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AN ANALYSIS OF THE FUTURE OF THE DISASTER ASSISTANCE RESPONSE TEAM WATER PURIFICATION CAPABILITY

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AIM

1. The Disaster Assistance Response Team (DART) is one of the most visible components of any Canadian Armed Forces (CAF) humanitarian assistance operation. The aim of this paper is to examine the specific DART capability of water purification and is based on recent lessons learned from operations where this capability was deployed. It will consider the impact of new equipment and technology and recommend amendments to the personnel composition and structure within the contingency plan (CONPLAN) RENAISSANCE table of organization and equipment (TO&E).

INTRODUCTION

2. The purpose of a DART water purification team is to, "produce potable water in direct support of the affected nations' population."[1] These teams are a relevant and viable contribution to the DART organization, demonstrated through their successes during operational deployments to locations such as Turkey in 1999, Haiti in 2010, and to the Philippines in 2013.

3. This paper will focus on various aspects of the water purification capability in order to develop a recommendation on the future of the DART package. First, the existing structure will be reviewed, based on the existing CONPLAN, as well as how the teams have operated while deployed. Second, the project criteria for new equipment procurements, established by the Directorate of Land Requirements (DLR), will be considered. Finally, an options analysis of potential water purification capability configurations will be developed and contrasted based on existing and future systems, prior to optimal structures being recommended.

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[1] Department of National Defence, Annex EE to 3120-CONPLAN RENAISSANCE (J5) (Ottawa: Canadian Joint Operations Command Headquarters, November 2014), EE-4/13.

DISCUSSION

Current Capabilities

4. As outlined in CONPLAN RENAISSANCE, a water purification site, "consist[s] of two [reverse osmosis water purification units] ROWPUs with associated stores …. operators, technicians, vehicles and equipment necessary to initiate and sustain operations."[2] The current DART establishment authorizes two water purification detachments, each containing five engineers. Combat engineers fill the majority of these positions; however, it is not unusual for at least one of the positions to be filled by a water, fuel and environment (WFE) technician. Finally, two heavy equipment support vehicles (HESVs) provide the means for mobility of equipment and personnel while deployed.

5. Once in place, a water purification site can operate between 16 to 24 hours each day in order to produce potable water to meet the medical and sustainment needs of the deployed Task Force (TF). Also, this water is distributed to the affected nations' population. Both ROWPUs operate independently from each other. While one is operating, the other is available to be maintained by the engineers running the site. Typically, each ROWPU may be operated for a maximum period of eight hours before having to be shut down for maintenance purposes. If required, the second ROWPU on the site may then be used to continue the task of purifying water. The full amount of operating time per day will depend upon the required water distribution rates. The amount of water that may be purified on an hourly basis depends upon the quality of the water source. Ultimately, it will depend upon the amount of dissolved solids and the temperature of the water. Three separate modes exist within the ROWPU system that allows water to be purified, based upon the water source and quality.

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[2] *Ibid.*

a. First Pass Mode Operation. This mode purifies water by, "separating dissolved solids from the feed water …. [and] is suitable for purifying brackish water, seawater and seawater containing suspended solids."[3] While operating the ROWPU to purify a fresh water source, the typical output per hour of operation is 5,250 litres.[4] Therefore, for an eight hour period of operation, a maximum of 42,000 litres of water could be purified.

b. Second Pass Mode Operation. This mode purifies, "brackish water sources that have not been contaminated by nuclear, biological, or chemical agents."[5] Due to the additional operating time to purify non-fresh water, the typical output per hour of operation is only 850 litres.[6] Therefore, for an eight hour period of operation, a maximum of 6,500 litres of water could be purified.

c. Double Pass Mode Operation. This mode purifies, "water contaminated by nuclear, biological, or chemical agents …. [t]his method is also the best means for purifying seawater."[7] The typical output per hour of operation is 2,750 litres.[8] Therefore, for an eight hour period of operation, a maximum of 22,000 litres of water could be purified.

6. The DART water purification capability, as described in the CONPLAN, is not always followed. While deployed to the Philippines in 2013, three separate sites were established and operated simultaneously for approximately one week. This was accomplished by accepting the risk of only having one ROWPU in operation at each site. As well, the two detachments of

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[3]Department of National Defence, C-92-140-000/MB-001, *Draft Operators Instructions – Reverse Osmosis Water Purification Unit (ROWPU)* (Ottawa: DND Canada, 2005), 1-3-1.
[4]*Ibid.*, 1-2-17.
[5]Department of National Defence, C-92-140-000/MB-001, . . . 1-3-1 – 1-3-2.
[6]*Ibid.*, 1-2-17.
[7]Department of National Defence, C-92-140-000/MB-001, . . . 1-3-2.
[8]*Ibid.*, 1-2-17.

engineers were separated in order to create a third detachment for the third site. This is an example of the flexibility able to be achieved by the deployed operators for a short time frame. For the remainder of the deployment, only one ROWPU system was used intermittently at either site due to the decreasing water distribution demands.

7. While deployed to the Philippines, there is no record of the total amount of water that was purified over the 21 day period in which the three separate ROWPU sites were in operation. However, the total amount of CAF purified water that was distributed over this period was 323,651 litres.[9] This equates to an average of 15,412 litres of purified water that was distributed each day. Based on this fact, and with the understanding that the teams in the Philippines operated predominantly in double pass mode while purifying water, three ROWPUs operating for an eight hour period could have produced a maximum of 66,000 litres of water. Another way of representing this number is that over an eight hour period of time, only 23% of the ROWPU system output was required. If this is extrapolated over the maximum of 16 hours that the ROWPUs could have been in operation, allowing for eight hours of maintenance per day, this system output requirement drops to approximately 12%. Though the ROWPU systems are very capable systems to purify water, they were never used to their full capacity while in the Philippines. However, as no smaller systems exist within the CAF inventory and separate water purification sites were necessary as part of this operation, there was no alternative.

8. Four ROWPU systems will remain part of the DART inventory for the next several years.[10] Apart from the disadvantages of not using the ROWPUs to their full capacity based on water distribution demand, there are additional problems associated with these systems in a disaster relief operation. The two most significant disadvantages are outlined below:

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[9]Cohn Odding, electronic mail correspondence with author, 28 January, 2016.
[10]Major Matthew Ng, electronic mail correspondence with author, 22 January, 2016.

a. The primary disadvantage is their size and weight. The ROWPU system weights 10,188 kg (22,460 lbs). Adding to this problem is the movement requirement of the HESV, which weighs 14,774 kg (32,500 lbs). As a result, one ROWPU system on an HESV will fill the majority of one C-17 aircraft.[11]

b. A second disadvantage is related to the ability to access water sites within the affected nation. It is often very challenging to manoeuvre through the disaster zones in large vehicles due to destroyed route infrastructure and the threats posed by fallen electrical wires. In some situations, the size of the HESV limited its ability to access suitable operating locations. As well, upon completion of a task at a select location, it was often just as dangerous to extract the ROWPU on the HESV due to the hastily reconstructed infrastructure.

Future Capabilities

9. Six new systems will be introduced to the CAF inventory as part of the Advanced Sub-Unit Water Purification System (ASUWPS) project, that employ similar methods as used by the ROWPUs. Its aim is to, "modernise and increase the water purification capability at the sub-unit level."[12] The ASUWPS project anticipates an initial operating capability (IOC) by 2021, with full operating capabilities (FOC) being achieved in 2022.[13]

10. Since the ASUWPS project is still only within the option analysis phase, no specific systems have been confirmed for inclusion within the CAF inventory. However, based on the mandatory criteria that much be achieved by the new systems, it is possible to make comparisons

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[11] Department of National Defence, *Water Purification (ROWPU) Package (2 x ROWPU – 2 x C177 Flights)* (Kingston, Ontario: 1 Canadian Division Headquarters, 2010).

[12] Department of National Defence, *Advanced Sub-Unit Water Purification System Project (ASUWPS): Industry Brief to SEI* (Ottawa: DND Canada, 21 January 2016), 2.

[13] *Ibid.*

between what the new systems will provide based on what has been required in previous operations.

a. Manning. The ASUWPS project states that any new system must be, "capable of being operated by only one pers."[14] Further discussions with DLR as well as with the DART Engineer[15] have identified that a proper assumption is that a minimum of two engineers would be required to operate one site with one ASUWPS. If two ASUWPS systems are located within the same site, the minimum number of engineers would be four to operate the site safely.

b. Movement. The new ASUWPS system will be mounted on a separate trailer system that is eight feet wide and ten feet long. The exact height of the trailer, loaded with the new ASUWPS system does not exist yet as the project is still only within the option analysis phase. However, this planning assumption means that a HESV will not be required for the movement of these new systems. This creates the potential for considerable space to be saved on C-17 load plans. The ASUWPS project mentions the possibility of using the new Medium Support Vehicle System (MSVS) though it remains uncertain as to when these new trucks will be delivered. A planning assumption for the purposes of this paper is that future movement requirements of the ASUWPS systems will be the new MSVS vehicles no later than 2021. Also, one MSVS will be suitable for one water production site containing either one or two ASUWPS.

[14] *Ibid*, 7.
[15] Major Ryan Wade, electronic mail correspondence with author, 26 January, 2016.

c. Purification Rates. Each new ASUWPS system will be, "capable of purifying 1000 litres / hour from a fresh water source … and 500 litres / hour from any sea water source."[16] Based on these planning figures, if three of the new ASUWPS systems had been employed in The Philippines, each system could have produced 4,000 litres of water in an eight hour time frame. Collectively, this would be 12,000 litres of water which is only 78% of the average daily distribution rates from the operation in the Philippines. Regardless, by only operating each system for one additional hour, the minimum required rate would have been achieved. However, if three ASUWPS were operated for 16 hours per day, allowing for eight hours of maintenance, 24,000 litres of water could be produced. This represents a 50% surplus of the daily purified water requirement in the Philippines. Based on the existing planning assumptions for the ASUWPS project, the newer and smaller systems could have produced the same results as the existing ROWPU systems, just in a more efficient manner.

Potential Water Purification TO&E Structures

11. This section will present and discuss the possible structures based on existing and future equipment. For brevity, only one type of water purification system will be considered per option, though it is realized hybrid approaches will create several additional options. When options identify the requirement for additional personnel or equipment in excess of what is currently authorized in the CONPLAN, it is identified in the associated analysis. Also, unknown

[16]Department of National Defence, *Advanced Sub-Unit Water Purification System Project (ASUWPS): Industry Brief to SEI . . .*, 7.

airlift requirements are noted as being “to be confirmed” pending the specifications of the new systems to be utilized.

a. Option 1: Maximum Use of ROWPUs per Site. Figure 1 outlines the basic requirements of this option. This would allow for a maximum of two independent sites to be operated simultaneously. As well, it enables the maximum amount of water to be purified on a 24/7 basis, if required. The principle disadvantages with this option is the airlift requirements, the size and height restrictions as well as the likelihood that the water purification capabilities would likely be far superior to the water distribution rates that would be required.

	Personnel	ROWPUs	Vehicles	C-17
One Site	5	2	2 x HESV	2
Two Sites	10	4	4 x HESV	4

Figure 1: Maximum Use of ROWPUs per Site

b. Option 2: Minimum Use of ROWPUs per Site. Figure 2 outlines the basic requirements of this option. This would allow for a maximum of three independent sites to be operated simultaneously based on current DART manning. If a fourth site was required, it would require the authorization of two additional engineers to be deployed. An element of increased risk is associated with this option by only having three operators at some of the sites. As well, each site would not be able to be operated on a 24/7 basis, lowering the daily yield of purified water for the operation.

	Personnel	ROWPUs	Vehicles	C-17
One Site	4	1	1 x HESV	1
Two Sites	7 - 8	2	2 x HESV	2
Three Sites	10	3	3 x HESV	3
Four Sites	12	4	4 x HESV	4

Figure 2: Minimum Use of ROWPUs per Site

c. Option 3: Maximum Use of ASUWPS per Site. Figure 3 outlines the basic requirements of this option. If a third site was required, it would require the authorization of two additional engineers to be deployed based on current DART manning.

	Personnel	ASUWPS	Vehicles	C-17
One Site	4	2	1 x MSVS	TBC
Two Sites	8	4	2 x MSVS	TBC
Three Sites	12	6	3 x MSVS	TBC

Figure 3: Maximum Use of ASUWPS per Site

d. Option 4: Minimum Use of ASUWPS per Site. Figure 4 outlines the basic requirements of this option. If a sixth site was required, it would require the authorization of two additional engineers to be deployed based on current DART manning.

	Personnel	ASUWPS	Vehicles	C-17
One Site	2	1	1 x MSVS	TBC
Two Sites	4	2	2 x MSVS	TBC
Three Sites	6	3	3 x MSVS	TBC
Four Sites	8	4	4 x MSVS	TBC
Five Sites	10	5	5 x MSVS	TBC
Six Sites	12	6	6 x MSVS	TBC

Figure 4: Minimum Use of ASUWPS per Site

CONCLUSION

12. This paper has provided a review of the existing DART water purification capabilities; identified existing concerns based on reports from recent operations, and it has assessed the future capabilities based on the new ASUWPS project criteria. From this analysis, it is argued that the current DART organization and establishment is not optimized. The ASUWPS project will create the opportunity to adjust the current construct of this capability package; however, it will likely be an iterative process. This is due to the fact that the DLR project remains in-

progress and other requirements such as manning and vehicle allocation will require further review and authorization from the chain of command. Regardless, based on this review, it is possible to recommend one approach to modify the future of the DART water purification capability.

RECOMMENDATION

13. There are three distinct timelines to consider for the future of the DART water purification capability. The first time frame is from the present until the declaration of IOC. The second is the year between IOC and FOC. The third time frame is from FOC onwards.

a. Present – IOC (2021). No change to the water purification capability is recommended as no alternate options exist at this time. As such, Option 1 as identified above is recommended for this time frame. Therefore, no changes to the DART TO&E are required.

b. IOC (2021) – FOC (2022). During this time frame, it is recommended that a hybrid approach be implemented in order to incorporate the new systems, while also maintaining a residual capability on the ROWPU until FOC is declared. This hybrid approach is identified in Figure 5. This time frame represents a surge of personnel and multiple types of equipment during a year of transition. Though it represents an overall increase in personnel and vehicles, the ASUWPS should be the priority for operational deployments of the DART. As such, the ROWPU systems would be maintained as a reserve in the event that unexpected complications arise with the new systems. This increase in manning and vehicles could be further rationalized by considering those personnel and vehicles associated with the ROWPUs as being restricted capabilities that would only deploy on decision from the Commander of the Canadian Joint Operations Command or, if necessary, from the Chief of the Defence Staff.

	Personnel	System	Vehicles	C-17
1st Site (Primary)	4	2 x ASUWPS	1 x MSVS	TBC
2nd Site (Primary)	4	2 x ASUWPS	1 x MSVS	TBC
3rd Site (Alternate)	5	2 x ROWPU	2 x HESV	2

Figure 5: Hybrid Use of ASUWPS and ROWPU

c. FOC (2022) Onwards. Following the declaration of FOC, it is recommended that all ROWPUs be removed from the DART water purification capability. Option 3 is the recommended approach for this future time frame though it will likely require further study based on the requirement to receive authorization to increase the manning from ten personnel to twelve and associated vehicles from four to six.

14. This recommendation identifies a start point for further debate on the future of the DART water purification capability. As new information is received concerning the actual systems that will be received, these options should be further refined in order to finalize the process in which the DART water purification capability will be structured until the project FOC is achieved.

BIBLIOGRAPHY

Canada. Department of National Defence, *Advanced Sub-Unit Water Purification System Project (ASUWPS): Industry Brief to SEI*. Ottawa: DND Canada, 2016.

———. *Annex EE to 3120-CONPLAN RENAISSANCE (J5)* Ottawa: Canadian Joint Operations Command Headquarters, 2014.

———. C-92-140-000/MB-001, *Draft Operators Instructions – Reverse Osmosis Water Purification Unit (ROWPU)*. Ottawa: DND Canada, 2005.

———. *Water Purification (ROWPU) Package (2 x ROWPU – 2 x C177 Flights)*. Kingston, Ontario: 1 Canadian Division Headquarters, 2010.