Technical Management (Pre 2013)

than a phone call. As the organization responsible for the Formation's Materiel Support Programme, N37 ensures maintenance periods are programmed into the ship's schedule and also coordinates the formation's response to operational deficiencies.[9] More importantly, N37 establishes FMF's maintenance priorities – without priority there is little chance that an Engineering Officer can get critical maintenance completed. While not normally involved in the service delivery of naval maintenance, N42 conducts independent maintenance inspections and provides authoritative interpretation of policy when required.[10] The technical eyes and ears of the Fleet Commander, the FTO, mentors formation Engineering Officers, offers "technical leadership" and provides operational engineering advice and support. Finally, and at arm's length, there are the Life Cycle Material Managers (LCMM) within DGMEPM that know their respective systems extremely well and can be engaged to provide a technical solution (or engage the third-line support contractor). Within these five organizations are public servants and military members that can be contacted at near anytime to provide –free – sound advice. Finally, these organizations functioned under fairly consistent and well known policies and procedures; specifically and in order of

[9] *Ibid*., 83.
[10] *Ibid*., 84.

seniority, the Naval Engineering Manual, the Naval Maintenance Management System and Ship Standing Orders.

UNDERSTANDING THE ENVIRONMENT (POST-2013)

Post 2013, the aforementioned picture remains similar but with three key modifications: a decreased number of platforms, a substantial change in Naval Maintenance doctrine and a pending transformation with the naval in-service support paradigm.

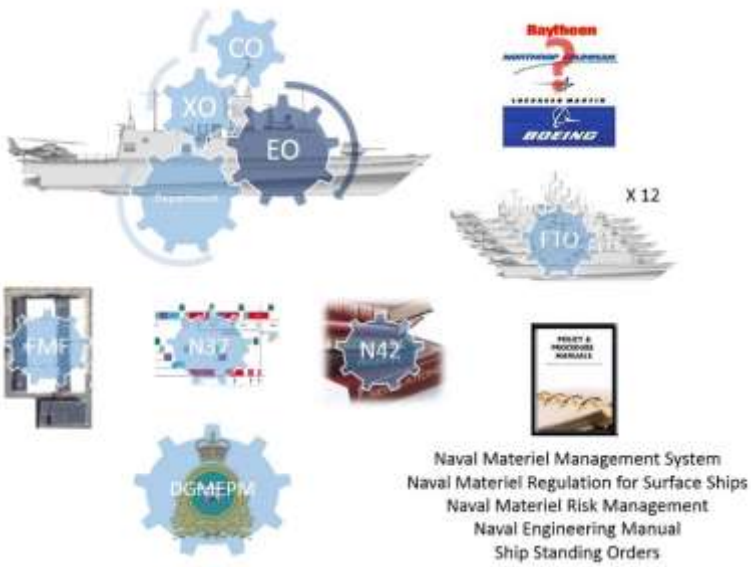

Figure 2: Formation Technical Management (Post 2013)

Smaller Fleet

The first, a decreased number of major warships. Since the start of the Halifax Class Modernization program in 2010 and ending with the decommissioning of the Iroquois and Protecteur class warships, the number of major warships within the RCN has dropped from 17 to 8 – 12 depending on the number of Halifax Class Frigates within the mid-life refit cycle. With this drop comes a decreased number of sea-days and a reduced variety of operational platforms. The reduced number of sea-days directly implies less at-sea training. A situation that results in two negative outcomes: less time at sea and decreased hands-on learning. Take for example the Naval Engineering Indoctrination course, a course that was designed to

introduce budding Engineering Officers to life onboard a Canadian Warship.[11] A course that saw about 8-10 students per platform getting a minimum of 15 days at sea. Today, entire courses are being place on a single platform and are getting far less than the required minimum of 15 sea-days. A similar situation holds true on the two remaining qualification courses: Basic Officer Qualification Afloat (BOQ) and Head of Department Afloat (AHOD). The reduced variety of operational platforms poses a different problem. With each platform type came different equipment and engineering challenges. In the past, it was highly likely that an Engineering Officer would complete one course on a tanker, become qualified on a Destroyer and finish his Head of Department (HOD) tour on a Frigate. Meaning, he/she would learn steam, move onto combined gas or gas (COGOG) and finish with combined diesel or gas (CODOG) propulsion knowledge. Today, the only knowledge base required would be the Frigate's CODOG configuration. The end result, future Engineering Officers with less practical training, less hands-on experience and a narrower scope of knowledge.

New Doctrine

The second, a substantial change in Naval Maintenance doctrine; specifically, the transformation of the Naval ***Maintenance*** Management System into the Naval ***Materiel*** Management System. An adjustment that introduces Naval Material Assurance (NMA)[12] into the maintenance management equation. NMA, which is an all-encompassing structure that ensures Canadian warships (and auxiliaries) comply with applicable

[11] Department of National Defence, *Maritime Command Qualification Standard and Plan – Naval Engineering Indoctrination* (Ottawa: DND Canada, 2007), 199.
[12] *Ibid.*, 5.

legislation requirements and standards[13], brought with it two additional levels of doctrine; namely, Naval Material Regulation (NMR) and Naval Material Risk Management (NMRM). The first, NMR, introduces and solidifies the concepts of design intent, design authority, certification framework and duty holder - any person with specific assigned safety responsibility.[14] The second, NMRM, highlights the key aspects of risk management as they relate to operational material support, details the use of Risk Management Record (RMR)/Aggregate Risk Assessment (ARA) tools and provides the general requirements for the Hazard Identification and Risk Assessment (HIRA) process.[15] The end result, future Engineering Officers will need to have a better appreciation of legal regulatory requirements and a robust knowledge of the different methodologies associated with determining hazards and analysing risk.

Changing Maintenance

Finally the third, the evolving nature of the naval in-service support paradigm. Due to human and financial resource constraints, the old methods of looking at a ship as a collection of unique and independent sub-systems will no longer be valid. Looking forward, a ship will need to be viewed as an integrated weapon system that will require a formal, structured maintenance approach.[16] That is, the current lines between systems and processes will be broken. For example, no longer will you have an organization that is responsible for the Command and Control System independent of the organization that is responsible for the Integrated Machinery Control System – they will be one in the

[13] Regulations and certificates of safety are based on the requirements of the current edition Naval Ship Code, Allied Naval Engineering Publication (ANEP) 77.
[14] Department of National Defence, C-23-005-000/AG-001, *Naval Materiel Regulation for Surface Ships* (Ottawa: DND Canada, 2013), 130.
[15] Department of National Defence, C-23-005-000/AG-002, *Naval Materiel Risk Management* (Ottawa: DND Canada, 2013), 148.
[16] Department of National Defence, Document No. 3748968, *Future In-Service Support Project: ISS System Analysis Document, Draft Version 5* (Ottawa: DND Canada, 2014), 25.

same. Additionally, ship level material management will be required to support both programme and operational outcomes.[17] While the end state is unknown at this point, it is highly likely that this endeavour will greatly increase the level of defence contractor involvement within the first and second line maintenance channels. Personnel involved will have to become smarter clients within a complex maintenance contracting environment. The end result, future Engineering Officers will need to have increased capability in a commercial and programmatic sense – equal to that of their contractor counterparts.

TWEAKING THE EQUATION

To be able to successfully face these future challenges, there are some bottom up tweaks that can be applied to the sea-going Engineering Officer's background, training and experience.

Occupation Specification

Starting with the document that defines what it is to be a Naval Engineering Officer in the RCN – the Job Based Occupation Specification. It is critical that this document truly reflect the tasks, skills and knowledge required of a sea-going Engineering Officer; however, given the last update to this document was done in 2010, there is little surprise that it is dated and does not reflect the requirements of the position. Take two quick examples. First, there is currently no duty area associated with NMA. As such, there are no related tasks specified to be completed in this field by a sea going Engineering Officer. It is noted that the required tasks associated with the NMA function may be spread across other duty areas; however, making the necessary links to other duty areas would be a subjective effort and may lead to unnecessary tasks being required or

[17] *Ibid.*

even worst, required tasks being omitted. Second, there are only three skills currently associated with being an Engineering Officer - technical writing, analyzing statistical data, and cross functional process management. Given the requirement for future Engineering Officers to be involved in Risk Management, it is not hard to envision risk mitigation and management skills being associated with the sea-going role. As the root document and the primary feeder of the training system, a complete review and refresh of this document is the first essential step. For completeness, Appendix A details the current tasks, skills and knowledge associated with being a sea-going Combat System Engineering Officer (CSEO) and Marine System Engineering Officer (MSEO).

Training Update

As a logical extension of the above recommendation, a complete review of Engineering Officer training, in terms of sequencing and scope, is also required. On the sequencing front, the current training regime is based on ample at sea-platforms and one-on-one training time. As highlighted earlier these are two things no longer exist. The training regime also includes courses that have questionable links to the occupation specification. To highlight the above shortcomings, again take the 11 week NEI course. A course that is intended to introduce students to life onboard a Canadian Warship as an Engineering Officer and was once the Occupation Functional Point (OFP). It is currently completed with students having little to no sea time, only provides for a limited number of knowledge points within the occupational specification (no tasks or skills) and is not linked to any job – its sole function is to allow members to continue training. That is, there are currently no jobs that can be accomplished by a NEI qualified Officer. An additional example is the placement of the Naval Engineering Common (NEC) course. A

course that is intended to provide future Engineering Officers with business management, project management and operational readiness training.[18] As such, it should be placed as close as possible to either the Assistant Head of Department tour or the Head of Department tour (just in-time training). However, the current training sequence sees this course being provided as an extension to the Basic Officer Qualification Ashore training, approximately two to three years ahead of the requirement. For inclusiveness, Appendix B highlights the current training sequence of both the Combat Systems and Marine Systems Engineering Officer.

Regarding the scope of training, two minor concerns arise. First, there are courses linked to outdated or incorrect occupations specifications. Take for example the Maritime Warfare Basic and the Defence Resource Management Information System courses - the first is linked to the 1998 General Officer Specification and the second to the Weapons Engineering Technician Specification.[19] Second, the three core courses (Basic Officer Qualification, Naval Engineering Common and Head of Department) have not been updated to reflect current doctrine. A scan of the Qualification Standard and Plan (QSP) of the above core courses reveals limited links and training associated with the concepts of regulatory authority and material regulation. Even when specifically detailed (one example), the QSP had no detailed links to the aforementioned RCN specific concepts; however, it was noted that general Risk Management theory is instructed on NEC. Appendix C is provided to highlight this example.

Job Experience

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[18] Department of National Defence, *Royal Canadian Navy Qualification Standard and Plan – Naval Engineering Common* (Ottawa: DND Canada, 2013), 142

[19] Department of National Defence, A-PD-055-002/PP-001, *Canadian Forces Manual of Military Occupation Structure - Volume 2 Part 1 - Job Based Occupational Specification for Weapons Engineering Technicians* (Ottawa: DND Canada, Amended 2010), 26.

Finally, the experience front. As stated at the beginning of this paper, the time between the start of a sea-going Engineering Officer's training and their HOD tour is approximately seven years. Irrespective of the recommendations above, it is envisioned that this duration will remain roughly the same (or slightly increase) for the near future given the growing delta between the number of qualified personnel and the decreased number of available platforms. During this growing seven years, budding at-sea Engineering Officers are expected to complete two to three postings outside of the training system. In the past, these posting have varied greatly. Individuals have been posted to Ottawa to progress projects within DGMEPM, have been posted to Egypt to complete operational tours and some have even completed sponsored post-graduate training. It is this author's opinion, this time would be better spent on the coast working directly with the fleet; namely, within N37 Engineering Operations managing fleet technical schedules, within N42 Fleet Technical Authority assisting with Hazards Identification Risk Assessments, or within FMF trials section conducting at-sea trials. Pushing this theme even further, some select members should be provided the opportunity to work within a foreign Navy's waterfront organization; specifically, the RAN and RN. Doing so will keep Junior Officers on the waterfront while learning from Navies that have made the leap to contracted in-service support.

C**onclusion**

The RCN is at the trough of fleet change. As it moves toward the crest it will see three new classes of ship entering into service and fundamentally different approaches to Naval Material Support. Approaches that will be based on a regulatory framework, risk management principles, and increased use of contracted services. As a result of these changes, the tide has turned. Sea-going Engineering Officers of the future fleet will be required to complete different tasks, have different skills and a different knowledge base than Engineering Officers of the past. To handle these differences, three actions are recommended; namely, a complete refresh of Naval Engineering Officer occupation specifications, a comprehensive review of training in terms of sequencing and scope, and finally a push to have junior Engineering Officer remain employed within fleet jobs in order to gain much needed shipboard experience.

The prelude to action is the work of the Engineroom Department

– Adm. Sir John Jellicoe, RN
Battle of Jutland, 1916

APPENDIX A – ENGINEERING OFFICER'S TASK, SKILLS, KNOWLEDGE

The below information is taken from the MOSID 0344 Naval Combat Systems Engineering Officer and MOSID 0345 Marine Systems Engineering Officer Occupation Specifications.

TASK/SKILLS		KNOWLEDGE
DEFINITION	**VALUE**	**DEFINITION**
The level of proficiency required to perform parts or elements of duties and tasks under continuous supervision	1	An awareness of the basic definitions and concepts associated with a topic or a body of knowledge
The level of proficiency normally required to perform duties and tasks under supervision	2	The level of understanding of definitions and basic concepts which enables the relating of this knowledge to job requirements
The level of proficiency required to independently and safely perform duties and tasks	3	The level of understanding of theory and principles of a topic or body of knowledge that is usually gained through formal training and job experience and which enables critical thought and independent performance
The level of proficiency which usually can be acquired by considerable training and extensive practical job experience	4	The level of knowledge which is gained from formal training and education and considerable job experience. This knowledge enables the synthesis/integration of theory facts and practical lessons learned to support the identification of solutions to non-routine problems
The level of proficiency indicated by a mastery of techniques and expert application of procedures	5	A recognized level of expertise, which includes a mastery of theory and application, related to a given body of knowledge

SERIAL	REQUIREMENTS	A/CSEO	CSEO	A/MSEO	MSEO
TASKS					
DUTY AREA A - GENERAL ADMINISTRATION/MANAGEMENT					
AT0005	Prepare maritime technical policy documents (eg. MARCORDS, FTBs)		2		2
AT0030	Liaise with laboratories/industries/establishments to support Naval Engineering	2	3	2	3
AT0040	Promote environmental awareness	2	3	3	3
AT0045	Implement/monitor energy conservation measures onboard ship			3	3

SERIAL	REQUIREMENTS	A/CSEO	CSEO	A/MSEO	MSEO
DUTY AREA B - PERSONNEL MANAGEMENT					
BT0005	Advise on operating limitations due to manning shortfalls	2	3	2	3
BT0010	Advise on the impact of personnel limitations on operations	2	3	2	3
BT0015	Lead and provide divisional support for military personnel	2	3	2	3
DUTY AREA C - TRAINING					
CT0010	Plan/conduct/assess shipboard battle problems/damage control drills	2	3	2	3
CT0015	Plan/conduct/assess shipboard Combat Systems Engineering drills	2	3	2	3
CT0050	Manage Operational Training (OT)	2	3	2	3
CT0055	Manage Individual Training and Education (IT&E)	2	3	2	3
DUTY AREA D - SHIP OPERATIONS/READINESS					
DT0005	Assess a ship's technical readiness			2	3
DT0010	Advise on ship's states of preparedness	2	3		
DT0015	Advise on shipboard degrees of readiness	2	3		
DT0020	Advise on operational limitations under various system operating modes	2	3		
DT0025	Advise on ship's mobility states (Notice for Steam/Power)			2	3
DT0030	Ensure ship's mobility state is achieved to carry out projected operations				
DT0035	Advise on technical readiness status of combat systems/equipment	2	3		
DT0040	Direct/supervise repair action due to equipment failures	2	3	3	3
DT0045	Advise on the impact of equipment failures on operations	2	3	2	3
DT0050	Conduct engineering rounds	2	3	2	3
DT0055	Conduct noise-short rounds	2	3	2	3
DT0060	Evaluate system condition (e.g. equipment health monitoring (EHM), non-destructive examination (NDE) etc.)	3	3	3	3
DT0065	Assess pre-sail checks	2	3	2	3
DT0070	Monitor status of engineering systems			2	3
DT0075	Direct the ship's Emergency Response Team (ERT)	2	3		
DT0080	Monitor pre-firing and post-firing checks	2	3		

SERIAL	REQUIREMENTS	A/CSEO	CSEO	A/MSEO	MSEO
DT0085	Assess the status of damage control states (preparedness and readiness)			2	3
DT0090	Determine ship's condition for docking/undocking			2	3
DT0095	Prepare/manage Operational Deficiencies (OPDEFs)	2	3	2	3
DT0100	Complete routine engineering reports	2	3	2	3
DT0105	Approve Maintenance Action Forms (MAFs)	2	3	2	3
DT0110	Review MAFs	2	3	2	3
DT0115	Identify requirement for spare parts	2	3	2	3
DT0120	Perform as ship's Signature Management Officer	2	3	2	3
DT0125	Participate in planning ship's operations/programme/routine	2	3	2	3
DT0130	Ensure Ship's CSE systems availability within stated Notice for Power (NFP)	2	3	2	3
DT0135	Assess the impact of MSE systems on Combat Systems	2	3		
DUTY AREA E - EMERGENCY PROCEDURES/DAMAGE CONTROL					
ET0005	Respond to Missile emergencies / Direct responses to shipboard engineering emergencies	2	3	2	3
ET0010	Assess battle damage to ship	2	3	2	3
ET0015	Develop ERT/DC policy/procedures	2	3	2	3
ET0020	Advise Command on the impact of damage, equipment/systems casualties and availability of spares / Monitor Damage Control conditions	2	3	2	3
ET0025	Direct HQ1/HQ2 and Section Base teams in action and emergency situations			2	3
ET0030	Direct HAZMAT Clean Up Team	2	3		
ET0035	Advise Command on the effects of systems/equipment casualties and the availability of spares			2	3
DUTY AREA F - SAFETY/HAZARDOUS MATERIAL					
FT0005	Ensure compliance with policies/procedures governing handling, stowage and disposal of hazardous material	2	3	2	3
FT0015	Perform as ship's Ammunition Officer	2	3		
	Plan/review/implememt pollution control measures			2	3
FT0020	Review CF fire reports			2	3
FT0025	Conduct fire prevention inspections			2	3
FT0030	Perform as Unit/Command General Safety Officer			2	3
FT0035	Perform as Radiation Hazard Officer (RADHAZO)	2	3		
	Perform as Unit/Command Environmental Officer			2	3

SERIAL	REQUIREMENTS	A/CSEO	CSEO	A/MSEO	MSEO
FT0040	Ensure compliance with general safety policies and procedures	2	3		
	Manage Interdepartmental Safety Procedures			2	3
FT0045	Manage interdepartmental safety procedures	2	3		
FT0050	Perform as Head of the HAZMAT Spill Clean-up Team	2	3		
DUTY AREA G - GENERAL ENGINEERING					
GT0005	Conduct Technical Investigations	3	3	3	3
GT0015	Prepare technical directives/orders	2	3	2	3
GT0035	Investigate the cause, nature and extent of material defects and failures	2	3	2	3
GT0040	Develop new maintenance procedures and techniques	2	3	2	3
GT0045	Evaluate new maintenance procedures and techniques	2	3	2	3
GT0050	Conduct engineering diagnostic tests	2	3	2	3
GT0055	Monitor the start-up, running, and shutdown of equipment and systems	2	3	2	3
GT0060	Review logs and system operating records	2	3	2	3
GT0070	Advise on optimum system configuration	2	3		
	Determine optimum system configuration			2	3
GT0075	Isolate system faults	2	3	2	3
GT0090	Interpret engineering documentation	3	3	3	3
GT0100	Manage TEMMIS	2	3		
DUTY AREA H - FIRST LINE O&M					
HT0020	Identify/refer maintenance tasks beyond the capability/capacity of ship's staff	2	3	2	3
HT0025	Prioritize maintenance action in concert with Fleet, Command, and Repair Facilities (RF) authorities	2	3	2	3
HT0030	Liaise with Formation Ship Systems Readiness section concerning priority of repairs/installations	2	3		
	Liaise with MARLANT/MARPAC/Ship Systems Readiness section concerning priority of repairs/installations to be done			2	3
HT0035	Control configuration management on board ship	2	3	2	3
HT0040	Prepare and staff first line O&M documentation	2	3	2	3
DUTY AREA I - SECOND LINE O&M					
IT0010	Plan emergency repairs	2	3	2	3
IT0015	Prepare ship for docking/undocking operations	2	3		
	Interpret Docking Plan			2	3

SERIAL	REQUIREMENTS	A/CSEO	CSEO	A/MSEO	MSEO
IT0020	Analyze shipboard noise sources	2	3		
	Conduct/oversee docking/undocking operations			2	3
IT0025	Prepare ship for docking/undocking operations			2	3
IT0030	Perform docking calculations			2	3
IT0035	Prepare docking/undocking reports			2	3
IT0040	Analyze shipboard noise sources			2	3
DUTY AREA J - THIRD LINE O&M					
JT0005	Plan/conduct a ship's Short Work Period (SWP)/Docking Work Periods (DWP)/Refit	2	3		
	Plan ships refit/Docking Work Periods (DWP)			2	3
JT0030	Conduct Quality Assurance (QA) inspections of ship's compartments	2	3	2	3
JT0035	Direct the survey of damaged/wasted hull structures			2	3
JT0040	Prepare and staff third line O&M documentation	2	3		
	Examine hull structure/systems			2	3
JT0050	Prepare and staff third line O&M documentation			2	3
DUTY AREA K - TESTS AND TRIALS					
KT0005	Develop a tests and trials programme	2	3	2	3
KT0010	Review/comment on trials agenda			2	3
KT0020	Conduct tests and trials	2	3		
KT0035	Analyse trials reports			2	3
KT0040	Prepare/review tests and trials documentation	2	3		
DUTY AREA L - LIFE CYCLE MANAGEMENT					
LT0040	Manage configuration changes	2	3	2	3
LT0055	Initiate Engineering Change Proposals (ECPs)	2	3	2	3
LT0060	Develop Engineering Change Proposals (ECPs)				3
LT0075	Identify deficiencies in maintenance schedules			2	3
LT0080	Use naval maintenance management information systems	3	3	3	3
DUTY AREA M - CONTRACT MANAGEMENT					
MT0005	Participate in initiating Contract Demands (Requisition for Goods and Services)	2	2		
	Initiate Contract Demands (Requisition for Goods and Services)			2	2
MT0010	Review contract proposals	2	2		
	Review contract tenders			2	2
MT0015	Participate in the negotiation of contracts	2	2	2	2

SERIAL	REQUIREMENTS	A/CSEO	CSEO	A/MSEO	MSEO
MT0020	Manage contract work under the authority of the unit/establishment	2	3	2	3
MT0025	Monitor technical compliance with contracts	2	3	3	3
MT0030	Monitor contract progress against scheduled milestones	2	3	3	3
MT0035	Conduct Quality Assurance (QA) inspections in support of contracts	2	3		
	Conduct QA inspections in support of contracts			2	3
MT0040	Ensure compliance with Procurement and Contracting Policy	2	3		
MT0045	Develop/manage a Capability Plan	2	3		
MT0050	Manage Budgets	2	3		
DUTY AREA N - PROJECT MANAGEMENT					
NT0100	Negotiate/review contract proposals with contractors			2	3
NT0110	Review Contract Change Proposals (CCP)	2	3		
NT0120	Monitor Observation Reports for defects/anomalies during refits/DWPs/ship construction			2	3
NT0150	Liaise with contractors' Quality Assurance organizations			2	3
NT0155	Review contract deliverables for compliance			2	3
NT0170	Manage engineering projects	3	3		
NT0175	Participate as a member of an engineering project team	3	3		
DUTY AREA O - COMBAT SYSTEMS					
OT0040	Manage Weapon Systems	2	3		
OT0041	Assess Weapon Systems	3	3		
OT0045	Manage Navigation Systems	2	3		
OT0046	Assess Navigation Systems	3	3		
OT0050	Manage Communication Systems	2	3		
OT0051	Assess Communication Systems	3	3		
OT0055	Manage Above Water Warfare Systems	2	3		
OT0056	Assess Above Water Warfare Systems	3	3		
OT0060	Manage Underwater Warfare Systems	2	3		
OT0061	Assess Underwater Warfare Systems	3	3		
OT0065	Manage Command and Control Systems	2	3		
OT0066	Assess Command and Control Systems	3	3		
OT0070	Manage Data Processing Systems	2	3		
OT0071	Assess Data Processing Systems	3	3		
OT0075	Manage Electronic Warfare Systems	2	3		
OT0076	Assess Electronic Warfare Systems	3	3		

SERIAL	REQUIREMENTS	A/CSEO	CSEO	A/MSEO	MSEO
OT0080	Manage/assess Marine Systems	1	1		
DUTY AREA O - MARINE SYSTEMS					
OT0135	Manage/Analyze Main Propulsion Systems			2	3
OT0140	Manage/Analyze Main Auxiliary Systems			2	3
OT0145	Manage/Analyze Control Systems			2	3
OT0150	Manage/Analyze Electrical Systems			2	3
OT0155	Manage/Analyze Hull Systems			2	3
DUTY AREA P - UNDERWATER WARFARE					
DUTY AREA P - LIQUID MANAGEMENT					
PT0005	Maintain ship trim/stability/stresses within safe limits.			2	3
PT0010	Control shipboard liquid transfer			2	3
PT0015	Assess ship stability			2	3
PT0020	Manage disposition of fluids/cargo to maintain ship trim and stability			2	3
PT0030	Ensure safe handling/storage of fluids			2	3
PT0035	Prepare a fuelling/defuelling/transfer plan			2	3
PT0040	Direct the embarkation, transfer, and storage of fluids			2	3
PT0045	Provide advice on the safe handling, stowage, and transfer of petroleum products			2	3
PT0050	Prepare final report on condition of vessel on completion of fueling evolution			2	3
PT0055	Advise Command on quality of fuel			2	3
PT0060	Maintain fuel log			2	3
DUTY AREA Q - ABOVE WATER WARFARE					
DUTY AREA Q - SHIP DESIGN/CONSTRUCTION					
QT0020	Determine the requirement for a hull survey			2	3
QT0025	Review and analyze Hull Survey Reports			2	3
DUTY AREA R - SHIP/DESIGN/CONSTRUCTION					
RT0025	Review and analyze Hull Survey Reports	2	3		
SKILLS					
S0005	Technical writing	2	3	2	3
S0010	Analyzing statistical data	3	3	3	3
S0015	Cross functional process management	2	3	2	3
KNOWLEDGE					
K0010	Technical Directives and Instructions	2	3	2	3
K0015	Role and employment of the MARE in the Canadian Navy	3	3	3	3

SERIAL	REQUIREMENTS	A/CSEO	CSEO	A/MSEO	MSEO
K0020	Career progression of the MARE and the Department Occupations	3	3	3	3
K0025	Characteristics and effects of shipboard weapons systems	3	3	1	1
K0030	Operational Readiness criteria	2	3	2	3
K0035	Effects of damage on operational effectiveness and ship safety	2	3	2	3
K0040	Ship's technical readiness	2	3	2	3
K0045	Ship's capabilities and limitations in various Damage Control/NBC conditions	2	3	2	3
K0050	Ship's weight control policy	2	3	2	3
K0055	Pollution/Emission control standards	2	2	3	3
K0060	Response to Notices for Power	2	3	3	4
K0065	Duties of the Engineering Watch	1	1	2	3
K0070	Capabilities and limitations of ship systems under limited/damaged operating conditions	2	3	2	3
K0075	Location and purpose of Damage Control equipment and first aid equipment			3	3
	Shipboard emergency power distribution	3	3		
K0080	Damage Control (DC) manual			3	3
	Ship radiological protection systems	3	3		
K0085	Influence of Damage Control and firefighting requirements on ship design			3	3
	Emergency Response Team Package (ERT PACK)	2	3		
K0090	Characteristics and use of shipboard fire/flood detection systems			3	3
	Combat systems engineering emergency procedures	3	4		
K0095	Shipboard flood control			3	3
	Safe handling and storage of explosive material onboard ship	3	3		
K0100	Shipboard emergency power distribution			3	3
	Shipboard main armament safety precautions	3	3		
K0105	Shipboard Damage Control measures			3	3
	Radiation hazards and man aloft procedures	3	4		
K0110	Ship radiological protection systems			3	3
	Principles of safety of explosives, fuses, detonation systems, Pyrotechnics, and propellants of all ammunition	3	3		

SERIAL	REQUIREMENTS	A/CSEO	CSEO	A/MSEO	MSEO
K0115	Shipboard CITADEL and ventilation control procedures			3	3
	Identification of shipboard ammunition	3	3		
K0120	Manoeuvring response procedures for shipboard emergencies and equipment failures			2	3
	Handling and stowage of ammunition and explosives	3	4		
K0125	Marine systems engineering emergency procedures			3	4
	Otto (torpedo) fuel safety procedures	3	3		
K0130	Gas freeing and certification			3	3
	Shipboard magazine safety	3	4		
K0135	Precautions for turning main engines while alongside			3	4
	Ammunition Allotment/Expenditure guidelines (MCAAL)	3	3		
K0140	Safety precautions during fuelling			3	3
	Ship and systems layout	2	2		
K0145	Water-tight/gas-tight risk and control markings			3	3
K0150	Ship and systems layout			2	2
	Principles of ship stability	1	1		
K0155	Purpose of ship structure and structural components			2	2
	DND drawing policy, practices and acceptances procedures.	2	2		
K0160	Principles of ship stability			3	3
	Ship Systems Engineering (SSE) and ship level integration of the hull, marine and combat systems	1	1		
K0165	Ships' stability standards			2	2
	Shipboard habitability considerations	1	1		
K0170	DND drawing policy, practices and acceptances procedures			2	2
	Shipboard noise generation	2	2		
K0175	Classification Society rules			1	1
	Principles of signature reduction	2	3		
K0180	Ship Systems Engineering (SSE) and ship level integration of the hull, marine and combat systems			1	1
	Recognition of potential "noise shorts"	2	3		
K0185	Shipboard habitability considerations			1	1
	Acoustic and thermal functions/properties of shipboard insulation	1	1		
K0190	Shipboard noise generation			2	2

SERIAL	REQUIREMENTS	A/CSEO	CSEO	A/MSEO	MSEO
	Materials used in the marine environment	1	1		
K0195	Principles of signature reduction			2	3
	Processes and principles of corrosion	2	2		
K0200	Recognition of potential "noise shorts"			2	3
	Ship's datums and levels	2	3		
K0205	Acoustic and thermal functions/properties of shipboard insulation			1	1
	The effects of nuclear radiation and Electromagnetic Pulse (EMP)	2	2		
K0210	Materials used in the marine environment			2	2
	Equipment Health Monitoring (EHM)	3	3		
K0215	Processes and principles of corrosion			2	2
	Special tools and test equipment (to include ATE/BITE)	3	3		
K0220	Watertight integrity in hull design			2	2
	Non Destructive Examination (NDE)	3	3		
K0225	Repair and maintenance capabilities of the hull technical department			2	3
	Vibration Analysis (VA)	3	3		
K0230	Ship's datums and levels			2	3
	Electrical engineering principles	3	3		
K0235	The effects of nuclear radiation and Electromagnetic Pulse (EMP)				3
	Mechanical engineering principles	2	2		
K0240	Equipment Health Monitoring (EHM)			3	3
	Heat transfer principles	2	2		
K0245	Special tools and test equipment (to include ATE/BITE)			3	3
	Fluid dynamics principles	2	2		
K0250	Non Destructive Examination (NDE)			3	3
	Computer engineering principles	3	3		
K0255	Vibration Analysis (VA)			3	3
	Instrumentation Principles	2	2		
K0260	Electrical engineering principles			2	2
	Naval Engineering Manuals (NEM)	3	3		
K0265	Mechanical engineering principles			3	3
	Engineering and Test Establishments	2	2		
K0270	Heat transfer principles			3	3
	Defence Research Establishments (DRE)	2	2		

SERIAL	REQUIREMENTS	A/CSEO	CSEO	A/MSEO	MSEO
K0275	Fluid dynamics principles			3	3
	International Standards Organization (ISO) 9000 Quality Assurance standards	1	1		
K0280	Computer engineering principles			2	2
	DND Quality Assurance policies, standards, records, reports / contractor's inspection and quality systems	2	2		
K0285	Instrumentation Principles			2	2
	Thermodynamic analyses	1	1		
K0290	Naval Engineering Manuals (NEM)			3	3
	Hydraulics Theory	2	2		
K0295	Engineering and Test Establishments			2	2
	Control theory	2	2		
K0300	Defence Research and Development Canada (DRDC) Units			2	2
	Oil and Coolant Condition Analysis Program (OCCAP)	2	3		
K0305	International Standards Organization (ISO) 9000 Quality Assurance standards			1	1
	Shop practices, tolerances, limits, and fits associated with ship construction, refit and repair	2	2		
K0310	DND Quality Assurance policies, standards, records, reports / contractor's inspection and quality systems			2	2
	Technical Statement of Requirements (TSORs)	1	1		
K0315	Thermodynamic analysis			2	2
	DND contract practices and procedures	2	3		
K0320	Hydraulics Theory			2	2
K0325	Control theory			2	2
	Statement of Work (SOW)	2	3		
K0330	Oil and Coolant Condition Analysis Program (OCCAP)			2	3
	Canadian Standards Association (CSA)	1	1		
K0335	Shop practices, tolerances, limits, and fits associated with ship construction, refit and repair			2	2
	Commercial standards (IEEE, ASME, ASTN, ASE)	1	1		
K0340	Welding technology			2	2
	Military standards (DODS, MILSTDS, NES)	1	1		
K0345	Welding requirements and specifications for surface ships and submarines			2	2
	Shipboard lifting appliances	2	3		

SERIAL	REQUIREMENTS	A/CSEO	CSEO	A/MSEO	MSEO
K0350	Fabrication/construction processes			1	1
	Principles of gearing	2	2		
K0355	Technical Statement of Requirements (TSORs)			1	1
	Principles of pumps	2	2		
K0360	DND contract practices and procedures			2	3
	Physical properties of lubricating oils	2	2		
K0365	Inclining experiment			2	2
	Fastners and shocking of mechanical equipment	1	1		
K0370	Statement of Work (SOW)			2	3
	Environmental effects (internal & external) on ships systems	2	2		
K0375	Canadian Standards Association (CSA)			1	1
	Nuclear emergency preparedness / DND capabilities	1	1		
K0380	Commercial standards (IEEE, ASME, ASTN, ASE)			1	1
	Principles and types of propulsion systems	1	1		
K0385	Military standards (DODS, MILSTDS, NES)			1	1
	Occupational Health and Safety Act (OHSA)	1	1		
K0390	Shipboard lifting appliances			2	3
	MARCORD 36-50 (Environmental Protection Management)	2	2		
K0395	Principles of gearing			3	3
	MARCORD 36-55 (HAZMAT)	3	3		
K0400	Principles of pumps			3	3
	Canadian Environmental Assessment Act - Impact analysis requirement	2	2		
K0405	Physical properties of lubricating oils			3	3
	Fisheries Act - Pollution Prevention, Sections 34-42.1	2	2		
K0410	Fastners and shocking of mechanical equipment			2	2
	Canadian Environmental Protection Act (CEPA) Part 6 -Ocean Dumping	2	2		
K0415	Environmental effects (internal & external) on ships systems			2	2
	MARPOL regulations (international standards for waste disposal)	2	2		
K0420	Nuclear emergency preparedness / DND capabilities			1	1
	Environmental Management System (EMS)	2	2		
K0425	Principles and types of propulsion systems			1	1

SERIAL	REQUIREMENTS	A/CSEO	CSEO	A/MSEO	MSEO
	Production industry performance measurement techniques	1	1		
K0430	Occupational Health and Safety Act (OHSA)			1	1
	Reliability, Availability and Maintainability (RAM)	1	1		
K0435	MARCORD 36-50 (Environmental Protection Management)			3	3
	Failure mechanisms of materials	2	2		
K0440	MARCORD 36-55 (HAZMAT)			2	2
	Structural responses to dynamic loadings	1	1		
K0445	Canadian Environmental Assessment Act - Impact analysis requirement			2	2
	Maintenance levels (first line, second line, third line)	2	3		
K0450	Fisheries Act - Pollution Prevention, Sections 34-42.1			3	3
	Shipboard insulation installation considerations	1	1		
K0455	Canadian Environmental Protection Act (CEPA) Part 6 -Ocean Dumping			3	3
	Engineering/technical evaluations and trials procedures	2	3		
K0460	MARPOL regulations (international standards for waste disposal)			3	3
	Characteristics, capabilities, and limitations of Canadian Naval ammunition and explosives	3	3		
K0465	Environmental Management System (EMS)			3	3
	Human engineering factors in ship design	1	1		
K0470	Production industry performance measurement techniques			1	1
	Design considerations in ship's pipe work	1	1		
K0475	Reliability, Availability and Maintainability (RAM)			1	1
	MARCOM organization, procedures and policies for the maintenance support of ships	2	3		
K0480	Failure mechanisms of materials			2	2
	Capabilities, and limitations of DND repair and engineering support organizations	2	3		
K0485	Structural responses to dynamic loadings			2	2
	Departmental maintenance requirements	2	3		
K0490	Maintenance levels (first line, second line, third line)			2	3
	Maintenance Management Information Systems	2	3		
K0495	Shipboard insulation installation considerations			1	1

SERIAL	REQUIREMENTS	A/CSEO	CSEO	A/MSEO	MSEO
	Ship's Maintenance Management Information System Manual (SMMISM) (C-03-005-012/AM-002)	2	3		
K0500	Intact and damage stability			3	3
	Canadian Forces Supply System (CFSS)	1	2		
K0505	Engineering/technical evaluations and trials procedures			2	3
	Refit/repair production procedures, monitoring, and factors affecting work	1	2		
K0510	Human engineering factors in ship design			1	1
	Shipboard Fitted Equipment List (FEL)	1	2		
K0515	Design considerations in ship's pipe work			2	2
	Capabilities and limitations of ships on-board repair facilities	2	2		
K0520	MARCOM organization, procedures and policies for the maintenance support of ships			2	3
	Responsibilities of shore authorities and ship's officers during docking/undocking	1	2		
K0525	Capabilities, and limitations of DND repair and engineering support organizations			2	3
	Naval Equipment Index (NEI)	2	2		
K0530	Departmental maintenance requirements			2	3
	Shipyard and naval dockyard operations	1	1		
K0535	Maintenance Management Information Systems			2	3
	Formation Technical Authority	2	3		
K0540	Ship's Maintenance Management Information System (SMMIS) (C-03-005-012/AM-002)			2	3
	Work period maintenance program	2	3		
K0545	Canadian Forces Supply System (CFSS)			1	2
	Underwater repair/maintenance of ship's systems	1	1		
K0550	Refit/repair production procedures, monitoring, and factors affecting work			1	2
	Fleet Maintenance Facility	2	3		
K0555	Shipboard Fitted Equipment List (FEL)			1	2
	Shipboard Non-Destructive Examination (NDE) requirements	1	1		
K0560	Capabilities and limitations of ships on-board repair facilities			2	2
	Organization of Canadian Forces Armament Depots	1	2		

SERIAL	REQUIREMENTS	A/CSEO	CSEO	A/MSEO	MSEO
	(CFADs)				
K0565	Responsibilities of shore authorities and ship's officers during docking/undocking			2	3
	Fleet Diving Unit (FDU) capabilities	1	1		
K0570	Naval Equipment Index (NEI)			2	2
	Policies and procedures for hull structure surveys	1	1		
K0575	Shipyard and naval dockyard operations			1	1
	Repair and refit specifications and procedures	2	2		
K0580	Formation Technical Authority			2	3
	Paint/coating systems	2	2		
K0585	Work period maintenance program			2	3
	Waivers	2	2		
K0590	Underwater repair/maintenance of ship's systems			1	1
	Trials organization	2	3		
K0595	Fleet Maintenance Facility			2	3
	Policies and procedures for tests and trials	2	3		
K0600	Docking calculations			2	2
	Procedures for submission, approval and promulgation of CF Naval O&M policies	2	3		
K0605	Concept, capabilities and use of Naval Maintenance Management System (NAMMS)	2	3		
K0610	Fleet Diving Unit (FDU) capabilities			1	1
K0615	Policies and procedures for hull structure surveys			2	2
	Policies and procedures for Life Cycle Materiel Management (LCMM)	2	2		
K0620	Repair and refit specifications and procedures			2	2
	Repair and Overhaul (R&O) policies and procedures	1	2		
K0625	Paint/coating systems			2	3
	Equipment Support List (ESL)	1	2		
K0630	Waivers			2	2
	Acquisition of spares	1	2		
K0635	Trials organization			2	3
	Cost estimating procedures	1	1		
K0640	Policies and procedures for tests and trials			2	3
	Ships/Systems/equipment disposal procedures	1	1		

SERIAL	REQUIREMENTS	A/CSEO	CSEO	A/MSEO	MSEO
K0645	Procedures for submission, approval and promulgation of CF Naval O&M policies			2	3
	National Defence Index of Documentation (NDID)	2	2		
K0650	Concept, capabilities and use of Naval Maintenance Management System (NAMMS)			2	3
	Concepts and principles of life cycle costing (LCC)	1	1		
K0655	Process for reviewing and amending engineering/technical specifications	1	1		
K0660	Policies and procedures for Life Cycle Materiel Management (LCMM)			2	2
	Engineering Change Specifications (ECP)	2	2		
K0665	Repair and Overhaul (R&O) policies and procedures			1	2
	Policies and procedures for configuration changes	2	3		
K0670	Equipment Support List (ESL)			1	2
	Weight control process in HMC ships	1	1		
K0675	Acquisition of spares			1	2
	Engineering Change Proposal process	2	3		
K0680	Cost estimating procedures			1	1
	Submarine safe-to-dive certification	1	1		
K0685	Ships/Systems/equipment disposal procedures			1	1
	Request for Technical Information (RTI)	1	1		
K0690	National Defence Index of Documentation (NDID)			2	2
	DND procurement policy	1	1		
K0695	Concepts and principles of life cycle costing (LCC)			1	1
	Field Service Representative (FSR) tasking	1	1		
K0700	Process for reviewing and amending engineering/technical specifications			1	1
	CF Quality Assurance organization	1	1		
K0705	Engineering Change Specifications (ECP)			2	2
	Statement of Capability Deficiency (SCD)	1	1		
K0710	Diesel Inspection Program (DIP)			2	2
	Logistics Support Analysis (LSA)	2	2		
K0715	Policies and procedures for configuration changes			2	3
	Dynamic Deliverable List (DDL)	1	1		
K0720	Weight control process in HMC ships			2	2
	Project Management	1	2		

SERIAL	REQUIREMENTS	A/CSEO	CSEO	A/MSEO	MSEO
K0725	Engineering Change Proposal process			2	3
	Integrated Logistics Support (ILS)	2	3		
K0730	Submarine safe-to-dive certification			1	1
	CF Policies regarding Research and Development (R&D)	1	1		
K0735	Request for Technical Information (RTI)			1	1
	Public Works and Government Services Canada (formerly DSS)	1	2		
K0740	DND procurement policy			1	1
	Management and scheduling techniques (eg. Network Analysis, Critical Path, PERT, etc.)	1	1		
K0745	Field Service Representative (FSR) tasking			1	1
	Risk analysis	1	2		
K0750	CF Quality Assurance organization			1	1
	Proposal evaluation	1	1		
K0755	Statement of Capability Deficiency (SCD)			1	1
	Reliability Centered Maintenance (RCM)	1	1		
K0760	Logistics Support Analysis (LSA)			2	2
	Shipboard electrical power generation and distribution systems	1	1		
K0765	Dynamic Deliverable List (DDL)			1	1
	Pollution control equipment and supplies	2	2		
K0770	Project Management			1	2
	Heating, Ventilation and Air Conditioning (HVAC) systems on board HMC ships	1	1		
K0775	Integrated Logistics Support (ILS)			2	3
	Cathodic protection	1	1		
K0780	CF Policies regarding Research and Development (R&D)			1	1
	Compressed air systems	1	1		
K0785	Public Works and Government Services Canada (formerly DSS)			1	2
	Combat Systems technologies	2	2		
K0790	Management and scheduling techniques (eg. Network Analysis, Critical Path, PERT, etc.)			1	1
	Theory and operation of navigation systems	2	3		
K0795	Risk analysis			1	2

SERIAL	REQUIREMENTS	A/CSEO	CSEO	A/MSEO	MSEO
	Gyro Systems	2	3		
K0800	Proposal evaluation			1	1
	Signal processing techniques	2	2		
K0805	Reliability Centered Maintenance (RCM)			1	1
	Naval Tactical Data Systems (NTDS)	2	3		
K0810	Steam main propulsion systems			1	1
	Weapon/sensor integration	2	2		
K0815	Diesel main propulsion systems			2	3
	Threat Evaluation Weapon Assignment (TEWA)	2	2		
K0820	Shipboard auxiliary systems/equipments (eg. prime movers, feedwater, seawater cooling, compressed air, fuel filling, etc			2	3
	Display systems	2	3		
K0825	Electrical main propulsion systems			2	2
	Tactical Information Processing Systems (AN/UYK 502, 505, 507, MRM)	2	3		
K0830	Gas turbine main propulsion systems			2	3
	Combat Systems Alignment	2	3		
K0835	Main propulsion ancillary systems including fuel, lubrication, cooling and air intake and exhaust			2	3
	Electromagnetic Interference/Electromagnetic Compatibility (EMI/EMC) control	2	2		
	Shipboard electrical power generation and distribution systems			2	3
K0840	Network concepts applicable to naval information processing systems	1	1		
K0845	Shipboard environmental protection systems			2	3
	Capabilities and limitations of the IFF/SIF equipment	2	3		
K0850	Pollution control equipment and supplies			2	2
	Detection theory for communication systems	2	2		
K0855	Shipboard firemain/bilge system			2	3
	Communications systems and equipment	2	3		
K0860	Machinery control and surveillance systems			2	3
	Frequency Spectrum Management	2	2		
K0865	Heating, Ventilation and Air Conditioning (HVAC) systems on board HMC ships			2	3
	Communications Security	2	2		

SERIAL	REQUIREMENTS	A/CSEO	CSEO	A/MSEO	MSEO
K0870	Ship's domestic systems including fresh water, heating, galley, laundry			2	3
	Data Link Systems	2	3		
K0875	Compartments and shipboard marking system in a HMC ship			2	2
	Ship's internal communication systems	2	3		
K0880	Microbiological growth			2	2
	Ship's sensor systems, associated processing and display sub-systems and equipment	2	3		
K0885	Cathodic protection			2	2
	Target Motion Analysis (TMA)	1	1		
K0890	Capabilities and limitations of a ship's steering arrangement			2	3
	Multisensor correlation	1	1		
K0895	Breathing Gas Systems			1	1
	Automated Detection and Tracking Systems	2	3		
K0900	Replenishment at sea equipment			2	3
	Software design/development requirement process	1	1		
K0905	Aircraft handling systems			2	2
	Software Configuration Management	1	1		
K0910	Refrigeration equipment			2	3
	Computer technology including principles of data transfer, data communications, and host-target systems relationships	2	2		
K0915	Seawater systems			2	3
	Software engineering principles	1	1		
K0920	Compressed air systems			2	3
	Oceanographic principles	2	2		
K0925	Fuel handling systems			2	3
	Underwater acoustics	2	2		
K0930	Fire detection and suppression system			2	3
	Theory and operation of sonar systems	2	2		
K0935	Characteristics/identification of fuels, lubricants and their substitutes			2	2
	Construction and operation of transducers and arrays	1	1		
K0940	Fuel tests			2	3
	Electro-acoustic transducer design and theory	1	1		

SERIAL	REQUIREMENTS	A/CSEO	CSEO	A/MSEO	MSEO
K0945	Policies, procedures, and practices for the safe handling of fluids			2	3
	Passive sonar systems	2	3		
K0950	Ship's trim, stability, and stress characteristics for all conditions of fluids loading/discharging/ballasting			2	3
	Active Sonar Systems	2	3		
K0955	Replenishment underway and alongside			2	3
	Sonar Performance Figure (SPF)	2	3		
K0960	Cleaning and gas-freeing of onboard liquid storage tanks			2	3
	Sound Range Trials	2	3		
K0965	Hazards of shipboard fuel handling			2	3
	Hull Outfits	2	3		
K0970	American Petroleum Institute (API) gravity, specific gravity, and flash point			2	3
	Towed Bodies	2	3		
K0975	Effect of temperature on volume of liquids			2	3
	Acoustic Range Prediction System (ARPS)	1	2		
K0980	Combat Systems technologies			1	1
	Non-Sonar Acoustic equipment	2	3		
K0985	Weapon/sensor integration			1	1
	Torpedo systems used in the Canadian Navy	2	3		
K0990	Electromagnetic Interference/Electromagnetic Compatibility (EMI/EMC) control			1	1
	Capabilities and limitations and operating characteristics of ASW torpedoes	2	3		
K0995	Ship's internal communication systems			1	1
	Acoustic counter measures	2	3		
K1000	Software design/development requirement process			1	1
	Towed array mechanics	2	3		
K1005	Software Configuration Management			1	1
	Close In Weapons System (CIWS)	2	3		
K1010	Computer technology including principles of data transfer, data communications, and host-target systems relationships			1	1
	Gun Weapons systems	2	3		
K1015	Software engineering principles			1	1

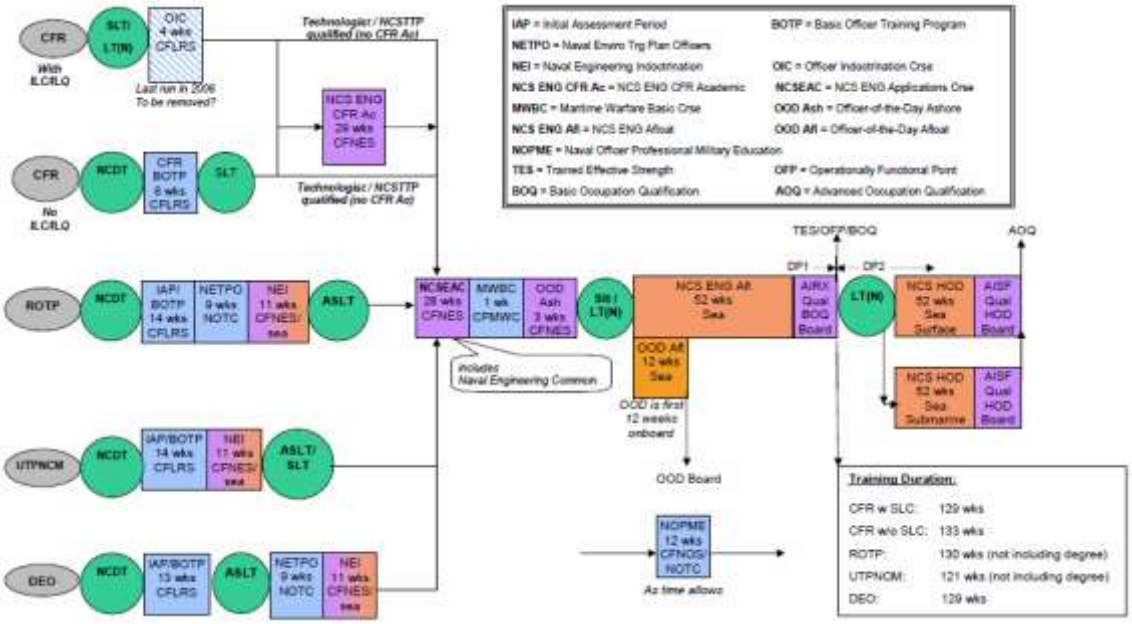
SERIAL	REQUIREMENTS	A/CSEO	CSEO	A/MSEO	MSEO
	Misfire and hot gun procedures	2	3		
K1020	Sound Range Trials			2	3
	Principles/theory of anti-air (AA) warfare	2	2		
K1025	Missile systems	2	3		
K1030	Ship survivability, including susceptibility and vulnerability			1	1
	Elements and characteristics of missile warheads (payload, fusing, safety and arming, target kill parameters)	2	2		
K1035	Ship design concepts to reduce vulnerability			1	1
	Preparation for missile firing on HMC ships	2	3		
K1040	Shipboard infrared (IR) suppression systems			2	2
	Ballistics	2	2		
K1045	Shipboard radar cross section			2	2
	Countermeasures against missile threat	2	2		
K1050	Types and applications of marine propellers			2	2
	Characteristics, capabilities and limitations of surface, AA targets and target towing vehicles	1	1		
K1055	Noise attenuation arrangements			1	1
	Weapons firing record-keeping	1	1		
K1060	Shipboard effects of shock, vibration or blast			1	1
	Electronic warfare (EW) theory	2	2		
K1065	Marine and Combat Systems and there ship level design impact			1	1
	EW systems	2	3		
K1070	Ship signature reduction techniques			1	1
	Radar Theory	2	2		
K1075	Ship motion theory			1	1
	TACAN and radio beacons	2	3		
K1080	Canadiam Forces Technical Orders (CFTOs)			2	2
	Navigation/surveillance Radars	2	3		
K1085	Maintenance adminstration in HMC ships			2	3
	Fire Control Radars/CWI	2	3		
K1090	Naval maintenance documentation			2	3
	Electro-Optic Systems (eg. - IR devices, lasers, Low-Light level TV)	2	3		
K1095	Routine engineering reports promulgated by HMC ships			2	3

SERIAL	REQUIREMENTS	A/CSEO	CSEO	A/MSEO	MSEO
	Telemetry	1	1		
K1100	Operational Deficiency (OPDEF)			2	3
	Ship survivability, including susceptibility and vulnerability	1	1		
K1105	Unsatisfactory Condition Report (UCR) procedures			2	3
	Ship design concepts to reduce vulnerability	1	1		
K1110	Pre-Installation Failure (PIF) Report procedures			2	3
	Shipboard radar cross section	2	2		
K1115	Engineering Officers Technical Instructions and memorandums			2	3
	Noise attenuation arrangements	1	1		
K1120	Periodic Engineering Letter (PEL)			2	3
	Shipboard effects of shock, vibration or blast	1	1		
K1125	Principles of Engineering Quality Management			1	1
	Marine and Combat Systems and there ship level design impact	1	1		
K1130	NDHQ Engineering Support Organization			2	2
	Ship signature reduction techniques	1	1		
K1135	Senior Review Board (SRB) process			1	1
	Ship motion theory	1	1		
K1140	Defence Management System (DMS)			1	1
	Canadiam Forces Technical Orders (CFTOs)	2	2		
K1145	Roles and responsibilities of DC Organiziation			3	3
	Maintenance adminstration in HMC ships	2	3		
K1150	Fleet Support planning			1	1
	Naval maintenance documentation	2	3		
K1155	Readiness and sustainment program			1	3
	Routine engineering reports promulgated by HMC ships	2	3		
K1160	Mission readiness checks			1	2
	Operational Deficiency (OPDEF)	2	3		
K1165	Force Generation concepts and doctrine			2	3
	Unsatisfactory Condition Report (UCR) procedures	2	3		
K1170	Pre-Installation Failure (PIF) Report procedures	2	3		
K1175	Information Management System			3	3
	Engineering Officers Technical Instructions and memorandums	2	3		
K1180	Periodic Engineering Letter (PEL)	2	3		

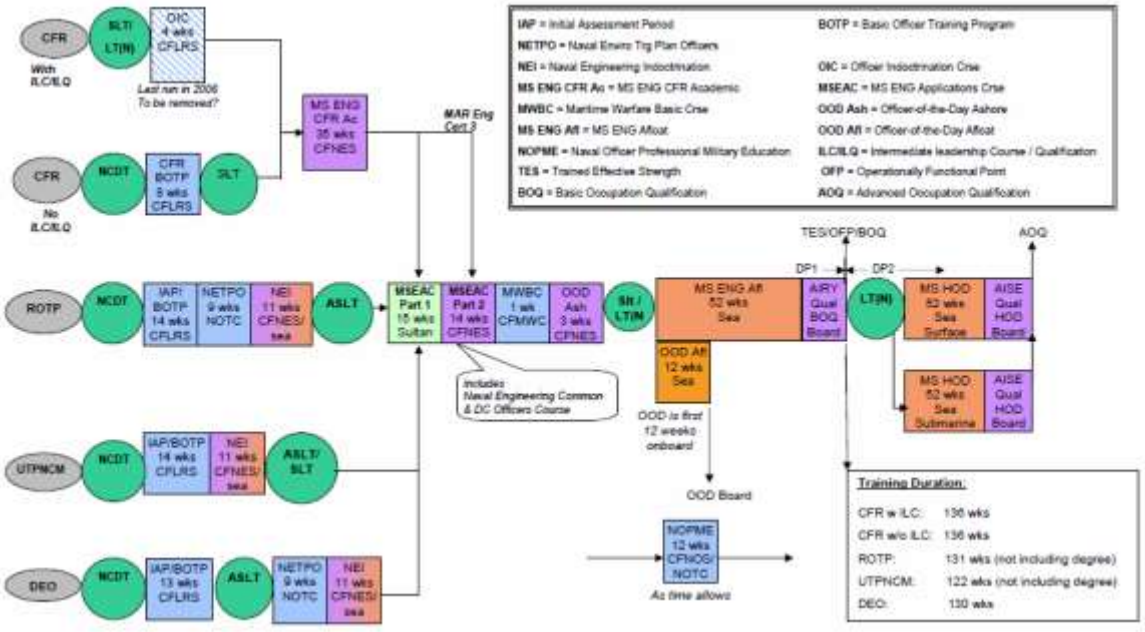
SERIAL	REQUIREMENTS	A/CSEO	CSEO	A/MSEO	MSEO
K1185	Principles of Engineering Quality Management	1	1		
K1190	NDHQ Engineering Support Organization	2	2		
K1195	Senior Review Board (SRB) process	1	1		
K1200	Defence Management System (DMS)	1	1		
K1205	Roles and responsibilities of DC Organiziation	2	2		
K1210	Fleet Support planning	1	1		
K1215	Readiness and sustainment program	1	3		
K1220	Mission readiness checks	1	3		
K1225	Force Generation concepts and doctrine	2	3		
K1235	Information Management System	3	3		
K2005	Nuclear Propulsion Systems			2	3
K2010	Principles of Bearings			2	3
K2015	Principles of Clutches			2	3
K2020	Principles of Shaft Lines			2	3
K2025	Principles of Shaft Sealing and Supports			2	3
K2030	Principles of Lubrication Systems			2	3
K2035	Principles of Fuel Systems			2	3
K2040	Principles of Cooling Systems			2	3
K2045	Main Propulsion Design Considerations			2	3
K2050	Operation of Main Propulsion Systems			2	3
K2055	Principles of Steam Systems			2	3
K2060	Operation of Auxiliary Systems			2	3
K2065	Operation of Machinery Control and Surveillance Systems			2	3
K2070	Principles of Degaussing/Deperming Systems			2	3
K2075	Principles of Telephone Systems			2	3
K2080	Operation of Electrical Systems			2	3
K2085	Operation of HVAC Systems			2	3
K2090	Effects of Damage on Operational Effectiveness and Ship’s Safety			2	3
K2500	Liquid Husbandry underway and alongside			2	3
K2505	Docking policy and principles			2	3
K2510	Docking Procedures			2	3
K2515	Combat Readiness Requirements			2	3
K2520	Pre-sail Checks			2	3
K2525	Personnel Readiness			2	3
K2530	Logistical Readiness			2	3

SERIAL	REQUIREMENTS	A/CSEO	CSEO	A/MSEO	MSEO
K2535	Magnetic Signature			2	3
K2540	Quiet Running States			2	3
K2545	Emergency Repairs			2	3
K2550	Quality Control/Quality Assurance			2	3
K2555	Maintenance Action Forms (CF 1304)			2	3
K2560	Supply Demands (CF 2302)			2	3
K2565	Gas Turbine Hot Section Inspection			2	3
K2570	Gearing Inspection			2	3
K2575	Boiler Inspection			2	3
K2580	Tank Inspection			2	3
K2585	Fuel Consumption Run			2	3
K2590	Failure Investigation			2	3
K2595	Trials program documentation			2	3
K2600	Types of Tests and Trials			2	3
K2605	Occupational Health and Safety Act			2	3
K2610	Canada Labour Code Part II			2	3
K2615	DND General Safety Program			2	3
K2620	Burning and Welding Principles			2	3
K2625	Confined Space Entry			2	3
K2630	Diving Operations			2	3
K2635	Man Aloft Procedures			2	3
K2640	Radiation Hazard (non-ionizing) Procedures			2	3
K2645	Ionizing Radiation Procedures			2	3
K2650	Ammunitioning			2	3
K2655	Personnel Policies and Procedures			2	3
K2660	Departmental Training			2	3
K2665	Ship's Company Training			2	3
K2670	Personnel Organizations			2	3
K2675	Military Personnel Policies			2	3
K2680	Civilian Personnel Policies			2	3
K2685	Maintenance Procedure Development and Management			2	3
K2690	Configuration Management Organization			2	3
K2695	Configuration Management Process			2	3
K2700	Contract Management			2	3
K2705	Business Planning			2	3

APPENDIX B - COMBAT SYSTEMS ENGINEERING OFFICER & MARINE SYSTEMS ENGINEERING OFFICER TRAINING PROGRESSION



Combat System Engineering Officer Training Progression



Marine System Engineering Officer Training Progression

Note - The above information was attained from the Canadian Forces Naval Engineering School Officer Training Division and is dates effective as of September 2010.

APPENDIX C - EXCERPT FROM THE NAVAL ENGINEERING COMMON QUALIFICATION STANDARD AND PLAN

Chapter 2 – Performance Objectives

PO 002 – Describe Risk Management

1. Performance: Describe Risk Management

2. Conditions:

a. Given: (1) Operational Ship;
(2) References; and
(3) Engineering and Operational Staff Support.

b. Denied: N/A

c. Environmental (e.g. Working Conditions):

(1) Ashore; and
(2) Afloat.

3. Standard: The NTO shall describe Risk Management, IAW refs, by:

a. Identifying elements of Risk Management; and
b. Describing the Risk Management Framework.

4. Reference Codes:

A1; A6; A12; A13; A14; A15; A18; A20; A33; A37; A52; A58; A62; A64; A65; A66; A67; A68; A69; A73; A74; A75; A76.

5. Training Limitations:

N/A.

Chapter 4 – Lesson Specifications

PO 002 – Describe Risk Management

EO 002.01 Identify Elements of Risk Management

1. Performance: Identify elements of Risk Management

2. Conditions:

    a. Given: Nil;
    b. Denied: N/A; and
    c. Environment: Boardroom.

3. Standard: The NTO shall identify the elements of Risk Management by:

    a. Summarizing policies and regulations;
    b. Discussing background and purpose;
    c. Identifying stakeholder organizations, roles and responsibilities;
    d. Defining issues, risk, and opportunity; and
    e. Introducing Risk Management terminology.

4. Training Aids:

    N/A.

5. Test Details:

    Refer to Annex K – Assessment Plan.

6. Remarks:

    N/A.

7. Teaching Points: (next page)

	TEACHING POINTS	METHODS	MEDIA	INSTRUCTIONAL ENVIRONMENT	TIME (in minutes)	REFERENCE (PAGE AND PARA IF APPLICABLE)
1	Summarize policies and regulations	Lecture	Instructor		50	
1.1	DND/CF Integrated Risk Management Policy					
2	Discuss background and purpose, to include the following:	Lecture	Instructor		50	
2.1	History					
2.2	Risk Culture					
2.3	Risk Management in the GoC					
2.4	Risk Management in DND/CF					
2.5	Risk Management in the Navy					
2.6	Operational Risk Management					
2.7	Purpose of Risk Management					
3	Identify stakeholders Organizations, Roles and Responsibilities	Lecture	Instructor		25	
4	Define Issue, Risk and Opportunity	Lecture	Instructor		50	
4.1	Characteristics of Issues					
4.2	Characteristics of Risks					
4.3	Characteristics of Opportunities					
5	Introduce Risk Management Terminology	Lecture	Instructor		25	
Total Instructional Classroom Time					**200**	
Total Instructional Practical (e.g. Field, Simulator, etc.) Time					**N/A**	
Total Instructional Time (Classroom + Practical)					**200**	
Total EC Time (Including debrief)					**N/A**	
Total EO Time (Instr Time + EC Time)					**N/A**	
Total PC Time (Including Debrief) To be placed in the Final EO of each PO only					**N/A**	
Total Time					**200**	

EO 002.02 Describe the Risk Management Framework

1. Performance: Describe the Risk Management Framework

2. Conditions:

a. Given: Nil;
b. Denied: N/A; and
c. Environment: Boardroom.

3. Standard: The NTO shall describe the Risk Management Framework, by:

a. Describing Operational/Technical Risk Management onboard ships;
b. Describing Integrated Risk Management;
c. Describing Risk Management in Projects;
d. Describing Risk Management Process; and
e. Identifying Risk Management Enablers.

4. Training Aids:

N/A.

5. Test Details:

Refer to Annex K – Assessment Plan.

6. Remarks:

N/A.

7. Teaching Points:

	TEACHING POINTS	METHODS	MEDIA	INSTRUCTIONAL ENVIRONMENT	TIME (in minutes)	REFERENCE (PAGE AND PARA IF APPLICABLE)
1	Describe Operational/Technical Risk Management onboard ships	Case study	Instructor		50	
1.1	Identifying Risk and Risk Mitigation Measures					
2	Describe Integrated Risk Management	Case Study	Instructor		50	
2.1	Risk Management Programs Onboard HMC Ships					
3	Describe Risk Management in Projects	Case study	Instructor		50	
3.1	Role and Requirements of Risk Management Organizations within DND					
4	Describe Risk Management Process	Case Study	Instructor		200	
4.1	Risk Planning: 1) Identifying risk factors (objectives at risk); 2) Identifying risk categories; 3) Identifying probabilities and impacts (probability and impact matrix, or Risk Exposure levels); 4) Defining overall methodology; and 5) Identifying stakeholders.					
4.2	Risk Identification and methods: 1) Defining Context, Conditions, Consequences; and 2) Defining Methods.					
4.3	Risk Analysis and methods: 1) Determining attributes; 2) Defining Classification; 3) Perform Quantitative Risk Analysis; 4) Perform Qualitative Risk Analysis; 5) Prioritizing; and 6) Defining Accountability, Responsibility, Authority.					
4.4	Risk Response Planning and Implementation: 1) Defining Acceptance; 2) Defining Transfer; 3) Defining Mitigate (ALARP); 4) Defining Avoid; 5) Identifying Risk Monitoring and Control methods; 6) Defining Risk Reporting methods; and 7) Defining Risk Closing method.					
5	Identify Risk Management Enablers to include the following	Case study	Instructor		50	
5.1	Prioritization					
5.2	Risk Management Plan					
5.3	Data Collection					
5.4	Integrated Logistics Support data					
5.5	Simulation Software					
5.6	Risk Register (Risk Information Sheet)					
5.7	Risk Management Software					
5.8	Lessons Learned					
5.9	Operational and Technical Knowledge					
5.10	Communication					
5.11	Tools and decision aids					
Total Instructional Classroom Time					500	
Total Instructional Practical (e.g. Field, Simulator, etc.) Time					N/A	
Total Instructional Time (Classroom + Practical)					500	
Total EC Time (Including debrief)					N/A	
Total EO Time (Instr Time + EC Time)					N/A	
Total PC Time (Including Debrief) To be placed in the Final EO of each PO only					N/A	
Total Time					500	

Bibliography

Canada. Department of National Defence. A-PD-055-002/PP-001, *Canadian Forces Manual of Military Occupation Structure - Volume 2 Part 1 - Job Based Occupational Specification for Naval Combat Systems Engineering Officer* (Ottawa: DND Canada, Amended 2010), 20.

Canada. Department of National Defence. A-PD-055-002/PP-001, *Canadian Forces Manual of Military Occupation Structure - Volume 2 Part 1 - Job Based Occupational Specification for Naval Marine Systems Engineering Officer* (Ottawa: DND Canada, Amended 2010), 20.

Canada. Department of National Defence. A-PD-055-002/PP-001, *Canadian Forces Manual of Military Occupation Structure - Volume 2 Part 1 - Job Based Occupational Specification for Weapons Engineering Technicians* (Ottawa: DND Canada, Amended 2010), 26.

Canada. Department of National Defence. A-PD-055-002/PP-003, *OGS MOSID 00002 Canadian Forces Officer General Specification* (Ottawa: DND Canada, Approved 2009), 56.

Canada. Department of National Defence. C-23-005-000/AG-001, *Naval Materiel Regulation for Surface Ships*. Ottawa: DND Canada, 2013.

Canada. Department of National Defence. C-23-005-000/AG-002, *Naval Materiel Risk Management*. Ottawa: DND Canada, 2013.

Canada. Department of National Defence. C-03-005-012/AM-001, *Naval Materiel Management System Manual.* Ottawa: DND Canada, 2013.

Canada. Department of National Defence. C-03-005-033/AA-000, *Naval Engineering Manual*. Ottawa: DND Canada, 2012.

Canada. Department of National Defence. Document No. 3748968, *Future In-Service Support Project: ISS System Analysis Document, Draft Version 5*. Ottawa: DND Canada, 2014.

Canada. Department of National Defence. *Maritime Command Qualification Standard and Plan – Naval Engineering Indoctrination*. Ottawa: DND Canada, 2007.

Canada. Department of National Defence. *Royal Canadian Navy Qualification Standard and Plan – Naval Engineering Common*. Ottawa: DND Canada, 2013.

Canada. Department of National Defence. *Royal Canadian Navy Qualification Standard and Plan – NCS Eng 00344 – Basic Occupation Qualification* (Ottawa: DND Canada, 2014), 343.

Canada. Department of National Defence. *Royal Canadian Navy Qualification Standard and Plan – NCS Eng 00344 – Head of Department Qualification* (Ottawa: DND Canada, 2005), 141.

Canada. Department of National Defence. *Royal Canadian Navy Qualification Standard and Plan – MS Eng 00345 – Head of Department Qualification* (Ottawa: DND Canada, 2005), 194.

Canada. Department of National Defence. SSO AL9CH2, *Ship's Standing Orders* (Halifax: DND Canada, 2014), 662.

Dhillon, B. S., *Design Reliability: Fundamentals and Applications*. Boca Raton, FL: CRC Press, 1999.

Dhillon, B. S., Engineering and Technology Management Tools and Applications. Artech House, 2002.

Dhillon, B. S., *Reliability, Quality, and Safety for Engineers*. Boca Raton, FL: CRC Press, 2005.

Haddon-Cave, Charles., Great Britain., Parliament., House of Commons., *The Nimrod Review: An Independent Review into the Broader Issues Surrounding the Loss of the RAF Nimrod MR2 Aircraft XV230 in Afghanistan in 2006: Report*. London: TSO, 2009.

Her Majesty the Queen in Right of Canada, represented by the Minister of Public Works and Government Services, 2011. *Chapter 5,"Maintaining and Repairing Military Equipment—National Defence", of the fall 2011 Report of the Auditor General of Canada*. [Ottawa]: Office of the Auditor General of Canada, 2011.

Markowski, Stefan., Hall, Peter., Wylie, Robert., *Defence Procurement and Industry Policy: A Small Country Perspective*. London; New York: Routledge, 2010.

Purcell, Mark,. "Maintenance of Ships in the Royal Australian Navy: The Rizzo Reform Programme - Capability Management, Accountability and Responsibility." *United Service* 63, no. 2 (2012): 14-16.

Rizzo, Paul J., *Plan to Reform Support Ship Repair and Management Practices*. Canberra: Ministerial and Executive Coordination and Communication Division, Department of Defence, Australia, 2011.

Williams, LCdr Sean. "This is Africa — The Challenges of Making Emergency Diesel Generator Repairs While Deployed," *Maritime Engineering Journal*, no. 65 (Fall 2009/Winter 2010): 5-9.