

# EMPLOYMENT AND UTILIZATION PROFILE REPORT

C002673  
Joint Support Ship



## **JOINT SUPPORT SHIP PROJECT** **PROJET DE NAVIRES DE SOUTIEN** **INTERARMÉES**

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**RECORD OF AMENDMENTS**

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**LIST OF ABBREVIATIONS**

AOR	Auxiliary Oiler Replenishment
BY	Budget Year
CFCD	Canadian Forces Controlled Document
CORA	Centre for Operational Research and Analysis
D&PE	Design and Production Engineering
DMP	Dedicated Maintenance Period
DND	Department of National Defence
DRDC	Defence Research and Development Canada
DWP	Docking Work Period
FW	Fresh Water
HMCS	Her Majesty's Canadian Ship
HF	High Frequency
HP	High Pressure
HVAC	Heating, Ventilation and Air Conditioning
IPMS	Integrated Platform Management System
JSS	Joint Support Ship
LP	Low Pressure
NETE	Naval Engineering Test Establishment
OGD	Other Government Department
OP	Operations
PMO	Project Management Office
R&M	Reliability and Maintainability
RAMP	Rest and Maintenance Period
RAS	Replenishment at Sea
RR	Reduced Readiness
SAR	Search and Rescue
SOR	Statement of Operational Requirements
TG	Task Group
TGEX	Task Group Exercise
TRP	Tiered Readiness Programme
VERTREP	Vertical Replenishment
WUPs	Work-Ups

## REFERENCES

- A. JSS Statement of Operational Requirements version 5.6, 27 November 2012
- B. NETE Developed System Utilization Model
- C. DRDC CORA LR 2012-148: Analysis of AOR Activities During Long Deployments: Replenishments at Sea, 4 July 2012
- D. DRDC CORA LR 2012-177: Helicopter and Boat Launching Activities on HMCS PROTECTEUR During Operation APOLLO, 7 August 2012
- E. HMCS PRESERVER's Operational Schedule, 6 December 1997 to 5 December 2002  
<http://halifax.mil.ca/N3/N31/Departments/N31-1/index.html>
- F. HMCS PROTECTEUR's Operational Schedule, 16 November 2001 to 15 November 2005,  
[http://esquimalt.mil.ca/marpac/n3/n31/N311%20Schedules/Historical\\_OPSKED/index.htm](http://esquimalt.mil.ca/marpac/n3/n31/N311%20Schedules/Historical_OPSKED/index.htm)
- G. CFCD 129 Readiness and Sustainment, October 2009

## 1. BACKGROUND

The objective of the Joint Support Ship (JSS) project is to recapitalize Canada's naval support vessels, modernizing its joint force capabilities in line with the Canada First Defence Strategy. The JSS will provide Canada with two modern, task tailored, globally deployable, naval support ships, with an option for a third ship.

During the in-service phase of the ships, DND will incur costs for personnel, operations and maintenance. In the case of JSS, the in-service costs over the 30-year life of the two ships are estimated to be \$4.5 billion (BY). Of that amount, the second largest expenditure during the in-service phase is the cost of maintenance support, which represents approximately 40% of the in-service costs.

Given the cost involved, the aim of the in-service support process must be to minimize the total ownership cost of the JSS class while ensuring its targeted operational capability and availability are achieved. Total ownership cost is defined as the overall cost through the entire life of the ship and includes design, construction, in-service support and disposal. One method for optimizing cost is to accurately profile the in-service employment and utilization of the JSS and its systems. These profiles will allow for more efficient and cost effective planning with regards to forming a baseline for the reliability and maintainability (R&M) assessment and support requirements and resulting costs. These profiles and the method through which they were developed are discussed in more detail in this report.

### 1.1 ASSUMPTIONS

The following assumptions were made in developing the employment and utilization profile:

- a. The Joint Support Ships will have an operational tempo similar to HMCS PRESERVER and PROTECTEUR conducted during the period of 1995-2005;
- b. The Joint Support Ships will have an operational profile composed of those core missions described in reference A;
- c. The Joint Support Ships will have a 5 year operating cycle that will conclude with a DWP;
- d. For the purposes of this profile, the operating cycle will have the following readiness rhythm:
  - It will commence with a 9 month Tiered Readiness Program (TRP), which will consist of trials, Work-Ups (WUPs) and Dedicated Maintenance Periods (DMPs) as per reference G;
  - At the start of the operating cycle, the JSS will be at High Readiness and conduct an extended deployment;

- Immediately prior to the extended deployment, the JSS will conduct deployment preparations consisting of required maintenance (DMP) and trials to ensure that the ship is capable of meeting its operational goals;
  - After returning from deployment and conducting an extended stay in home port (for crew rest and repairs), the JSS will spend the majority of its readiness rhythm at Standard Readiness, as per reference G, during which time it will conduct several minor operations, lasting approximately a month and a half each;
  - Each minor operation will be followed by a stay at Home Port, where the ship's crew will be allowed to rest, train and perform required maintenance;
  - Throughout the readiness rhythm there will be an average 75 days per year allotted to DMPs to allow for extended maintenance operations to be accomplished by the ISS Contractor; and
  - At the end of its operating cycle the JSS will be at Extended Readiness, as per reference G, lasting up to 6 months. The extended readiness period will consist of 2 months preparation (Reduced Readiness) and a 4 month Docking Work Period (DWP).
- e. The JSS ships will average 120 days of sea time per year, including foreign port visits and ashore trials;
- f. For the purposes of this profile, the extended deployment will have the following characteristics:
- A maximum total duration of 180 days with the following breakdown:
    - 40 days of transit: 20 days to and from the Area of Operations;
    - 109 days of Task Group support: Once in the Area of Operations, the JSS's primary role will be to conduct Task Group support. It will carry out this task in three 34-day intervals, each interval includes two days of transit to and from the port of replenishment. There will also be a shorter 7-day interval at the end of the deployment as the JSS leaves the Area of Operations; and
    - 31 days in foreign port: Over the course of the deployment, the JSS will spend 21 days in foreign port for the purpose of crew rest, replenishment and performing required maintenance. As well, at the mid-point of the deployment, there will be an additional 10 day Rest and Maintenance Period (RAMP) for ship's crew at a foreign port.

## 1.2 DEFINITIONS

Ship Employments: are defined as the various roles or activities that the JSS will conduct during its readiness rhythm. For the purpose of this profile, based on the core missions

described in reference A, the ship employments will include Task Group Support, Area of Operations Patrol, Sealift Operations, transit to an Area of Operations, time spent in Home and Foreign Port, Sea Trials and Work-Ups (includes alongside trials), Dedicated Maintenance Periods (DMP) and Reduced Readiness DWP preparations.

Ship Operations: are defined as the actual actions that the JSS conducts to accomplish a ship employment. For the purpose of this profile, ship operations include: Replenishment at Sea (RAS), helicopter operations, small boat operations, underway at sea, tied up in home and foreign port, conducting a DMP and being at Reduced Readiness alongside in home port.

Ship Systems Usage: represents the time that a given ship system will be in operation, presented as a ratio from 0 (not required) to 1 (continuous operation).

Required Availability: represents the time that a given ship system is required to be available for operations, presented as a ratio from 0 (not required) to 1 (continuously available).

Readiness Rhythm: is defined as the operational state/schedule that a ship undertakes from the end of one DWP to the end of the next DWP.

### 1.3 PURPOSE OF EMPLOYMENT AND UTILIZATION PROFILE

The Employment and Utilization Profile was undertaken to predict the usage and required availability for key ship systems. The required availability and system usage were ascertained for the 120 days of average sea time per year, the 75 days allotted to DMP per year, the remaining 170 days per year, a 180 day deployment and for a 5 year readiness rhythm. The systems studied include: the propulsion system, the power generation and distribution system, the steering system, the compressed air systems, the refrigeration and HVAC systems, IPMS, the firemain, the fresh water production and distribution systems, the ballast system, the cargo fuel system, the oil pollution prevention system, helicopter systems, boat cranes, deck crane, deck equipment (including capstans, winches, anchor, etc.), navigation systems (including the inertial navigation system, vital repeaters, echo sounder, etc.), communication systems (HF, SATCOM, etc.) and command and control system.

The purpose of determining this system usage and required availability is to assist in the development of ship systems, selection of equipment, purchase of spares and preparation of maintenance profiles that can meet the most onerous potential JSS operational schedule, while minimizing the total ownership cost of the JSS ships.

### 1.4 SHIP EMPLOYMENT PROFILE

The ship's anticipated core missions and their duration will greatly impact the operating hours and required availability for ship systems. It is therefore necessary to determine the typical employment for the ships, the time spent in each operation, the systems usage for each scenario and the ship availability for maintenance in order to estimate the operating hours, system availability and determine the required reliability and

maintainability. This Employment and Utilization Profile will reflect the core mission scenarios as described in the JSS Statement of Operational Requirements, reference A, and will assess the demand on systems during the 120 days of sea time per year, the 75 days allotted to DMP per year, the remaining 170 days per year, a 180 day deployment and over a 5 year readiness rhythm.

### **1.5 SYSTEM UTILIZATION MODEL**

To develop a method to translate the ship employment profiles listed in reference A into system operating hours and required availability, PMO JSS tasked the Naval Engineering Test Establishment (NETE) with creating a System Utilization Model.

The developed model is Excel based and calculates the resulting system usage or required availability by first breaking down the ship's operational schedule into various ship employments. These employments are then further broken down into ship operations, which have defined ship systems usage characteristics. Then by using matrix multiplication, the model calculates the resulting ship system usage or required availability for a ship employment profile, in system operating hours.

In this way the model provides results that allow for a better understanding of the expected demands on ship systems and allows for them to be designed, built and maintained in an effective and cost efficient manner.

### **1.6 SYSTEM USAGE VERSUS AVAILABILITY**

This report provides results for both system usage and required availability. System usage represents the number of operating hours that a ship system as a whole is expected to experience during the ship's employment profile; whereas, the required availability represents the number of hours that a ship system should be available and capable of operating. Thus, the required availability not only includes the operating hours captured in system usage, but those hours when the system is idle or shutdown and available for maintenance, but is required to be available for operation at short notice or in a timeframe dependent on the ship's degree of readiness, as specified in reference G. An example of this would be the propulsion system in foreign port, which would be shut down, but required in short order in the event of an emergency.

Both results are important, as they provide an indication of the operating hours that ship systems should expect and also the amount of hours that ship systems should be available for without the requirement for maintenance that would force them offline for an extended period of time.

## **2. SHIP EMPLOYMENT PROFILES**

A three-step process was used to develop the JSS ship employment profiles. First, a realistic profile of the operational tempo of the JSS had to be determined. The operational tempo captures the amount of time that a ship spends at sea conducting operations. Second, this operational tempo had to be analyzed and from it a worst case scenario employment profile created. The last step was to then super-impose the core

mission profiles listed in reference A, on to this worst case scenario employment profile to create a reasonable profile of the JSS's future employment.

## 2.1 OPERATIONAL TEMPO

To determine the operational tempo for JSS, the historical operational schedules from HMCS PRESERVER and HMCS PROTECTEUR were analyzed.

Based on the availability of unclassified operational schedules, this profile focuses on HMCS PRESERVER's operational schedule from 6 December 1997 to 5 December 2002 and HMCS PROTECTEUR's operational schedule from 16 November 2001 to 15 November 2005, references E and F.

These timelines are beneficial for several reasons. First, they both represent a complete readiness rhythm from DWP to DWP. Second, the timelines cover an earlier portion of the AORs' lifecycle, before age and obsolescence issues began impacting their operational capabilities and availability. Finally, each ship conducted an extended deployment during these readiness rhythms, OP APOLLO.

After performing a quick review of the various ship employments conducted during these operational schedules, they were grouped into the following seven categories: tied up alongside in home port, tied up alongside in foreign port, conducting a dedicated maintenance period (DMP), trials and work-ups, transit, conducting operations and reduced readiness. All missions/operations were grouped under the umbrella "conducting operations" to facilitate the super-imposition of the predicted core missions in step three.

The two operational schedules were then analyzed in more detail and it was determined how much time each ship had spent conducting each of the seven ship employments. The results of this analysis appear in the following [table](#).

HMCS PRESERVER 1997/2002			HMCS PROTECTEUR 2001/05			
Operational Schedule	Ship Activity	Duration	Operational Schedule	Ship Activity	Duration	
TRP	Sea Trials & WUPS	82	TRP	Sea Trials & WUPS	47	
	Home Port	300		DMP	131	
	DMP	63		Home Port	20	
	Foreign Port	3		Extended Deployment	Operations	86
	Transit	7			Transit	52
Minor Op	Operations	17	Home Port	Foreign Port	37	
	Transit	7		Home Port	161	
	Foreign Port	16		DMP	182	
	Home Port	209		Sea Trials & WUPS	10	
Home Port	Home Port	209	Minor Op	Operations	11	
	Operations	12		Operations	3	
	DMP	64		Transit	2	

HMCS PRESERVER 1997/2002			HMCS PROTECTEUR 2001/05		
Operational Schedule	Ship Activity	Duration	Operational Schedule	Ship Activity	Duration
	Sea Trials & WUPS	19		Foreign Port	6
	Foreign Port	3		Home Port	142
Minor Op	Operations	26		Sea Trials & WUPS	23
	Transit	12		DMP	26
	Foreign Port	10	Minor Op	Operations	26
	Home Port	73		Transit	8
Home Port	Home Port	44		Foreign Port	9
	DMP	45		Home Port	53
	Sea Trials & WUPS	2		Sea Trials & WUPS	5
	Operations	2	Minor Op	Operations	16
Minor Op	Operations	22		Transit	5
	Transit	3		Foreign Port	1
	Foreign Port	13		Home Port	52
Home Port	Home Port	39		Sea Trials & WUPS	2
	DMP	26		DMP	49
	Sea Trials & WUPS	2	Minor Op	Operations	27
Minor Op	Sea Trials & WUPS	13		Foreign Port	2
	Transit	22		Home Port	54
	Foreign Port	15		Sea Trials & WUPS	2
	Operations	22	Minor Op	Operations	7
Minor Op	Home Port	130		Foreign Port	1
	DMP	51		Home Port	103
	Operations	23		Sea Trials & WUPS	3
	Sea Trials & WUPS	2	Minor Op	Operations	31
Extended Deployment	Operations	116		Transit	4
	Foreign Port	20		Foreign Port	7
	Transit	54		Home Port	14
	Sea Trials & WUPS	3		Sea Trials & WUPS	9
DWP Preps	Operations	26			
	Home Port	113			
	Foreign Port	4			
	Sea Trials & WUPS	3			
	DMP	75			
	<b>TOTAL</b>	<b>1821</b>		<b>TOTAL</b>	<b>1429</b>

Table 1: Historical 5 Year Readiness Rhythm Timelines

The two historical operational schedules were then summarized into ship employment profiles. It should be noted that HMCS PROTECTEUR's operational schedule between

DWPs was only 4 years. Therefore, the results were extrapolated to a standard 5 year readiness rhythm to match the HMCS PRESERVER results. The two historical profiles appear in the [table](#) below.

Ship Activity	PRESERVER 1997/2002	PROTECTEUR 2001/05
Operations	274	259
Transit	105	89
Foreign Port	84	79
Home Port	908	749
Sea Trials & WUPS	126	126
DMP	324	485
<b>TOTAL</b>	<b>1821</b>	<b>1787</b>

Table 2: Historical 5 Year Readiness Rhythm Profiles

## 2.2 WORST CASE SCENARIO SHIP EMPLOYMENT

After developing the operational tempo, the profiles and timelines ([table 1](#) and [2](#)) were then compared and a worst case scenario ship employment profile was created. The worst case scenario has the same framework as the historical scenarios. It commences with a Tiered Readiness Programme (TRP), then moves on to an extended deployment, followed by several minor operations interspersed by stays in home port and then ends with a DWP. To incorporate the forecasted DWP (4 months) and its preparations (2 months) within the 5 year readiness rhythm, the worst case profile has been adjusted accordingly. This results in the following [profile](#):

Ship Activity	Total Number of Days Spent Conducting
Operations	209
Transit	95
Foreign Port	72
Home Port	765
Sea Trials & WUPS	166
DMP	338
RR	60
DWP	120
<b>TOTAL</b>	<b>1825</b>

Table 3: Worst Case 5 Year Readiness Rhythm Profile

The timeline appears below:

Operational Schedule	Ship Activity	Duration
TRP	Sea Trials & WUPS	66
	DMP	101
	Home Port	91
Deployment Preps	Home Port	134
	Sea Trials & WUPS	38
	DMP	32
Extended Deployment	Operations	109
	Transit	40
	Foreign Port	31
Extended Home Port	Home Port	134
	DMP	13
Minor Op #1	Operations	20
	Transit	11
	Foreign Port	8
Home Port	Home Port	91
	DMP	44
	Sea Trials & WUPS	13
Minor Op #2	Operations	20
	Transit	11
	Foreign Port	8
Home Port	Home Port	90
	DMP	44
	Sea Trials & WUPS	13
Minor Op #3	Operations	20
	Transit	11
	Foreign Port	9
Home Port	Home Port	134
	DMP	61
	Sea Trials & WUPS	23
Minor Op #4	Operations	20
	Transit	11
	Foreign Port	8
Home Port	Home Port	91
	DMP	43
	Sea Trials & WUPS	13
Minor Op #5	Operations	20
	Transit	11
	Foreign Port	8
DWP Preps	RR	60
DWP		120
	<b>TOTAL</b>	<b>1825</b>

Table 4: Worst Case 5 Year Readiness Rhythm Timeline

It should be noted that when generating the worst case scenario, several guidelines for the JSS were inserted. First, the requirement for 75 days allotted to contractor led DMP per

year over the course of the readiness rhythm (excluding the DWP and its preparations) was incorporated. This necessitated that the total number of days conducting DMP would be 338 days (75 multiplied by 4.5). Second, the requirement for an average of 120 days at sea per year (excluding the DWP and its preparations) necessitated that the total number of days spent conducting operations, transit, sea trials & WUPS and tied up in foreign port would be roughly 542 (120 multiplied by 4.5).

### 2.3 SUPER-IMPOSITION OF CORE MISSIONS

The third and last step of creating the ship employment profiles was to super-impose the core missions identified in reference A onto the historically generated worst case scenario ship employment profile and timeline. Prior to super-imposition, the core mission profiles had to be converted into ship employments.

Reference A notes six core missions. They are:

1. Conduct Daily Domestic and Continental Operations: includes Search and Rescue (SAR) in Canada, Surveillance/Control of Canadian Territories and Approaches and Defence of Canadian/US Territory;
2. Support a Major International Event in Canada: includes Act in National Interest/Support to Other Government Departments (OGDs);
3. Respond to a Major Terrorist Attack: includes Aid of the Civil Power;
4. Support Civilian Authorities during a Crisis in Canada: includes Disaster Relief in Canada;
5. Lead and/or Conduct a Major International Operation for an Extended Period: includes Peace Support Operations; and
6. Deploy Forces in Response to Crises Elsewhere in the World for Shorter Periods: includes International Humanitarian Assistance, Protection and Evacuation of Canadians Overseas and Peace Support Operations.

These core missions can then be grouped into the following ship employments:

1. Task Group Support: core mission #5 which largely focuses on supporting other ships within a task group for an extended period of time;
2. Area of Operations Patrol: core missions #1 and 2 which largely focus on patrolling a given area and conducting surveillance flights and boarding operations; and
3. Sealift Operations: core missions #3, 4 and 6 which largely focus on delivering supplies and extracting personnel.

Task Group Support employment focuses primarily on the replenishment (RAS) of other elements of the Task Group, while still conducting secondary boat and helicopter operations. Area of Operations Patrol has a reduced replenishment onus, but significantly more boat and helicopter operations are conducted. Finally, Sealift Operations have a similar profile to Patrols, except that a large amount of time is spent in Foreign Port or at anchor embarking and disembarking supplies and personnel.

After determining the ship employments, their distribution within the worst case scenario employment profile had to be determined. As core mission #5 represents the extended deployment, Task Group Support was selected as the ship employment for the extended deployment. Next it was decided that as Task Group Support and Area of Operations Patrol represent the most likely ship employments for JSS, each one would be selected to represent two of the five minor operations. Finally, it was decided that Sealift Operations would represent the last remaining minor operation, as this ship employment is largely dependent on World events.

The resulting ship employment [profile](#) and [timeline](#) appear as follows:

Ship Activity	Total Number of Days Spent Conducting
Task Group Support	149
Area of Operations Patrol	40
Sealift Operation	20
Transit	95
Foreign Port	72
Home Port	765
Sea Trials & WUPS	166
DMP	338
RR	60
DWP	120
<b>TOTAL</b>	<b>1825</b>

Table 5: JSS 5 Year Readiness Rhythm Ship Employment Profile

Operational Schedule	Ship Activity	Duration
TRP	Sea Trials & WUPS	66
	DMP	101
	Home Port	91
Deployment Preps	Home Port	134
	Sea Trials & WUPS	38
	DMP	32
Extended Deployment	Task Group Support	109
	Transit	40
	Foreign Port	31
Extended Home Port	Home Port	134
	DMP	13
Minor Op #1	Area of Operations Patrol	20
	Transit	11
	Foreign Port	8
Home Port	Home Port	91
	DMP	44
	Sea Trials & WUPS	13
Minor Op #2	Task Group Support	20
	Transit	11
	Foreign Port	8

Operational Schedule	Ship Activity	Duration
Home Port	Home Port	90
	DMP	44
	Sea Trials & WUPS	13
Minor Op #3	Sealift Operation	20
	Transit	11
	Foreign Port	9
Home Port	Home Port	134
	DMP	61
	Sea Trials & WUPS	23
Minor Op #4	Area of Operations Patrol	20
	Transit	11
	Foreign Port	8
Home Port	Home Port	91
	DMP	43
	Sea Trials & WUPS	13
Minor Op #5	Task Group Support	20
	Transit	11
	Foreign Port	8
DWP Preps	RR	60
DWP		120
	<b>TOTAL</b>	<b>1825</b>

Table 6: JSS 5 Year Readiness Rhythm Ship Employment Timeline

## 2.4 SECONDARY SHIP EMPLOYMENT PROFILES

### EXTENDED DEPLOYMENT

A similar three-step process was used to determine the JSS ship employment profile for a 180 day deployment scenario. Please note that as Task Group Support has already been selected as the ship employment for the extended deployment, steps two and three will be presented simultaneously. The historical deployment profiles were first developed from analyzing references E and F. These profiles and timelines appear in tables 7 and 8.

Ship Activity	PRESERVER - OP APOLLO 2001/02	PROTECTEUR - OP APOLLO 2002
Operations	116	86
Transit	41	52
Foreign Port	19	32
<b>TOTAL</b>	<b>176</b>	<b>170</b>

Table 7: Historical Profiles for 180 Day Deployment

Ship Activity	PRESERVER - OP APOLLO 2001/02	PROTECTEUR - OP APOLLO 2002
Departure from Home Port		
Transit to Area of Op	16	24
Foreign Port During Transit	5	5
First Operation	7	35
Foreign Port	1	6
Second Operation	38	28
Foreign Port	8	10
Third Operation	36	18
Foreign Port	4	5
Fourth Operation	35	5
Transit Home	25	28
Foreign Port During Transit	1	6
Return to Home Port		
<b>TOTAL</b>	<b>176</b>	<b>170</b>

Table 8: Historical Timelines for 180 Day Deployment

These two deployment timelines were then compared and a worst case deployment scenario was developed. The worst case scenario has a similar structure as the historical timelines. It begins with a transit to the area of operations, followed by four extended operations at sea (which includes transit time to and from foreign port); interspersed by foreign port visits, with an extended visit at the midpoint of the deployment for the RAMP, and finally the transit back to home port. With the insertion of Task Group Support, this results in the following JSS ship employment [profile](#) and [timeline](#):

Ship Activity	Total Number of Days Spent Conducting
Task Group Support	109
Transit	40
Foreign Port	31
<b>TOTAL</b>	<b>180</b>

Table 9: JSS 180 Day Deployment Ship Employment Profile

Ship Activity	Duration
Departure from Home Port	
Transit to Area of Op	20
Foreign Port During Transit	5
First TG Support	34
Foreign Port	5
Second TG Support	34
Foreign Port - RAMP	10
Third TG Support	34
Foreign Port	5
Fourth TG Support	7
Transit Home	20
Foreign Port During Transit	6
Return to Home Port	
<b>TOTAL</b>	<b>180</b>

Table 10: JSS 180 Day Deployment Ship Employment Timeline

### AVERAGE SEA TIME PER YEAR

To determine the JSS ship employment profile for the 120 days of average sea time per year, the JSS 5 year readiness rhythm [profile](#) was analyzed. The seafaring and foreign port activities were then isolated and divided by 4.5, to provide the yearly average for the 5 year operating cycle, excluding the 6 months dedicated to the DWP and its preparations. The resulting ship employment profile appears in the [table](#) below.

Ship Activity	Total Number of Days Spent Conducting
Task Group Support	33
Area of Operations Patrol	9
Sealift Operations	4
Transit	21
Sea Trials & WUPS	37
Foreign Port	16
<b>TOTAL</b>	<b>120</b>

Table 11: JSS 120 Days of Average Sea Time per Year Ship Employment Profile

The average remaining days of the year will have the following [profile](#):

Ship Activity	Total Number of Days Spent Conducting
DMP	75
Home Port	170
<b>TOTAL</b>	<b>245</b>

Table 12: JSS Remaining 245 Days per Year Ship Employment Profile

It should again be noted that the Dedicated Maintenance Period will be reserved for Contractor led maintenance, while the time in home port will be dedicated to crew maintenance, training and leave.

### 3. SYSTEM UTILIZATION MODEL

As described in [section 1.5](#), PMO JSS tasked the Naval Engineering Test Establishment (NETE) with creating a System Utilization Model. The purpose of this model was to translate ship employment profiles into system operating hours and required availability hours.

#### 3.1 MODEL EXPLANATION

As described previously, NETE developed a model that is Excel based and calculates the system usage or required availability by using matrix multiplication.

The model first multiplies the amount of time that the ship spends conducting each ship employment by the ratio of time spent conducting the various ship operations (presented as an average number of hours per day) while conducting those ship employments. This multiplication results in the number of hours that the ship spends conducting each of the ship operations. The model then multiplies this result by the defined ship systems usage or required availability for each ship operation. This multiplication determines the hours of system usage or required availability for each ship system for each ship operation. The model then adds all the results for each system and determines the required system usage or required availability hours for a given ship employment profile.

The following sections will describe how the various inputs to the model were determined.

#### 3.2 SHIP EMPLOYMENT PROFILE INPUTS

The ship employment profile inputs for the model are described in detail in [section 2](#) of this report.

#### 3.3 SHIP OPERATIONS INPUTS

As described in [section 2](#), for the purpose of this report there are 9 distinct ship employments: tied up alongside in home port, tied up alongside in foreign port, dedicated maintenance period (DMP), sea trials and work-ups, transit, Task Group support, Area of Operations patrol, sealift operations and being at reduced readiness.

After analyzing the various ship employments, the following ship operations were identified: RASing, helicopter operations, small boat operations, sailing at sea, remaining alongside in foreign port, remaining alongside in home port, conducting a dedicated maintenance period (DMP) and being alongside in home port at reduced readiness.

To determine the ship operations inputs, the model requires that the various ship employments be broken down into a ratio of the time spent conducting the corresponding ship operations, expressed as a ratio of the average number of hours per day. To determine the ratio of time spent in each of these ship operations while conducting the various ship employments, the historical operational schedules, standard Naval practices and reference C and D were reviewed and analyzed.

The breakdowns of the home port, foreign port, dedicated maintenance period and reduced readiness ship employments were simple as each of these ship employments also represents a ship operation. Thus their breakdowns are simply 100% of the time spent conducting that ship employment is spent conducting the corresponding ship operation.

The breakdowns for Task Group support and transit were more complicated. Both ship employments are broken down into time spent at sea, conducting replenishments at sea (RASing), conducting helicopter operations and conducting small boat operations.

According to reference C, a single replenishment at sea takes on average 1 hour to conduct. It also states that HMCS PROTECTEUR conducted 87 replenishments at sea during its Task Group support role during OP APOLLO and 10 during its transit to and from the operational area. Comparing these replenishment at sea figures, this roughly corresponds to 1.0 hour a day while the ship is conducting Task Group support and 0.2 hours a day while the ship is transiting. This drop in replenishments at sea during transit is due to the fact that it is standard RCN practice to sail at economical speed to reach the Area of Operations.

According to reference D, a helicopter takes 30 minutes to launch or recover, whereas a small boat takes approximately 22 minutes to launch and recover. It also states that HMCS PROTECTEUR during OP APOLLO conducted approximately two helicopter launches per day while conducting Task Group Support and during transit. Meanwhile, HMCS PROTECTEUR during OP APOLLO launched a small boat 0.16 times per day while conducting Task Group Support and 0.38 times while in transit. Comparing these helicopter and small boat figures, this roughly corresponds to 2.0 hours a day conducting helicopter operations while the ship is conducting Task Group support and transiting. It also results in 0.06 hours a day conducting small boat operations while the ship is conducting Task Group Support and 0.14 hours a day while transiting. This maintenance of helicopter activity and increase in small boat activity during transit is largely due to training requirements prior to entering the Area of Operations.

The breakdowns of Area of Operations Patrol and Sealift Operations were largely based on the breakdowns of Task Group Support and Transit. Similar to Task Group Support and Transit, both ship employments are broken down into time spent at sea, conducting

replenishments at sea (RASing), conducting helicopter operations, conducting small boat operations and for Sealift Operations, time spent in foreign port.

For Area of Operations Patrol the focus is on the use of helicopters and small boats rather than RASing other ships. Therefore, the Transit ship employment figures were used for RASing (0.2 hours per day) and for small boat operations (0.14 hours per day) as they represented a lower onus on RASing and an increased usage of small boats. To further differentiate Area of Operations Patrol from Task Group Support, with regards to increased helicopter operations, the helicopter operations figure from Task Group Support and Transit was doubled to 4.0 hours per day. The remainder of the time would be spent underway at sea.

As for Sealift Operations, it has a very similar breakdown to Area of Operations Patrol, except that every third day (8.0 hours per day) is spent in foreign port embarking and disembarking supplies and personnel. This results in 0.13 hours per day conducting RAS, 2.67 hours per day conducting helicopter operations and 0.25 hours per day conducting small boat operations. And the remainder of the time would be spent underway at sea.

The sea trials and work-ups breakdown was also very complex, because it involves time at sea, time spent conducting replenishments at sea, helicopter operations, small boat operations and time in home port. To determine the ratio between time spent at sea and in harbour, the amount of trials time spent at sea and in harbour in HMCS PRESERVER's and HMCS PROTECTEUR's operational schedules, references E and F, were analyzed and compared. After analyzing these times, it was determined that roughly 84% of trials time is spent at sea and 16% in home port. This results in 3.8 hours per day being spent in home port. As much of the trials program is based on simulating the most onerous ship employment scenario, it is assumed that the highest amount of time conducting each of the ship operations (RAS, helicopter operations and boat operations) would be the most accurate. Therefore, 1.0 hour a day is spent RASing, 4.0 hours are spent conducting helicopter operations and 0.38 hours are spent conducting small boat operations. And the remainder of the time would be spent underway at sea.

The various ship state breakdowns are presented in the [table](#) below.

Ship Employment	Average Daily Breakdown of Ship Operations	Ship Operation
Home Port	24.0	Home Port
Foreign Port	24.0	Foreign Port
DMP	24.0	DMP
Reduced Readiness	24.0	Reduced Readiness
TG Support	20.94	At Sea
	1.0	RASing
	2.0	Helicopter Operations
	0.06	Small Boat Operations
Transit	21.42	At Sea
	0.2	RASing
	2.0	Helicopter Operations
	0.38	Small Boat Operations
Area of Operations Patrol	19.42	At Sea
	0.2	RASing
	4.0	Helicopter Operations
	0.38	Small Boat Operations
Sealift Operations	12.95	At Sea
	0.13	RASing
	2.67	Helicopter Operations
	0.25	Small Boat Operations
	8.0	Foreign Port
Sea Trials and Work-Ups	14.82	At Sea
	1.0	RASing
	4.0	Helicopter Operations
	0.38	Small Boat Operations
	3.8	Home Port

Table 13: Ship Operations Breakdown

### 3.4 SYSTEM USAGE AND AVAILABILITY INPUTS

The ship system usage and required availability for each ship operation were determined by analyzing standard RCN practices and consulting experienced members of the naval community.

#### SYSTEM USAGE INPUT

The analysis behind the system usage figures is as follows:

- a. For Replenishment at Sea: all systems are in operation, except water production, the bow thruster, the mission and deck equipment (except for helicopter systems needed for Vertical Replenishment (VERTREP), as required), the horizon bars and High Frequency (HF) transmit communications;
- b. For Helicopter Operations: all systems are in operation, except the bow thruster, the cargo fuel system, the ballast transfer system, the small boat cranes and the deck equipment and crane;
- c. For Small Boat Operations: All systems are in operation, except the bow thruster, the cargo fuel system, the ballast transfer system, the helicopter systems, the deck equipment, the horizon bars. The deck crane will be used on occasion for launching the Landing Craft, Vehicle, Personnel (LCVP) and High Frequency transmissions will be ceased during launch and recovery;

- d. For At Sea: all systems are in operation, but the bow thruster is only required for slipping, coming alongside and positioning of the ship with regards to launched small boats, the deck equipment is only required for slipping and coming alongside and at anchor, the cargo fuel system is used to recirculate one tank per day (33% or 8 hrs per day), the ballast transfer system is only used to correct for trim and the horizon bars will be used a maximum 15% of the time while at sea. The helicopter systems, small boat cranes and deck crane are not required;
- e. For Foreign Port: in the worst case scenario, where no shore power is available, all systems are in operation, except water production, main propulsion, bow thruster, the steering system, the oil pollution prevention system, ballast transfer and treatment, the helicopter systems, small boat cranes, the vital repeaters, the echo sounder and the horizon bars. The deck crane and cargo fuel system are required to embark stores and fuel (8% or 2.0 hrs per day) and the HF transmit and the receive sub-system are required approximately 2% of the time;
- f. For Home Port: only habitation, machinery control, safety, deck and inertial navigation systems are required all the time, all other systems are only required for routine maintenance or for storing ship in the case of the deck crane (2% or 0.5 hrs per day). Water production is not required;
- g. For Dedicated Maintenance Period: only habitation, machinery control, safety, deck and inertial navigation systems are required all the time, all other systems are only required for extended maintenance (5% or 1-1.5hrs a day). Water production is not required; and
- h. For Reduced Readiness: only habitation, machinery control, safety, deck and inertial navigation systems are required all the time, all other systems are only required for extended maintenance (5% or 1-1.5hrs a day). Water production is not required.

Please note that the continuous system usage of the Inertial Navigation System is based on the assumption that the fitted Gyro will require 16 hours to calibrate upon start-up. This calibration time necessitates leaving the system on continuously to avoid delaying any emergent operational requirements. This same assumption applies to the system availability input table as well.

It is possible that the Joint Support Ship will be equipped with a Gyro that only requires 1 hour to calibrate and this would result in a drastic reduction in Inertial Navigation System usage and required availability.

The ship system usage for each ship operation, presented as a ratio value from 0 (not required) to 1 (continuous operation), can be seen in [table 14](#) below.

System	Sub-System	RAS	Helo Ops	Boat Ops	At Sea	Foreign Port	Home Port	DMP	RR
Power Distribution and Generation	Power Generation	1	1	1	1	1	0.02	0.05	0.05
	Power Distribution	1	1	1	1	1	1	1	1
IPMS	Machinery Control	1	1	1	1	1	1	1	1
	Fire Fighting & Damage Control	1	1	1	1	1	1	1	1
Refrigeration and HVAC	Fridges	1	1	1	1	1	1	1	1
	HVAC	1	1	1	1	1	1	1	1
	Citadel	1	1	1	1	1	1	1	1
	Chilled Water	1	1	1	1	1	1	1	1
Fresh Water System	Water Production	0	1	1	1	0	0.02	0.05	0.05
	Water Distribution	1	1	1	1	1	1	1	1
Firemain		1	1	1	1	1	1	1	1
Compressed Air System	LP Air	1	1	1	1	1	1	1	1
	HP Air	1	1	1	1	1	1	1	1
Propulsion	Main Propulsion	1	1	1	1	0	0.02	0.05	0.05
	Bow Thruster	0	0	0	0.01	0	0.02	0.05	0.05
Steering System		1	1	1	1	0	0.02	0.05	0.05
Oil Pollution Prevention System		1	1	1	1	0	0.02	0.05	0.05
Cargo Fuel System		1	0	0	0.33	0.08	0.02	0.05	0.05
Ballast System (FW)	Ballast Transfer	1	0	0	0.10	0	0.02	0.05	0.05
	Ballast Treatment	1	1	1	0.10	0	0.02	0.05	0.05
Mission and Deck Equipment	Helicopter Systems	0.25	1	0	0	0	0.02	0.05	0.05
	Small Boat Cranes	0	0	1	0	0	0.02	0.05	0.05
	Deck Crane	0	0	0.05	0	0.08	0.02	0.05	0.05
	Deck Equipment	0	0	0	0.02	1	1	1	1
Navigation	Inertial Navigation System	1	1	1	1	1	1	1	1
	Vital Repeaters	1	1	1	1	0	0.02	0.05	0.05
	Echo Sounder	1	1	1	1	0	0.02	0.05	0.05
	Horizon Bars	0	1	0	0.15	0	0.02	0.05	0.05
Communications	HF Transmit Only	0	1	0.8	1	0.02	0.02	0.05	0.05
	SATCOM	1	1	1	1	1	0.02	0.05	0.05
	Non-HF and HF Receive	1	1	1	1	0.02	0.02	0.05	0.05
Command and Control		1	1	1	1	1	0.02	0.05	0.05

Table 14: Ship System Usage for the Various Ship Operations

## SYSTEM AVAILABILITY INPUT

The rationale behind the required system availability figures is as follows:

- a. For Replenishment at Sea: all systems need to be available, except water production, the bow thruster and High Frequency transmissions;
- b. For Helicopter Operations: all systems need to be available, except the bow thruster;
- c. For Small Boat Operations: all systems need to be available, except the bow thruster;
- d. For At Sea: all systems need to be available;
- e. For Foreign Port: all systems need to be available, except water production, the oil pollution prevention system and ballast transfer and treatment;
- f. For Home Port: only habitation, machinery control, safety, deck and inertial navigation systems need to be available continuously, all other systems are only required for extended routine maintenance or storing ship in the case of the deck crane (5% or 1-1.5 hrs a day);
- g. For Dedicated Maintenance Period: only habitation, machinery control, safety, deck and inertial navigation systems need to be available continuously, all other systems are only required for extended maintenance (15% or 3-3.5hrs a day); and
- h. For Reduced Readiness: only habitation, machinery control, safety, deck and inertial navigation systems need to be available continuously, all other systems are only required for extended maintenance (15% or 3-3.5hrs a day).

The required system availability for each ship state, represented as a ratio value from 0 (not required) to 1 (continuously available) can be seen in [table 15](#).

System	Sub-System	RAS	Helo Ops	Boat Ops	At Sea	Foreign Port	Home Port	DMP	RR
Power Distribution and Generation	Power Generation	1	1	1	1	1	0.05	0.15	0.15
	Power Distribution	1	1	1	1	1	1	1	1
IPMS	Machinery Control	1	1	1	1	1	1	1	1
	Fire Fighting & Damage Control	1	1	1	1	1	1	1	1
Refrigeration and HVAC	Fridges	1	1	1	1	1	1	1	1
	HVAC	1	1	1	1	1	1	1	1
	Citadel	1	1	1	1	1	1	1	1
	Chilled Water	1	1	1	1	1	1	1	1
Fresh Water System	Water Production	0	1	1	1	0	0.05	0.15	0.15
	Water Distribution	1	1	1	1	1	1	1	1
Firemain		1	1	1	1	1	1	1	1
Compressed Air System	LP Air	1	1	1	1	1	1	1	1
	HP Air	1	1	1	1	1	1	1	1
Propulsion	Main Propulsion	1	1	1	1	1	0.05	0.15	0.15
	Bow Thruster	0	0	0	1	1	0.05	0.15	0.15
Steering System		1	1	1	1	1	0.05	0.15	0.15
Oil Pollution Prevention System		1	1	1	1	0	0.05	0.15	0.15
Cargo Fuel System		1	1	1	1	1	0.05	0.15	0.15
Ballast System (FW)	Ballast Transfer	1	1	1	1	0	0.05	0.15	0.15
	Ballast Treatment	1	1	1	1	0	0.05	0.15	0.15
Mission and Deck Equipment	Helicopter Systems	1	1	1	1	1	0.05	0.15	0.15
	Small Boat Cranes	1	1	1	1	1	0.05	0.15	0.15
	Deck Crane	1	1	1	1	1	0.05	0.15	0.15
	Deck Equipment	1	1	1	1	1	1	1	1
Navigation	Inertial Navigation System	1	1	1	1	1	1	1	1
	Vital Repeaters	1	1	1	1	1	0.05	0.15	0.15
	Echo Sounder	1	1	1	1	1	0.05	0.15	0.15
	Horizon Bars	1	1	1	1	1	0.05	0.15	0.15
Communications	HF Transmit Only	0	1	1	1	1	0.05	0.15	0.15
	SATCOM	1	1	1	1	1	0.05	0.15	0.15
	Non-HF and HF Receive	1	1	1	1	1	0.05	0.15	0.15
Command and Control		1	1	1	1	1	0.05	0.15	0.15

Table 15: Ship System Required Availability for the Various Ship States

### 3.5 INSERTION INTO MODEL

These inputs were then inserted into the System Utilization Model and the system usage and required availability were determined for the 120 days of average sea time per year, the 75 days allotted to DMP per year, the remaining 170 days per year, a 180 day deployment and a 5 year readiness rhythm. These results are listed in [section 4](#) of this report.

## 4. RESULTS

This section lists the results from the System Utilization Model for system usage and required availability for the 120 days of average sea time per year, the 75 days allotted to DMP per year, the remaining 170 days per year, a 180 day deployment and a 5 year readiness rhythm.

As described in [section 1.6](#), the system usage results represent the number of operating hours that a ship system as a whole is expected to experience during the ship's employment profile; whereas, the required availability results represent the number of hours that a ship system should be available and capable of operating during that ship employment profile.

Results for the minor operations that appear in the JSS 5 year readiness rhythm ship employment profile (Task Group Support, Area of Operations and Sealift Operations) appear in Annex A of this report.

### 4.1 AVERAGE YEARLY SHIP EMPLOYMENT PROFILE

The results for the 120 days of average sea time per year appear in [table 16](#).

System	Sub-System	System Usage (Hrs)	Required Availability (Hrs)
Power Distribution and Generation	Power Generation	2741	2745
	Power Distribution	2880	2880
IPMS	Machinery Control	2880	2880
	Fire Fighting & Damage Control	2880	2880
Refrigeration and HVAC	Fridges	2880	2880
	HVAC	2880	2880
	Citadel	2880	2880
	Chilled Water	2880	2880
Fresh Water System	Water Production	2248	2252
	Water Distribution	2880	2880
Firemain		2880	2880
Compressed Air System	LP Air	2880	2880
	HP Air	2880	2880
Propulsion	Main Propulsion	2325	2745
	Bow Thruster	22	2337
Steering System		2325	2745
Oil Pollution Prevention System		2325	2329
Cargo Fuel System		744	2745
Ballast System (FW)	Ballast Transfer	271	2329
	Ballast Treatment	602	2329
Mission and Deck Equipment	Helicopter Systems	325	2745
	Small Boat Cranes	31	2745
	Deck Crane	38	2745
	Deck Equipment	596	2880
Navigation	Inertial Navigation System	2880	2880
	Vital Repeaters	2325	2745
	Echo Sounder	2325	2745
	Horizon Bars	593	2745
Communications	HF Transmit Only	2251	2668
	SATCOM	2741	2745
	Non-HF and HF Receive	2333	2745
Command and Control		2741	2745

Table 16: Results for 120 Days of Average Sea Time per Year

The results for the yearly 75 day DMP appear in [table 17](#).

System	Sub-System	System Usage (Hrs)	Required Availability (Hrs)
Power Distribution and Generation	Power Generation	90	270
	Power Distribution	1800	1800
IPMS	Machinery Control	1800	1800
	Fire Fighting & Damage Control	1800	1800
Refrigeration and HVAC	Fridges	1800	1800
	HVAC	1800	1800
	Citadel	1800	1800
	Chilled Water	1800	1800
Fresh Water System	Water Production	90	270
	Water Distribution	1800	1800
Firemain		1800	1800
Compressed Air System	LP Air	1800	1800
	HP Air	1800	1800
Propulsion	Main Propulsion	90	270
	Bow Thruster	90	270
Steering System		90	270
Oil Pollution Prevention System		90	270
Cargo Fuel System		90	270
Ballast System (FW)	Ballast Transfer	90	270
	Ballast Treatment	90	270
Mission and Deck Equipment	Helicopter Systems	90	270
	Small Boat Cranes	90	270
	Deck Crane	90	270
	Deck Equipment	1800	1800
	Inertial Navigation System	1800	1800
Navigation	Vital Repeaters	90	270
	Echo Sounder	90	270
	Horizon Bars	90	270
	HF Transmit Only	90	270
Communications	SATCOM	90	270
	Non-HF and HF Receive	90	270
	Command and Control	90	270

Table 17: Results for the Yearly 75 Day DMP per Year

The results for the average 170 days spent in home port per year appear in [table 18](#).

System	Sub-System	System Usage (Hrs)	Required Availability (Hrs)
Power Distribution and Generation	Power Generation	82	204
	Power Distribution	4080	4080
IPMS	Machinery Control	4080	4080
	Fire Fighting & Damage Control	4080	4080
Refrigeration and HVAC	Fridges	4080	4080
	HVAC	4080	4080
	Citadel	4080	4080
	Chilled Water	4080	4080
Fresh Water System	Water Production	82	204
	Water Distribution	4080	4080
Firemain		4080	4080
Compressed Air System	LP Air	4080	4080
	HP Air	4080	4080
Propulsion	Main Propulsion	82	204
	Bow Thruster	82	204
Steering System		82	204
Oil Pollution Prevention System		82	204
Cargo Fuel System		82	204
Ballast System (FW)	Ballast Transfer	82	204
	Ballast Treatment	82	204
Mission and Deck Equipment	Helicopter Systems	82	204
	Small Boat Cranes	82	204
	Deck Crane	82	204
	Deck Equipment	4080	4080
	Inertial Navigation System	4080	4080
Navigation	Vital Repeaters	82	204
	Echo Sounder	82	204
	Horizon Bars	82	204
	HF Transmit Only	82	204
Communications	SATCOM	82	204
	Non-HF and HF Receive	82	204
	Command and Control	82	204

Table 18: Results for the Average 170 days Spent in Home Port per Year

## 4.2 EXTENDED DEPLOYMENT

The results for a 180 day deployment appear in [table 19](#).

System	Sub-System	System Usage (Hrs)	Required Availability (Hrs)
Power Distribution and Generation	Power Generation	4320	4320
	Power Distribution	4320	4320
IPMS	Machinery Control	4320	4320
	Fire Fighting & Damage Control	4320	4320
Refrigeration and HVAC	Fridges	4320	4320
	HVAC	4320	4320
	Citadel	4320	4320
	Chilled Water	4320	4320
Fresh Water System	Water Production	3459	3459
	Water Distribution	4320	4320
Firemain		4320	4320
Compressed Air System	LP Air	4320	4320
	HP Air	4320	4320
Propulsion	Main Propulsion	3576	4320
	Bow Thruster	31	3883
Steering System		3576	4320
Oil Pollution Prevention System		3576	3576
Cargo Fuel System		1212	4320
Ballast System (FW)	Ballast Transfer	431	3576
	Ballast Treatment	751	3576
Mission and Deck Equipment	Helicopter Systems	327	4320
	Small Boat Cranes	22	4320
	Deck Crane	61	4320
	Deck Equipment	807	4320
	Inertial Navigation System	4320	4320
Navigation	Vital Repeaters	3576	4320
	Echo Sounder	3576	4320
	Horizon Bars	769	4320
	HF Transmit Only	3470	4203
Communications	SATCOM	4320	4320
	Non-HF and HF Receive	3591	4320
Command and Control		4320	4320

Table 19: Results for a 180 Day Deployment

### 4.3 READINESS RHYTHM

The results for a 5 year readiness rhythm appear in [table 20](#).

System	Sub-System	System Usage (Hrs)	Required Availability (Hrs)
Power Distribution and Generation	Power Generation	13228	14753
	Power Distribution	40920	40920
IPMS	Machinery Control	40920	40920
	Fire Fighting & Damage Control	40920	40920
Refrigeration and HVAC	Fridges	40920	40920
	HVAC	40920	40920
	Citadel	40920	40920
	Chilled Water	40920	40920
Fresh Water System	Water Production	10995	12521
	Water Distribution	40920	40920
Firemain		40920	40920
Compressed Air System	LP Air	40920	40920
	HP Air	40920	40920
Propulsion	Main Propulsion	11340	14753
	Bow Thruster	944	12915
Steering System		11340	14753
Oil Pollution Prevention System		11340	12865
Cargo Fuel System		4206	14753
Ballast System (FW)	Ballast Transfer	2067	12865
	Ballast Treatment	3560	12865
Mission and Deck Equipment	Helicopter Systems	2309	14753
	Small Boat Cranes	986	14753
	Deck Crane	1015	14753
	Deck Equipment	30610	40920
	Inertial Navigation System	40920	40920
Navigation	Vital Repeaters	11340	14753
	Echo Sounder	11340	14753
	Horizon Bars	3520	14753
	HF Transmit Only	11008	14409
Communications	SATCOM	13228	14753
	Non-HF and HF Receive	11378	14753
	Command and Control	13228	14753

Table 20: Results for a 5 Year Readiness Rhythm

## 5. CONCLUSION

To ensure that the JSS is capable of meeting the demands of its ship employments, the key ship systems will need to be able to meet the system usage hours listed in [section 4](#) of this report. This will enable those systems to endure the operating hours that they will most likely experience in-service.

Of equal importance, is for systems to be designed to meet the required availability hours listed in [section 4](#) of this report. This is essential as maintenance will need to be conducted in such a way that it minimizes the impact on the ship's operational availability. Therefore, the required availability includes not only operating hours, but those hours where the key ship systems are offline and available for maintenance, but must be capable of being brought back online in accordance with the response times specified in reference G.

These results will allow ship systems to be developed, equipment selected, spares purchased and maintenance profiles prepared that can meet the most onerous potential JSS operational schedule, while minimizing the total ownership cost of the JSS ships.

**ANNEX A: MINOR OPERATION RESULTS**

This annex lists the results from the System Utilization Model for system usage and required availability for the three types of minor operations: Task Group Support, Area of Operations Patrol and Sealift Operation.

**TASK GROUP SUPPORT – 39 DAY DURATION**

System	Sub-System	System Usage (Hrs)	Required Availability (Hrs)
Power Distribution and Generation	Power Generation	936	936
	Power Distribution	936	936
IPMS	Machinery Control	936	936
	Fire Fighting & Damage Control	936	936
Refrigeration and HVAC	Fridges	936	936
	HVAC	936	936
	Citadel	936	936
	Chilled Water	936	936
Fresh Water System	Water Production	722	722
	Water Distribution	936	936
Firemain		936	936
Compressed Air System	LP Air	936	936
	HP Air	936	936
Propulsion	Main Propulsion	744	936
	Bow Thruster	7	846
Steering System		744	936
Oil Pollution Prevention System		744	744
Cargo Fuel System		254	936
Ballast System (FW)	Ballast Transfer	88	744
	Ballast Treatment	155	744
Mission and Deck Equipment	Helicopter Systems	68	936
	Small Boat Cranes	5	936
	Deck Crane	16	936
	Deck Equipment	205	936
	Inertial Navigation System	936	936
Navigation	Vital Repeaters	744	936
	Echo Sounder	744	936
	Horizon Bars	160	936
	HF Transmit Only	725	914
Communications	SATCOM	936	936
	Non-HF and HF Receive	748	936
Command and Control		936	936

Table A1: Results for a 39 Day Task Group Support Minor Operation

**AREA OF OPERATIONS PATROL – 39 DAY DURATION**

System	Sub-System	System Usage (Hrs)	Required Availability (Hrs)
Power Distribution and Generation	Power Generation	936	936
	Power Distribution	936	936
IPMS	Machinery Control	936	936
	Fire Fighting & Damage Control	936	936
Refrigeration and HVAC	Fridges	936	936
	HVAC	936	936
	Citadel	936	936
	Chilled Water	936	936
Fresh Water System	Water Production	738	738
	Water Distribution	936	936
Firemain		936	936
Compressed Air System	LP Air	936	936
	HP Air	936	936
Propulsion	Main Propulsion	744	936
	Bow Thruster	6	816
Steering System		744	936
Oil Pollution Prevention System		744	744
Cargo Fuel System		227	936
Ballast System (FW)	Ballast Transfer	69	744
	Ballast Treatment	182	744
Mission and Deck Equipment	Helicopter Systems	104	936
	Small Boat Cranes	12	936
	Deck Crane	16	936
	Deck Equipment	204	936
	Inertial Navigation System	936	936
Navigation	Vital Repeaters	744	936
	Echo Sounder	744	936
	Horizon Bars	196	936
	HF Transmit Only	739	930
Communications	SATCOM	936	936
	Non-HF and HF Receive	748	936
Command and Control		936	936

Table A2: Results for a 39 Day Area of Operations Patrol Minor Operation

**SEALIFT OPERATION – 40 DAY DURATION**

System	Sub-System	System Usage (Hrs)	Required Availability (Hrs)
Power Distribution and Generation	Power Generation	960	960
	Power Distribution	960	960
IPMS	Machinery Control	960	960
	Fire Fighting & Damage Control	960	960
Refrigeration and HVAC	Fridges	960	960
	HVAC	960	960
	Citadel	960	960
	Chilled Water	960	960
Fresh Water System	Water Production	579	579
	Water Distribution	960	960
Firemain		960	960
Compressed Air System	LP Air	960	960
	HP Air	960	960
Propulsion	Main Propulsion	584	960
	Bow Thruster	5	871
Steering System		584	960
Oil Pollution Prevention System		584	584
Cargo Fuel System		198	960
Ballast System (FW)	Ballast Transfer	54	584
	Ballast Treatment	139	584
Mission and Deck Equipment	Helicopter Systems	77	960
	Small Boat Cranes	9	960
	Deck Crane	31	960
	Deck Equipment	386	960
	Inertial Navigation System	960	960
Navigation	Vital Repeaters	584	960
	Echo Sounder	584	960
	Horizon Bars	150	960
	HF Transmit Only	585	955
Communications	SATCOM	960	960
	Non-HF and HF Receive	592	960
Command and Control		960	960

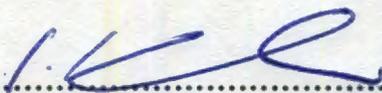
Table A3: Results for a 40 Day Sealift Operation Minor Operation

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