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Title - Sujet Tactical Power System	
Solicitation No. - N° de l'invitation W8476-206276/B	**Amendment No. - N° modif.** 004
Client Reference No. - N° de référence du client W8476-206276	**Date** 2020-10-28
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Solicitation Closes - L'invitation prend fin **at - à** 02:00 PM **on - le** 2021-03-31	**Time Zone** **Fuseau horaire** Eastern Standard Time EST
F.O.B. - F.A.B. Specified Herein - Précisé dans les présentes **Plant-Usine:** ☐ **Destination:** ☐ **Other-Autre:** ☑	
Address Enquiries to: - Adresser toutes questions à: Anthony, Joan	**Buyer Id - Id de l'acheteur** 003qt
Telephone No. - N° de téléphone (819) 230-5385 ( )	**FAX No. - N° de FAX** ( ) -
Destination - of Goods, Services, and Construction: **Destination - des biens, services et construction:**	

SOLICITATION AMENDMENT
MODIFICATION DE L'INVITATION

The referenced document is hereby revised; unless otherwise indicated, all other terms and conditions of the Solicitation remain the same.

Ce document est par la présente révisé; sauf indication contraire, les modalités de l'invitation demeurent les mêmes.

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Canada

<u>TPS - Industry Survey Guidance</u>

1. A simple survey has been developed to obtain input from interested suppliers. It is intended to gauge the potential participation in the acquisition and sustainment contract for the various capability components. This information will be used to examine possible contracting grouping for the components.

2. To support the survey, the Selected System Effectiveness Requirements (SSER) has provided the current draft operational concepts and effectiveness requirements to reflect Option 2 (New Generator Systems plus Energy Storage and Micro-Grids), which was recently approved as the preferred option for the project. There has been a noted evolution in the operational concept from that presented at the first industry day, and was partly shaped from the responses received to the LOI.

3. The following should be noted regarding the SSER:

   a. The section/paragraph numbering will not appear consecutive in nature. The Table of Content accurately depicts the information within the SSER;

   b. A list of all acronyms can be found at the end of the document; and

   c. All SSER content is considered to be draft and is subject to change.

Survey Responses

4. Respondents are asked to complete the following:
   a. The Industry Survey - All responses will be held in strict confidence and will not be shared outside the TPS Project team; and
   b. Any comments regarding the content of the SSER. In particular, if there are requirements believed to be unachievable (and why) plus whether there are sufficient differences in the requirements between the MOTS and COTS versions to justify the acquisition of both versions as opposed to the consolidating of the requirements into one version only.

5. Provide your responses by **November 30th, 2020.**
   Responses to: Joan Anthony at Joan.anthony@tpsgc-pwgsc.gc.ca

National Defence | Défense nationale

Selected System Effectiveness Requirements (SSER)

Tactical Power System (TPS)
Système tactique d'alimentation électrique (STAE)
C.000728

TABLE OF CONTENTS

1.5 Current Situation

The project has reached the end of the Options Analysis phase and is ready to proceed into the Definition phase. In anticipation of cutting capability/quality, the full PSOR is being written to allow two tiers of capability. One is focused on combat and is expected to have higher and tighter specifications (the 'Green' fleets or MOTS). The other will have some lower specification and features and will not be as robust or capable (the 'White' fleets or COTS). However, it will still be adequate to provide power in Canada or on lower-risk missions. Within the final SOR, the differences may be minor, but as additional work and industry engagement is done during definition, they may become more pronounced.

Another factor which will impact the final SOR is more fidelity on current generator use. Currently, virtually no data is collected, including the hours used, the amount of fuel consumed, and the loads/demand. Efforts are underway to help better estimate this data (especially the loading) to help properly size the generators to match the needs and focus procurement where it is needed the most. However, with COVID-19 underway at the time of writing, data collection has become difficult. Even if/when restrictions are loosened, caution is needed, travel will be problematic, and training events may be fewer and smaller than in the past.

2 SYSTEM OPERATION

2.1 Mission and Scenarios

Within the latest Defence Policy, SSE, and the Minister of National Defence Mandate letter, the Government establishes a clear level of ambition for the Canadian Armed Forces, based on a realistic assessment of future threats and security challenges that the Forces will likely face both domestically and internationally. This vision requires the Canadian Armed Forces to be:

- Strong at home, with its sovereignty well-defended by forces who are also ready to assist in times of natural disaster and other emergencies;
- Secure in the defence of North America, in partnership with NORAD and the United States; and
- Engaged in the world by making meaningful contributions to international security through peace support operations and peacekeeping.

The Canadian Armed Forces will deliver on this vision by maintaining the ability to conduct eight core missions which includes the following simultaneous operations:

- Defend Canada including responding to multiple domestic emergencies in support of civilian authorities;
- Meet NORAD obligations; with new capacity in some areas;
- Meet commitments to NATO allies under Article 5 of the North Atlantic Treaty; and
- Contribute to international peace and stability through:
    - Two sustained deployments of 500-1500 personnel;
    - One time-limited deployment of 500-1500 personnel;
    - Two sustained deployments of 100-500 personnel;
    - Two time-limited deployment of 100-500 personnel;
    - One Disaster Assistance Response Team deployment (DART) with scalable response; and
    - One Non-combatant Evacuation Operation with scalable support.

Each of these operations require the CAF to have the ability to sustain itself, therefore, the requirement to provide troops with power exists in all conceivable scenarios from full combat missions overseas, to peacetime training in Canada. In extreme situations, circumstances may arise where the CAF are requested to provide power to local civilians for short periods of time until power can be restored. This may occur both internationally and domestically, during floods, fires, or other disasters.

While not a mission or task under SSE, there is also a requirement to conduct training at home and abroad to prepare for operations. The CAF spends most of its time training, and in many cases, the training events are significantly larger than the deployments mentioned above.

The TPS will replace the current tactical power capability (generators) used throughout the CAF. It will impact both the Regular and Reserve Forces, and include the Canadian Army (CA), the Royal Canadian Air Force (RCAF), Royal Canadian Navy (RCN), and numerous smaller organizations from coast to coast.

It will be used to generate and distribute electrical power to support virtually every operation at home and abroad, under any level of threat. It provides general-purpose power for headquarters and units to operate (radios, computers, lights, etc.) and supports small deployed camps (workshops, kitchens, accommodations, etc.). It will not be used to power Canadian bases or wings, large facilities such as the base in Kandahar, nor major pieces of equipment with onboard generators (such as radars or howitzers).

Most land operations, especially when conducting adaptive dispersed operations, are characterized by a high degree of mobility, flexibility, and grouping/regrouping of force elements on a regular basis. The TPS business case analysis includes several vignettes not repeated here to help visualize different types of scenarios which require the generation and distribution of reliable power. They range from a few people with a hand-portable generator to hundreds of people in one location using several larger trailer mounted generators and energy storage devices.

2.2 Environment

2.2.1 General. TPS will be required to operate and complete missions and tasks throughout a wide range of environments. These will include plains, coastal areas, desert, hilly and/or wooded areas with or without good roads, as well as rural and urban areas. The climatic conditions could vary from tropical to temperate to cold weather. The TPS could be deployed to any region of the world. The following environmental conditions are applicable to the green fleets; the white fleet is not expected to be as stringent, and changes should be expected.

2.2.1.1 Sand and Dust. All TPS systems and sub-systems shall be designed for and withstanding, without preparation or any degradation in performance or reliability, blowing dust and sand as specified in the appropriate MIL-STD, to the maximum extent feasible.

2.2.1.2 Sea/Salt Spray. All TPS systems and sub-systems shall be designed for and withstanding, without preparation or any degradation in performance or reliability, sea and salt spray as specified in the appropriate MIL-STD, to the maximum extent feasible.

2.2.1.3 Vibration. All TPS systems and sub-systems shall be designed for and withstanding, without preparation or any degradation in performance or reliability, the vibration spectra as specified in the appropriate MIL-STD, to the maximum extent feasible.

2.2.1.4 Shock. All TPS systems and sub-systems shall be designed for and withstanding without, preparation or any degradation in performance or reliability, the shock up to the rail impact tests as specified in the appropriate MIL-STD, to the maximum extent feasible.

2.2.1.5 Altitude. All TPS systems and sub-systems shall be designed for and withstanding without, preparation or any degradation in performance or reliability, the altitude requirements as specified in the appropriate MIL-STD, to the maximum extent feasible.

2.2.1.6 Fungus. All TPS systems and sub-systems shall be designed for and withstanding, without preparation or any degradation in performance or reliability, the fungus requirements of the appropriate MIL-STD, to the maximum extent feasible.

2.2.1.7 Outdoor storage. Most TPS systems and sub-systems shall be designed to be stored in outdoor conditions ranging from climatic conditions A1 through to C3 as shown in the table below, except for battery storage, which may have a reduced temperature range based on chemical and physical limitations.

2.2.2 Essential Climatic Conditions. It is essential that the TPS operate in the following climatic conditions: Hot Dry (A1), Hot Dry (A2), Intermediate (A3), Wet Warm (B1), Wet Hot (B2), Hot Humid (B3), Mild Cold (C0), Intermediate Cold (C1), Cold (C2), and Severe Cold (C3).

For C2 conditions the lower boundary will be measured at -40 degrees Celsius. At -40 degrees Celsius the TPS generators shall start from a "cold soaked" condition, with assistance permitted from integral heaters if needed. "Cold soaked" is defined as the state where the components are at the ambient temperature after prolonged exposure to the elements.

Climatic Condition E= Essential / D= Desirable	**White/COTS Generators**	**Green/MOTS Generators**	**Energy Storage**	**Distribution System and PMM**
Hot Dry (A1)	E	E	E	E
Hot Dry (A2)	E	E	E	E
Intermediate (A3)	E	E	E	E
Wet Warm (B1)	E	E	E	E
Wet Hot (B2)	E	E	E	E
Hot Humid (B3)	E	E	E	E
Mild Cold (C0)	E	E	E	E
Intermediate Cold (C1)	E	E	E	E

Climatic Condition E= Essential / D= Desirable	**White/COTS Generators**	**Green/MOTS Generators**	**Energy Storage**	**Distribution System and PMM**
Cold (C2)	E	E	E	E
Severe Cold (C3)	D	E	D	E

2.3 Threats

The TPS is not meant to be engaged in active combat, so the expected threat from direct fire weapons is considered extremely low, although harassing fire or being ambushed during transit is possible.

The largest external threat is expected to be system components exposed to blast/ fragmentation from artillery. This may result from speculative fire or from targeted fire after being detected by enemy sensors. For that reason, signatures produced must be minimized to lower the chance of detection, realizing that nearby surrounding equipment (especially a HQ) also produces light, heat, and radio-frequency emissions.

With modern generators having firmware/software features, there is a chance they could be targets of cyber-attacks/hacking. When used, the PMM is a more probable target for cyber-attacks/hacking as it is a software-based system connected to several generators, batteries, and loads.

Extremely high levels of Electromagnetic Interference (EMI) from other equipment or an Electromagnetic Pulse (EMP) from a nuclear blast has the potential to damage electronic aspects of the equipment, however it is considered highly unlikely unless full-scale combat occurs. More likely is an extremely strong coronal mass ejection producing similar effects over the illuminated side of the planet, but astronomers should provide enough warning to minimize the risks to power grids and electronics (both civilian and military).

Other threats to a reliable power supply are long duration in nature, such as UV degradation of distribution cables, fatigue of various connections, or elevated levels of airborne particulates or poor-quality fuel for generators. All of these can be mitigated by proper inspection and maintenance procedures.

The largest controllable threat to a reliable power supply is considered operator or user error. This includes improper hookup of cables, wrong choice of voltages/frequencies, and crushing or tearing of distribution cables and connectors by vehicles driving over them.

2.4 Concepts of Operations

General. Electrical power to conduct military operations or training may come from a variety of sources. In ideal cases, it may be provided by the host nation (shore power), which is normally the case for training, domestic, and permissive/semi-permissive expeditionary operations. However, shore power cannot be counted on at all times for reasons including poor electrical infrastructure, natural or man-made disasters, and deliberate efforts to disable parts of the grid. For those reasons, at least some TPS assets will be deployed on any operation. For large deployed camps, Camp Sustain may be available, however, that is normally preceded by TPS components.

In more tactical settings, there are three common sources to power CAF equipment. The first is coming from within a vehicle itself, which is often the case for combat vehicles such as LAVs where there may already be a requirement to keep the vehicle running to allow communications, sensors, and weapons systems to be at full readiness. The second is normally found on speciality equipment and vehicles where there is a built-in or dedicated generator. This includes assets such as the Medium Range Radar (MRR), various water purification systems, and most MSVS vehicles with SEV/workshop functions. As a minimum, they have enough power to meet their own requirements, and in some cases may have surplus capacity for other limited uses.

The third source is from TPS. The TPS will be a quickly deployable capability to support Land Forces (including non-Army assets) and joint operations for mission scenarios described in SSE. It will accompany troops deploying to areas with destroyed, damaged, or unreliable electrical power infrastructure. It will operate in a wide variety of extremely demanding and austere physical environments in all climatic zones.

Once in theatre, TPS components will normally be transported by wheeled vehicles moving on roads and cross-country, by aircraft and helicopters, and (for some lighter components) by light vehicles such as snowmobiles or all-terrain vehicles, and even by hand for short distances. Larger equipment such as that supporting the HQSS will normally be contained within a sea-container or on a pallet. It will be designed to be used by all CAF personnel, with most components requiring very minimal training. Users range from a few personnel requiring a temporary power source for a few hours, to small camps which could remain in one location for years.

The TPS systems must be easily moved, assembled, and disassembled numerous times during a deployment. It must also be safe and durable enough to endure rough handling by soldiers who are fatigued, hungry, stressed, and/or pressed for time. The most common human-machine interface (HMI) will be the controls at the generator and Energy Storage Unit (ESU). In most cases, there will be limited interaction with the distribution system once it has been laid down. The HMI for the PMM will require the most training (as it is software based) but is still expected to remain an all-trades responsibility.

Since this is a replacement capability, it will continue to support all doctrine, including joint and international operations. While not directly related to doctrine, the flexibility of the storage medium allows the CAF to accept future renewable sources of power, which may change Tactics, Techniques, and Procedures (TTPs) should they be acquired in the future.

<u>Minimalization, Amenities, and Reality</u>. Regardless of current funding, the overriding requirement is to provide the minimum power required to conduct tactical operations with few amenities. The focus on essential power means less generator weight and volume needs to be stored and carried at all levels, though there will be some allowance for future growth. With excess power production kept to a minimum, there are also operational benefits such as reduced fuel costs, lower fuel farm requirements, and fewer refueling convoys (which creates a secondary cycle of fuel savings).

From an Army perspective, this can be envisioned as a gradation of amenities provided. In a basic austere environment, troops, command posts, and critical functions (including HQSS medical) move on a regular basis, with soldiers using foam mattresses and bivouac bags to sleep close to their vehicles in all types of weather. Showers and sit-down meals are rare, and there is a clear focus on immediate threats and tasks.

If/when demands increase by moving to a static camp (with amenities such as covered dining facilities or heated/air-conditioned accommodations), significant additional power is needed. Ideally, this could be accomplished by connecting together all components to create micro-grids in a modular and scalable manner, controlled by a PMM. Micro-grids are achievable with larger components, but the cost to include such features on small, man-portable generators is expected to be above current funding levels (though still desired).

Savings on camps can be realized using the PMM to direct power to where it is needed the most. For example, during the day, the HQSS accommodations HVAC can be shut off and power directed to workshops and offices. As the workplace winds down, that power can be redirected to accommodations, messing, and other amenities. If sufficient power for a static camp still cannot be obtained using unit holdings, additional assets will be required. These need to be obtained by re-allocating assets from units not concurrently using TPS, by in-theatre rental/leasing, and possibly local power grids.

For initial planning purposes, the power generation CONOPS has been grouped by Army levels of command in a tactical setting. It does not fully reflect other users such as the RCAF or RCN or a camp setting but provides a reasonable framework to define broad categories of equipment.

Sub-sub-sub-unit (Section and equivalent) and below. The expectation is that few sections have a requirement for TPS power production and distribution equipment. There is typically fewer than 10 personnel with most trades needing little power. Most vehicles already come equipped with alternators/receptacles to meet smaller demands and (especially combat arms) are already experiencing pressure on storage and weight limitations. Most of the larger or specialized pieces of equipment such as howitzers, medium-range-radars, water purification, maintenance vehicles/SEVs etc. used by sections or detachments already include onboard generators. Finally, when sections operate, it is normally in close proximity (in both time and space) to a platoon/troop HQ or equivalent which can provide support. In cases where a section is away from its supporting HQ for a significant period of time, arrangements will need to be made to obtain or transfer equipment from higher HQ equipment pools.

Notwithstanding the above, some sections (such as specialist engineers, kitchen staff, etc.) may hold equipment without an integral generator; this must be addressed on a case by case basis or by borrowing from higher. Finally, while sections may be self-sufficient or not require power in full tactical conditions, once they form a camp, those loads must still be accounted for.

Sub-sub-unit HQ (Troop/Platoon/equivalent) and below. The expectation is most loads in this category are very low (likely under 3 kW) for tactical uses and the HQ needs to be moved on a very regular basis (often more than once per day) with a minimum of effort.

The HQ generally consists of a very small command post inside a LAV or truck, occasionally expanded by a small shelter attachment. Typical loads consist of 1-3 laptops, 1-2 radios, various chargers for small electronics (GPS, smartphones, etc.) and recharging of other equipment (soldier systems vests, night vision equipment, cordless tools, etc.). There are normally less than four personnel in the HQ, and a coffee maker or heaters/air-conditioners are rare.

For these reasons, size and simplicity is the aim, and it is expected the components can be hand-loaded into/onto a LAV or other vehicle by one or two personnel. It is envisioned they will have a small generator no larger than 5 kW. For elements with larger loads, there shall also be a small ESU device to handle surges. The generator and the storage device work as a pair that will be connected together by some kind of cable. However, these components can operate independently if needed. For example, users can conduct quick maintenance or refuel the generator while still drawing power from the battery. For short term/low power requirements, they could take the battery unit and not run a generator to prevent fumes, noise, and heat signatures. Practical examples may be inside a building, observation post, recharging on the move, range days or recruiting events.

If additional power is needed, there should be a way to easily connect (at least) one additional set of equipment to allow doubling of power instead of ordering a larger generator from higher. Three-phase power is not a requirement at this level and for simplicity reasons, is actively discouraged. Because of the low power demands, low output, and single-phase power, compatibility with the PMM and a micro-grid is not required either.

The distribution system for the smaller systems must also be simple. Since the source will be run in the immediate vicinity of the users (normally within 10m), has low demands, and virtually all equipment uses 'normal' North American plugs, the distribution system preference is simple 'extension cords' in lieu of a more complicated and rugged modular distribution systems. Because of the proximity to users and opposing forces, the generator signatures need to be low.

Sub-unit HQ (Squadron/Company) Equivalent. The expectation is most loads in this category are also very low (expected to be in the 3-5 kW range) for tactical uses and the HQ is also moved on a regular basis. The HQ consists of a LAV or truck, frequently attached to a small canvas shelter, with 2-8 personnel operating within the HQ (though the HQ organization may be larger, several personnel are frequently absent, including the OC, CSM/SSM, storesperson, and cooks/medics who remain with their equipment).

Typical loads include up to 6 laptops and 2 or 3 radios, plus recharging of small electronics. Large-screen monitors are common, as is a coffee machine. It is also common to find a heater or air-conditioning unit. The TPS components will be carried in/on a LAV or truck and should be light enough to be unloaded by hand. If studies in definition determine the loads are higher than expected (resulting in heavier equipment), the generator (and ESU if provided) can operate from the carry-location or be mounted to a trailer or skid.

It is envisioned they will have a generator under 5 kW range, and in most cases, coupled with an ESU for surge demands. As with the smaller system, the generator and ESU should be two physically different components connected together, although in most situations they will remain connected. Ideally these components are similar (or identical to) the sub-sub-units.

It is expected different sub-units will have different power sources. Sub-units who normally remain forward or do not co-locate on a regular basis (most combat arms) should be equipped with systems similar to the sub-sub-unit to allow savings in weight/space and cost. Other sub-units tend to remain in rear-areas and co-locate with similar sub-units to form a temporary camp (albeit still with few amenities). This is normally the Administration Coy/Sqn with their QM and maintenance assets, but it could include other sub-units. These units should be equipped with generators and ESU that are compatible with the larger systems below, since this allows them to contribute to the micro-grid. While this may be oversize/wasteful when operating independently, it yields benefits when co-location occurs. Alternatively, the possibility of a small generator and a larger generator may provide a solution at a higher weight/volume penalty.

Unit HQ (or equivalent). The expectation is loads at most unit HQ will be moderate. While its structure will vary greatly, at typical set-up will consist of an HQSS (Army type 4) backbone with up to four vehicles plugged into it, and up to 32 personnel (often lower). The location normally only changes once every day or two. The HQ complex will typically have a significant number of laptops, radios, printers, large monitors or projectors, lights, and other equipment such as satellite communications. It invariably includes coffee makers, and HQSS HVAC equipment. The administrative elements of the unit, such as QM, maintenance, and personnel administration may also be co-located, which offers the option to create a micro-grid.

At this level, it is expected that larger generators with three-phase power and a robust modular distribution system shall be the norm. Larger ESUs shall be found with some combinations of generators, though not every individual generator will receive an ESU (e.g. a 15 kW and two 30 kW generators work together, but only receive one ESU between them). The equipment shall be designed to accept full PMM control and be integrated into TPS equipment from other units or formations. It is extremely unlikely larger components can be manhandled which is acceptable. While the generators and storage units remain physically different but interconnected components, they may be mounted on the same skid or trailer for ease of movement. The distribution systems may also be skid or trailer mounted. The most common HQSS Unit HQ (Army Type 4) may use upward of 105 kW of power at full load.

Brigade HQ (or equivalent). While there are various configurations possible, the primary consumer of power is the main HQ. It consists of 6 vehicles which back into the HQSS modules to form the backbone of the HQ complex, plus additional vehicles nearby, and up to 100 personnel (though 70 is more common). The location may change once a day, but it often sits in one location for several days simply due to the effort required to move it.

It will have dozens of laptops, radios, and printers, plus microwave and satellite communications, large monitors or projectors, and other equipment. There will be several amenities and a significant amount of HQSS HVAC equipment. Nearby equipment may include specialized communications vehicles. Like a unit HQ, it may have several administrative elements co-located nearby.

At this level larger generators, larger ESU, three-phase power, and a robust modular distribution system shall be used. It shall be designed with full PMM control to allow expansion with other users. The ESU may be mounted or be strapped to the same skid or sea-container as the generator to minimize handling. Storage for distribution system components may also be incorporated if feasible. The Brigade HQSS (Type 2) may require up to 165 kW of power needed at full load.

In addition to the Brigade main HQ, there may be other components. The most common are a step-up or forward HQ (8-15 personnel), and the rear HQ (20-40 personnel) which is located in the Brigade Service Area alongside many of the other unit administrative elements.

Medical Facilities. The HQSS is also being issued to Medical units. These shelters would be erected in during combat conditions in the field and are treated in the same manner as the HQ listed above. Because of the HVAC demands, most loads will be higher than tactical loads of other trades/corps. However, they are simple to determine based on HQSS entitlements. When they form part of a static camp, they could continue to operate using their own micro-grid or potentially connect into a larger one.

Static Camps. If operations permit, it is possible any of these HQ elements may cease being tactical and form the nucleus of a static camp, which is then expanded downward to the section level. Camps could range from a few dozen to several hundred personnel. These camps use modular tent, HQSS accommodation facilities, or existing infrastructure to significantly improve the quality of life compared to field conditions.

This may include administrative/office areas, numerous accommodation structures, ablutions, kitchen/messing, QM, recreational areas, perimeter lighting, and other functions (maintenance, engineering, helicopter or aircraft support, etc.) depending on the situation. Static camps also allow equipment with onboard generators to draw from the camp power vice operating onboard generators, so these loads must also be considered (even if ultimately not included).

Calculating loads for these camps can be done with support from CJOC (J Engr, 1 ESU), various software packages, or from first principles. Once the loads are known, the additional power requirements to meet them are easy to determine. Even when PMM is used, these loads may often exceed the capacity of any individual HQ mentioned above to support. When that occurs, higher HQ can re-allocate TPS components from other units (or control them at higher levels initially), lease/rent locally, or in some cases, use local power grids.

2.5 Concept of Support

The concept of support will be finalized during the definition phase as part of the Sustainment BCA. Current major expectations are described below.

Existing generation and distribution equipment will remain in service until declared obsolete by the Life Cycle Materiel Manger (LCMM), then disposed of in accordance with current processes.

Starting at the lowest level, the production and distribution of power to users is an all-trades responsibility, including operator inspections and basic maintenance.

They will be supported with technical advice and first/second line maintenance by RCEME technicians (primarily EO techs) and potentially Engineers (primarily EGS techs), using the Land Equipment Management System (LEMS) having the OEM expected to be primarily responsible for holding spare parts and assemblies. Additional In-Service Support (ISS) will be handled by the LCMM using supplier/industry contracts, to include technical publications, special tooling and test equipment (STTE) and provision of spare parts for two years.

Support to training is covered in more detail in section 7, but in terms of operator training, units will train personnel via distributed-learning followed by hands-on activity with the training plans held by CADTC (expected to be the RCEME School and/or CFSME). Maintainers will be exposed to the systems during trades training while attending those schools, just as they are now. There will be an initial requirement for ICT by the OEM, as well as the provision of training aids/materials/software.

It is expected that all generators and distribution systems will be stored outdoors with minimal changes to existing footprints from current equipment. It is expected that the ESU will need to be stored inside due to chemical properties, though the desire is to co-locate larger ones with the generators.

The components shall be managed in accordance with the assigned CFSS class designation (A, B, C, or D) and follow existing processes for cataloguing, entitlements, storage, issue, repair, and disposal.

2.6 Key Roles

Operator. The operator role may be drawn from any trade within the CAF and care of the power and distribution systems are almost certainly a secondary task during the deployment/exercise. For example, he/she/it may be a squadron clerk, a radio operator, a cook, a medic, a sentry, an air-frame technician, etc. They already have primary duties to fulfill but allocate part of their time to ensure their organization receives reliable power. Upon arrival to a site, they must unload/prepare the generators lay the proper distribution system, and connect (and possibly program) it all together in addition to setting up their clinic or CP. Once the system is running a radio operator may leave the CP (or medic leaves the clinic) every hour to check enough fuel remains, temperature and other attributes have remained within acceptable parameters, nothing seems amiss (odd noises, fuel leaking, etc.) and distribution cables have not been shifted or damaged. The operator role could very easily change from day to day or week to week.

In some rare cases (perhaps a larger camp), an individual may be assigned full-time to the task of ensuring reliable power is delivered to the users. However, if the task is that time consuming the commander may assign RCEME or Engineer personnel to the task.

Assistant Operator(s). Other members whose role is to support the operator. These are also drawn from any trade as a secondary duty. They are particularly needed during set-up and tear-down where many hands are required, but also allow continuity when the primary operator is away or sleeping.

Users. The very raison d'etre of the TPS is to provide power so personnel may operate their equipment and execute their duties. Interestingly, the role of TPS users is unique among military systems in that it requires absolutely no knowledge or training on how the equipment operates. While they consume power, they do not contribute whatsoever to the operation or maintenance of the system that generates or distributes it. Examples would be planning staff, clerks, hospital personnel and patients, personnel resting/sleeping, kitchen, and QM personnel. This may include personnel from allied nations, or in extreme cases, local populations.

Maintainers. The role of the maintenance staff is to ensure the components remain in operating condition. Precise qualifications and knowledge breakdowns will be determined by a training analysis through the definition and implementation phases as specific equipment is selected. Maintenance roles may include the following trades:

- Electronic-Optronic Technician (Land) – 00327;
- Electrical Generating Systems Technician – 00303;
- Electrical Distribution Technician – 00302;
- Material Technician – 00134; and
- Vehicle Technician – 00129.

LCMM. The LCMMs are the principal logistics managers who have primary responsibility for co-ordinating the management activities associated with their materiel in concert with other functional managers (e.g. supply and procurement). LCMMs must oversee all aspects of design, engineering, acquisition, installation, logistic support, and disposal for all their assigned equipment fleets.

In Service Support (ISS) Contractors. The role of the ISS Contractor will be defined during the Sustainment Business Case Analysis (SBCA). The recommended option to be examined will be a single provider that will be selected in parallel with the acquisition contract. It is expected that the duration of this relationship will be for the life of the equipment. The contractual approach will be for a fixed period with options that will be renewed if satisfactory and cost-effective performance is achieved.

2.8 User Characteristics

The TPS project solution will be designed to be operated/maintained by CAF personnel who fall within the 5-95 percentile of physical parameters and who meet the minimum standards for employment and Universality of Service as outlined in Defence Administrative Orders and Directives (DAOD) 5023-0 and Minimum Operational Standards related to Universality of Service DAOD 5023-1 as interpreted by the Canadian Human Rights Act (sub section 15(9) (CHRA) and the National Defence Act section 33 (NDA). As such, the TPS solution is expected to be gender agnostic with respect to GBA concerns.

In less legal terms, humans involved with tactical power can be divided into two broad categories: operator/maintainers of the equipment, and users/consumers of the power.

The operators will be members of any trade in the CAF. Their characteristics are very wide ranging, and only limited by the CAF trade specification. This includes ages between 18 and 60, all sexes/genders, all language (though he/she/it must be fluent in either English or French), high school or higher education levels, all ethnic and religious backgrounds, various physical, sensory, and cognitive characteristics, and varying degrees of experience and maturity. The maintainers will be drawn from various RCEME and Engineer trades, with the same wide range of characteristics, but with a slightly more technical background.

3 DESIGN AND CONCEPT GUIDANCE

General. As mentioned in Section 2 there is an unlimited spectrum of users. Examples range from a school conducting an afternoon rifle range to several hundred CAF personnel housed in a static camp for over a year. Regardless of the situation, a generic system will require an energy source (generator and/or ESU), and an ability to distribute the power to the user, which may also include software control of the generation and loads.

Because a one-size-fits-all design approach will not suffice, components and sub-systems will vary in size/capacity to allow flexibility in operations and to match the expected electrical loads. Not all components will be issued to all users; and it is accepted that a smaller version of component 'X' will not have as much functionality as the larger version. This is done for cost vs benefit reasons (which include weight, ease of operation, expected amount of use for some features, etc.).

Therefore, not every TPS component must be fully interoperable with every other TPS component. For example, the lightweight distribution system for a platoon-level 2 or 3 kW generator does not need to plug into the faceplate of a 60 kW three phase generator being run with PMM software. However, interoperability should be maximized to the greatest degree feasible (e.g. all smaller generators use the same type of distribution system, all large generators can be controlled by one type of software, etc.).

Division and Nomenclature. The concept of varying capability is extended to the concept of a White/COTS fleet for in-Canada and/or low-risk environments, and a Green/MOTS fleet which can reliably operate in combat. This document is organized along those lines, to allow easier refinement of requirements as the project proceeds. As more work is done, some may be combined.

In terms of acronyms and nomenclature, items starting with a 'W' are white fleets, and 'G' are green fleets, followed by various equipment descriptor acronyms. Also note from a CAF project perspective, the distribution components are technically a sub-system of the TPS. However, industry practice and most users refer to that capability as a 'distribution system' vice 'distribution sub-system', and both terms shall be used interchangeably.

Current Fleets. An ideal situation would fully incorporate the current fleets of generators into the TPS, but it is accepted they are or will be at life-end (or beyond) by the time TPS is fielded. For that reason, the PMM and energy storage aspects are not required to connect to current fleets, but it is desired the distribution systems components are backwards-compatible with current generators, so long as it does not hamper the CAF from moving forward. If new distribution systems require significant engineering or adaptation to match older technology, then the old generators and distribution systems can continue to run in stand-alone applications until they are disposed of.

Initial Groupings. Since the project is not doing a one-for-one generator replacement, and the loads of various current users are still only rough estimations, more information still needs to be gathered during definition before specific sizes/capacities and quantities of deliverables can be determined. Full scope estimates based on current holdings required approximately 1600 smaller power sources (under 12 kW), and 1100 larger power sources (12-60 kW). However, because of funding realities, planning numbers are estimated to be closer to 870 small sources (with about half including an ESU) and 510 large sources (with about 40 ESU).

Micro-grids are certainly feasible with larger generators, but the cost to design and include such features on small, man-portable generators is expected to be above current funding levels. The focus shall be ensuring the larger equipment can operate as a micro-grid. The desire to integrate smaller generators and ESU into a micro-grid still remains but is a lower priority.

Section 2.4 CONOP included a very detailed vision of what/how each level of command should expect for power generation in terms of equipment and how it would be employed, which provides expectations of the systems to assist with design.

As mentioned in the CONOP, the focus shall be on the tactical aspects first. Once tactical power is available, the transition to powering a static camp is simple (calculate camp loads, determine the additional required power, then re-allocate equipment or rent/lease equipment to make up the shortfall). Equipment design shall be flexible enough to include features for static camps, despite the paucity of assets to support it.

4 SYSTEM EFFECTIVENESS REQUIREMENTS

4.1 General Requirements

Any TPS subsystem or component which is not fit for the intended purpose shall be deemed unacceptable, notwithstanding that fact it may meet all of the required technical requirements. The overriding principle is that the system, subsystem, and associated components shall be capable of sustained, effective, combat operations and peacetime training requirements.

The TPS is deployable and shall be rugged enough to sustain prolonged use in harsh environments. It shall require minimal preparation to move from one location to another, easy to set up, operate, maintain, tear-down, and repackage for movement.

The system should have growth potential in order to cater to future improvements such as technology upgrades or renewable energy sources (specifically solar and wind), hence the desire for a modular system. It should be brand- agnostic to prevent future sole-sourcing of additional or replacement components.

The systems shall be designed such that they are able to provide power to an operations cell within 20 minutes of arriving on site using no more than five personnel. This includes positioning, unloading, connecting, and starting any required components. It does not require connections to plans cells, briefing areas, etc. if they are part of that HQ. This is focused at unit and Brigade HQ equivalent organizations, with other cells and PMM functions added after the Ops cell is functioning.

All gauges, indicators, and warnings shall use System International (SI) units. Imperial/US units are desired as a secondary measurement.

Any digital displays shall be readable in sunlight, backlit for night use, and have adjustable brightness and contrast. They shall also have a normal/blackout toggle. Any touchscreens or menu-driven software not using icons shall be able to toggle between English and French, and SI and Imperial/US units. They should (where feasible) include symbols or shapes to assist identification under red-light or night-conditions, or for personnel with colour vision issues.

All TPS components should include a digital asset tag (RFID or other technology) to assist operators/storespersons and the LCMM with rapid, non-contact inventory counting and asset tracking throughout the life of the component. Although considered permanent, should a tag become inoperable, there shall be a method to replace it and update database contents to the new ID number.

See section 5 for subsystem-specific requirements.

4.2 Operability

All components shall be designed to be set up, connected, and operated by one trained person from any trade, once properly positioned on site. It is expected more than one person will assist, especially when running larger distribution systems or multiple generators, but for success measurement purposes, this is considered a one-person task.

At the strategic level, all components shall be transportable by rail, sea, and various cargo aircraft such as the CC-130 Hercules. At the operational level, all components shall be transportable by large vehicles and trailers similar to the MSVS, the CC-130 Hercules, and the CH-147 Chinook.

Because of the modularity, various sizes, and number of components (expected to be several dozen) mobility at the tactical level can only be addressed in general terms. It shall range from hand-carried, to small vehicles such as quad-runners or pickup trucks, to larger vehicles such as LAVs, MSVS, and LVM, to aircraft such as helicopters and utility aircraft (twin-otters, etc.). The opening paragraph under General Requirements comments on being fit-to-purpose, which includes the ability of equipment to be the right size, shape, and weight that it can be moved to and handled at the desired location by appropriate CAF vehicles.

Components shall be safely transportable on highways, unpaved roads with washboard surfaces, vehicle tracks, and cross-country conditions which may include rocky ground, plowed fields, sand, mud, and snow/ice. This dictates operability after being exposed to vibration and shock.

Components shall be able to be operated continuously at angles up to 15° and should be able to operate up to 30°. The only equipment that may have issues would be the generators due to fuel movement.

There is no requirement for any component to be air droppable. This does not preclude components from being air-dropped should a scenario arise, but they shall not be designed or certified for this purpose.

See section 5 for subsystem-specific requirements.

4.3 Survivability

All components shall be designed to operate effectively in the environments mentioned in section 2.2.

Live Fire Testing. There is no requirement for components to be subject to small arms, heavy weapons, or explosives testing.

See section 5 for subsystem-specific requirements.

4.4 Maintainability

TPS components shall be sustained by the CAF and supported by the OEM for a period of 20 years. Subject to confirmation by the SBCA during definition, it is expected standard CA levels and lines of maintenance shall be used. Domestic maintenance support may leverage an ISS package if operationally and cost effective.

TPS components shall be designed and constructed to provide access and ease of maintenance with a minimum of special tools, test equipment, and skills (STTE). This includes the requirement to remove the most frequently used access panels without any tools.

To the maximum extent feasible, assemblies and components shall be capable of battlefield replaceable or repairable without the need to recover to a maintenance facility.

For software supported components, built in test and self-diagnosis shall locate and identify a point of concern/failure, and ideally the cause of failure. Prognostics is desired to ensure preventative maintenance is conducted in a timely manner.

Manuals and other documentation shall be in bilingual electronic form and should be written in appropriate CAF terminology. Interactive electronic technical manuals shall be provided.

See section 5 for subsystem-specific requirements.

4.5 Availability

Fleet operational availability shall be no less than 98%.

TPS fleet availability shall be considered operable when (CAF wide) 50% of each green component and 50% of each white component are in serviceable condition and able to be packaged for a deployment within 24 hours. 50% was chosen based on the CA org of three Mechanized Brigades plus the CCSB, the Reserves, and CADTC notionally pooling all equipment. Even with one full Brigade deployed (just over ¼ of the CA equipment), it leaves just under ¼ of the CA equipment to meet CA training needs and other emergencies, while non-CA assets still remained untouched to provide an additional factor of safety. The 50% of each fleet allows for a variety of component sizes to meet operational needs. Should the RCAF or other elements deploy, the problem is simplified as less equipment is required.

Availability will vary between components. See section 5 for subsystem-specific requirements.

As operators are an all-trades task with little training required, units should never have a shortage of operators throughout the life of the components. Therefore, their availability shall be considered 1.00.

4.6 Reliability

It is impossible to stipulate or predict a TPS system reliability since the sub-systems are dispersed across the country and will be configured differently for every use.

Components are planned for a 20-year lifespan, and the failure rate of any specific component is expected to follow a standard bath tub curve. The reliability of the local system must be high as a modern military cannot operate without power.

The power production is the weakest block in the system with lower MTBF than other components. However, if generators and ESUs are used in parallel, it increases system availability to local users regardless of the individual component reliability. The ESU shall have a much higher reliability than the generators. The distribution system shall also have an extremely high reliability. Because it is simple (copper wire and some minor electronics) this should not be a problem to achieve. The PMM reliability may be lower than other electronics since the local system can operate without it (albeit not be as fuel efficient). However, the PMM reliability is still expected to be higher than the generators as it is software-based vice consisting of moving parts.

The human factors reliability is expected to be lower than the equipment. While the training is simple and all-trades, human fatigue, hunger, and distractions coupled with environmental factors create a higher potential for failure. This may range from missed maintenance or inspections, improper connections, or simply causing system failure by driving a vehicle over distribution boxes or cables.

See section 5 for subsystem-specific requirements.

4.7 Environmental Sustainability

The TPS project is likely to have a significant positive impact on DND environmental goals and targets. Fossil-fueled engines produce emissions, but considering they are replacing equipment several decades old, it will still be an improvement. If lithium batteries are used in components, CAF and the ISS contractor handling and disposal procedures shall be followed to prevent degradation of the environment. An efficient micro-grid will also contribute to increased power generation system efficiency and reduction of environmental impact.

The design and construction of the components shall minimize or eliminate environmentally damaging materials where feasible.

See section 5 for subsystem-specific requirements.

4.9 Safety and Health

All components shall meet the current Canadian Electrical Code, CSA standards and other applicable standards for outdoor use.

All components shall be designed to minimize to the greatest degree (and ideally avoid) the chance of human contact with line voltages.

The components and systems shall have a fail-safe design for components, connections, and operator procedures, so as not to endanger the operator and users.

Notwithstanding GBA+ considerations, weights for man-portable components shall not exceed 37.2 kg as per Mil-Spec 1472G for one male carrying an object 10 m or less. This shall be scaled higher for items requiring more than one person to lift. This Mil-Spec is reasonable and adopted for most TPS activities, as vehicles can normally move components to within 10 m of the desired location. For occasions where longer distances are needed, other personnel can assist, the trip can be broken into shorter segments, or an exception may be invoked.

All man-portable equipment shall have adequate handles, corners, loops, or other features to provide personnel with a secure carrying grip.

All equipment shall be designed to be handled and operated while wearing work gloves (with the exception of touchscreens).

All equipment shall be equipped with applicable warning icons (preferred) or bilingual text (acceptable) to indicate dangerous or caution warnings including identification of hazardous materials.

See section 5 for subsystem-specific requirements.

4.10 Delivery Requirements

Quantities shall be determined during definition, but the full scope requirement was roughly estimated at approximately 2700 generator and energy storage components with 1600 being at the lower end (under 12 kW) and another 1100 at the higher (above 12 kW). Distribution systems and PMMs shall be scaled accordingly.

They are expected to be delivered to most bases and wing across Canada via the depots in Montreal and Edmonton. It is expected that some degree of whole fleet management shall be required. Products shall be free from defects and work properly IAW the SOW upon receipt.

5 SUB-SYSTEM EFFECTIVENESS REQUIREMENTS

5.1 Generators (White/COTS)

5.1.1 General Requirements

Not applicable. Requirements covered in other sections.

5.1.2 Operability

<u>All White Generators (WG)</u>

WG fleets shall produce various power to allow the user to operate his/her/its equipment, and to recharge any ESU connected to it. This does not preclude a single generator from having variable power output.

Operators shall be able to connect/disconnect WG from the ESU and distribution systems without needing specialty tools. It is desired the disconnect can be done by hand (no tools).

A single WG shall be able to produce power within 5 minutes after arriving on-site at temperatures above freezing. this is intended for power at the generator terminals; the distribution system is exempt.

WG shall have no more than 6.0% total harmonic distortion (THD) and be frequency stable at the chosen frequency to allow use with sensitive electronics.

WG shall be capable of operating at altitudes of 1200 m (approximately 4000 feet) without requiring any conversions, adjustments, or preparation. They should be capable of operating at altitudes of up to 1500 m (approximately 4900 feet) without requiring any conversions, adjustments, or preparation.

<u>White Generators Small (WGS)</u> (sizes tbd under 12 kW, but virtually all are expected to be under 6 kW)

WGS shall produce single phase 60 Hz power. 120 V is mandatory, 240 V is desirable. There is no requirement to have 50 Hz capability, but it and other waveforms are acceptable. WGS connections shall allow users to directly connect equipment to a receptacle integral to the generator (North American NEMA 5-15 or 5-20 receptacle is mandatory, other receptacles such as 120 V locking or 240 V are acceptable). Most WGS will power small North American loads such as lights, monitors, power adapters/rechargers, or heaters. Therefore, the output requirements are minimized to cut weight/volume and to allow funding to be redirected towards higher power generators with multiple waveforms. The 240 V aspect is to support comms vehicles, however other solutions have been developed locally.

There shall be a means to connect the WGS to a small ESU (this may incorporate the same outputs already mentioned or a different output).

At least one fleet of WGS shall have the ability to produce 24 V DC with appropriate connections. This requirement may disappear but remains included until further study can be done.

Inverter technology is desired to protect sensitive electronics.

It is desired to have the capability to synchronize at least one other WGS from the same family to increase the available power. This allows a doubling (or more) of small generators to meet heavier loads for shorter periods of time using the lightweight assets. For extended periods such as when in a static camp, it will normally be better to draw from a larger system.

Because of the desire for simplicity and the built-in receptacles, the WGS distribution system shall be based on standard North American extension cords already in service (not provided by TPS unless exceptional cases exist).

WGS shall be recoil start. It is desirable to have start-assist features (pushbutton, electric, etc.).

WGS Run times shall be at least six hours (at partial loads tbd during definition). It is essential they can be refilled by a jerry can or similar portable container. It is desirable that an external fuel line or tank (jerry can, or manufacturer supplied tank) can be connected to WGS for longer run times.

At least two WGS fleets are expected: one fleet using commercial gasoline (MOGAS) with up to 10% ethanol to allow lighter weight for some users, and one fleet using military diesel/kerosene equivalents (F34 and F54) for longer durability where weight is not as important.

WGS MOGAS generators under 3 kW shall be man-portable by one person, and those in the 3-6 kW range by three persons. Diesel/kerosene equivalents shall be man-portable by twice as many people.

WGS shall be automatically controllable to idle when the ESU is fully charged. Ideally this includes shutting off and restarting.

WGS shall have gauges or indicators for operating hours, fuel level, and low-oil alert (or automatic shutdown in lieu of low oil alert). It is desirable to have displays for instantaneous load, voltage/current/frequency, maintenance diagnostics, and other indicators.

WGS shall have all controls normally expected on a small engine such as run/kill, fuel shutoff, choke, etc. It shall also have circuit breakers to protect the output. Other controls (voltage or frequency selection, etc.) are desirable.

There is no requirement to capture and store WGS operating parameters other than operating hours, though it is desirable.

User acceptance of WGS shall largely be based on already proven and accepted COTS/MOTS equipment (vice development of new equipment). A literature review shall occur prior to the bidding process to identify yellow flags. Once a vendor has been selected, there will be a series of design review and user trials of TPS equipment at the sub-system and system levels.

White Generators Large (WGL)

WGL approximate sizes are expected to be 15, 30, and/or 60 kW but may change. They shall produce three-phase 60 Hz power at 120/208 V. 50 Hz capability is desired, but not mandatory for the white fleet.

WGL shall have a pin and sleeve connector receptacle(s) to match the power distribution system components, and/or lugs to which technicians can attach a short cable which terminates to that type of receptacle. If using lugs, they shall be behind a safety enclosure so operators cannot touch them.

WGL shall have the ability to synchronize and connect with at least two additional units for simple parallel operation. This shall be accomplished with minimal user oversight (push and forget) and occur within 60 seconds once both generators are running. All generator farms shall have the option to be controllable via a PMM for more efficient grid operation.

WGL shall have the ability to connect to a large ESU (this may incorporate the same pin and sleeve connector outputs/connections already mentioned or a different output/connection).

WGL shall come equipped with appropriate grounding rods or plates and tools to emplace/remove the grounding device.

WGL shall have a 24 V DC slave connection to allow a military vehicle to start the generator or vice versa).

WGL shall use military diesel/kerosene equivalents (F-34 and F-54, both low and high sulfur) and meet or exceed Tier 3 emissions standards. Compatibility with other fuels is desirable. There is no requirement or desire for the use of DEF.

WGL run times shall be at least 12 hours (at partial load tbd during definition). They shall have the ability to be refueled by jerry can or similar portable container as well as by a POL vehicle with a pump dispenser. WGL shall also have the ability to connect to an external fuel supply.

WGL are expected to be a mixture of trailer mounted or pallet or skid mounted systems. Some larger systems may be housed in ISO containers (quad-con or potentially bi-con sizes to allow for easier handling). Mass/weight to be determined during definition.

WGL shall automatically idle when an ESU is fully charged. WGL should be able to shut off and restart when an ESU is fully charged (via ESU operator selectable parameters).

The WGL operator interface and HMI shall have controls (as a minimum) to:

- Start/stop the engine;
- Select voltage output; and
- Circuit breakers to protect the generator/users.

The WGL operator interface/HMI shall have gauges or indicators (as a minimum) for:

- Cumulative operating hours;
- Fuel level;
- Low-oil alert;
- RPM;
- Coolant temperature;
- Voltage, current, frequency; and
- Instantaneous load.

The majority (if not all) of these gauges and controls shall be co-located at the HMI and be readable and useable in all environmental conditions with the operator in a standing or kneeling position.

WGL built-in test and diagnostics shall locate and identify a point of concern or failure, and ideally the cause of failure. Prognostics is desired to ensure preventative maintenance is conducted in a timely manner. These codes shall be stored until downloaded.

WGL should have strip-recording of operating parameters (quantity of samples and type of data tbd) for later analysis by the operators, LCMM, and vendor or OEM.

WGL diagnostics and strip-records shall be downloadable by a computer connection or removable memory device (device type and exported software format tbd). Wi-Fi or Bluetooth diagnostics are permitted for the white fleets but are not requested or desired. Uploads of new firmware and software will be by the same access points.

WGL shall be equipped with visual and audible alarms (with a silence feature) to warn of low fuel, low oil level/pressure, high coolant temperature, system malfunctions, and overload conditions. Additional alarms are acceptable.

User acceptance of WGL shall largely be based on already proven and accepted COTS/MOTS equipment (vice development of new equipment). A literature review shall occur prior to the bidding process to identify yellow flags. Once a vendor has been selected, there will be a series of design review and user trials of TPS equipment at the sub-system and system levels.

5.1.3 Survivability

<u>All WG</u>

WG electromagnetic emissions shall comply with applicable Industry Canada and FCC emissions regulations. It is desirable they comply with NATO/Mil-spec standards. Civilian standards are expected to be less stringent than NATO/military standards.

WG noise emission standards are covered under safety and health.

WG heat/IR emissions should match NATO standards. Field SOPs and TTPs such as sandbagging, burying the generator, and using camouflage nets will assist to reduce signatures during training or domestic operations.

WG colours shall be olive drab, with potential of some desert tan variants.

Cyber-resilience of equipment is still in the early stages within the CAF and is currently being developed by the Land Cyber-Mission Task Force and other organizations. TPS will examine the potential to implement some draft processes and safeguards through the definition and implementation phases to assist the TF. This includes WG fleets.

Once WG are fielded, cyber security shall incorporate SOP and TTPs such as limiting data entry points and control of user privileges. Wi-Fi, Bluetooth, or cellular diagnostics and monitoring are permitted for the white fleet, but not desired.

WG control cables and connectors between generators, ESU, and the distribution system shall be designed and labelled to reduce the chance of confusion.

All WG plugs and sockets shall have weather resistant covers.

WG should pass the NATO Road/Cross Country Vibration Test Mil Std 810E and rail impact test. WG are unlikely to have been tested to a NATO standard which is why this is not a 'shall', but there may be similar/equitable civilian standards which subject the equipment to repeated shock and vibration.

5.1.4 Maintainability

See section 4.4.

WG routine operator inspections and maintenance shall be no more than 15 minutes.

Scheduled first line maintenance shall take no more than one hour.

Unscheduled first line maintenance shall take no more than three hours.

5.1.5 Availability

See section 4.5.

Availability of WG MOGAS generators is expected to be no less than 0.95.

Availability of WG diesel/kerosene generators is expected to be no less than 0.98.

5.1.6 Reliability

See section 4.6.

WG shall have a duty cycle no less than 22 hours per day, seven days per week (154 hours). The remaining 2h per day allow for movement between sites, maintenance (operator and maintainer) etc.

WG using MOGAS expected usage is three weeks equivalent per year (500 hrs). They shall have a MTBF of at least 600 hours.

WG using diesel/kerosene expected annual usage is 13 weeks equivalent per year (2200 hrs). They shall have a MTBF of at least 1000 hours.

5.1.7 Environmental Sustainability

See section 4.7.

While not a TPS deliverable, appropriate in-service petroleum spill kits shall be located near all generators when being used or refueled. Space for this is covered under section 5.9.

5.1.9 Safety and Health

See section 4.9.

WG noise levels shall not cause discomfort or long-term hearing loss for personnel working in the immediate area (defined as within 7m of the generator). It should be quiet enough to allow normal conversation (in-person or radio) while the generator is running in the immediate area.

WGS requiring more than one person to move shall be fitted with removable wheels to assist in movement over floors or hard-packed surfaces. WGL are mounted to pallets, skids, or trailers, therefore no requirement for wheels.

WGL shall have an external baffle/shield to minimize (ideally prevent) the spread of fire should one occur.

5.2 Generators (Green/MOTS)

5.2.1 General Requirements

As per white requirements unless modified below.

Nil.

5.2.2 Operability

As per white requirements unless modified below.

Add: GG shall have no more than 3.0% total harmonic distortion (THD) and be frequency stable at the chosen frequency to allow use with sensitive electronics (vice 6.0% for white fleets).

<u>All Green Generators (GG)</u>

Add: GG shall have a cold-start capability down to -46°C without external assistance. The use of any special cold weather/winter kit is permitted.

<u>Green Generators Small (GGS)</u>

Add: In addition to the 60 Hz 120 V power, it is desirable to have a 60 Hz, 240 V and 50 Hz, 240 V capability (vice there is no requirement for 50 Hz power). This is not listed as mandatory, as most loads remain Canadian in nature. Since small electronics and chargers are now designed for worldwide sale/use, locally purchased electronics (cell phones, etc.) will also work on the North American generator. Issues should only exist for line-voltage items such as locally purchased appliances or refrigeration units, but they are unlikely to be powered by the small generators. They would be found on static camps, where the larger generators are capable of 50 Hz operation.

Add: The GGS shall utilize F-34 and F-54 fuel (vice F-34 and F-54, plus MOGAS variants). This is due to the availability of diesel/kerosene in most parts of the world and increased reliability/less maintenance during a mission. This will incur a significant weight penalty, especially for light forces, so commanders may choose to supplement the GGS fleets with some WGS MOGAS generators to retain mobility.

<u>Green Generators Large (GGL)</u>

Add: The 50 Hz, 240/416 V capability is mandatory (vice it is desired for WGL). This interoperability feature is to allow provision of compatible power to non-US allies and host nations.

Add: GGL shall have a battle-override capability. This allows production of electricity to continue while ignoring normal shut-down parameters such as low-oil, low-fuel, high-temperature, etc.

5.2.3 Survivability

As per WG unless modified below.

Add: GG shall conform/pass the NATO Rail Impact Test and NATO Road/Cross Country Vibration Test.

Add: GG EMI and RF emissions standards must also meet current NATO standards. This provides additional protection against detection and EMP pulses, while still ensuring it does not adversely affect nearby users of the EM spectrum.

Add: GG Exterior coating for shielding, skids, trailers, and other exposed metal surfaces shall be coated with Chemical Agent Resistant Coating (CARC). Any shiny or reflective surface shall have the ability to be covered.

Add: GG Exhaust smoke shall not be continuously visible at a distance of 100 m.

Add: GG Exposed exhaust pipes shall be shielded and/or insulated. This is to prevent burning or melting by conduction any camouflage nets draped over the exhaust pipe.

Add: All GG plugs and sockets shall have military grade weather resistant covers (vice weather resistant covers on WG).

Add: Wi-Fi, Bluetooth, and cellular diagnostics shall not be permitted for the GGL (vice allowed but not desired for the WGL). This is to reduce the RF signature and the chance of EW interference and cyber-attack/hacking.

5.2.4 Maintainability

As per white requirements unless modified below.

Nil.

5.2.5 Availability

As per white requirements unless modified below.

Nil.

5.2.6 Reliability

As per white requirements unless modified below.

Green diesel/kerosene generators expected use is 26 weeks equivalent (4400 hours) per year.

5.2.7 Environmental Sustainability

Not applicable, covered in section 4.7

5.3 Energy Storage Units (White/COTS)

5.3.1 General Requirements

White ESU (WESU)

There shall be at least two WESU sizes; one small (WESUS), and at least one large (WESUL). Each size shall be able to be paralleled with others of the same size. Specific Amp-hour (Ah) capacities will be determined during definition and must balance between weight/size and operational impact/capacity. For initial planning purposes, they were estimated to be in the 2-5 kWh and 12-16 kWh range but can certainly change.

A WESU shall provide one AC waveform type (frequency/phase/voltage) at any given time. This shall be protected by an appropriate circuit breaker. Additional simultaneous waveforms (AC or DC) are accepted, but not requested.

All WESU shall have intelligent charging capabilities where charging rates are monitored and optimized by algorithms to allow rapid recharging while maximizing the life of the battery chemistry. It shall also monitor and control discharge rates to allow a balance between high demands and maximizing the life of the battery.

Operators shall be able to connect/disconnect a WESU from generators and distribution systems without needing specialty tools. It is desired this can be done by hand (no tools).

It is desired the WESUS and WESUL can also operate together, but it is not a requirement. This is not mandatory since each has different outputs (phases, frequencies, voltages, and connectors) which may over-complicate the smaller WESUS.

5.3.2 Operability

All WESU

WESU shall utilize two-way inverters to allow them to accept power (charge) and to provide power (discharge) simultaneously.

WESU shall accept power to charge from various sources detailed below. Line cord(s) shall be detachable and replaceable by operators.

WESU shall be capable of providing power (waveforms) to users in stand-alone mode as detailed below.

When paired with a single generator, the WESU shall be capable of assisting a generator when loads exceed allowable limits either as a transient spike (e.g. a motor is turned on) or for longer duration (e.g. higher than normal use of radios for a period of time). When the demand drops to within generator capability, the ESU shall begin to recharge.

The same principle applies to a generator farm, however, the WESU must cover the period of time until an additional generator comes up to speed and synchronizes with the rest of the equipment.

WESU built in test and diagnostics shall locate and identify a point of concern/failure, and ideally the cause of failure. Prognostics is desired to ensure preventative maintenance (if needed) is conducted in a timely manner. The controller shall store diagnostic and warning/trouble codes (along with device ID number and time/date stamp) for export to operators and maintainers.

WESU Small (WESUS)

WESUS charging sources shall include 60 Hz 120 V. It should include 24V DC, 12V DC for vehicle-based support or alternative energy sources, and 240V for faster recharging while in garrison (both 50 and 60 Hz). Additional charging sources are acceptable. If 240 V charging is included, a multi-voltage plug on the supply cord is acceptable; there is no requirement to have separate 120/240 V ports on the WESUS itself.

WESUS maximum charge time from full discharge (using 120 V, 20 A receptacles) shall be under three hours. It is desirable to be under two hours.

WESUS output waveforms shall include single-phase 60 Hz, 120 V with at least one integral receptacle (NEMA 5-15 or 5-20), and 5 V DC with at least five USB charge ports. It should include 12 V (automotive) and 24 V DC (military jumper) receptacles. It is acceptable to include 240 V outputs at 50/60 Hz, but not requested. Connection of WESUS to the TPS distribution system is desired, but not mandatory.

When in 'operation' mode, WESUS shall operate with a small generator (WGS or GGS) to provide power to a load. Ideally, it should cycle the generator off and on at certain setpoints as opposed to the generator sensing the ESU is charged and reducing its speed/output until more power is needed. These setpoints should be operator adjustable. A simple recoil starter generator must run all the time so the second scenario would apply, though the lower rpm still saves fuel and maintenance, and it is simpler to design/operate. An electric start generator could be started/stopped, but the drawback is the weight, size, complexity, and cost of the generator has increased. This will be examined during definition.

WESUS output waveform shall be selectable by a switch or keypad and shall only provide power to the proper connection for that waveform. There shall be an indicator or display which indicates the output waveform chosen.

WESUS shall have a means to intentionally discharge the batteries to appropriate levels for transport by military and commercial aircraft or other carriers with cargo restrictions. This discharge feature may also be used for maintenance purposes, storage, or other uses. The desired method is via an internal feature, but an external device is acceptable if it results in significant weight/space savings.

The WESUS HMI shall display the following information: charging status (charging only/discharging only/normal operation), power remaining, self-test/diagnosis results, warning/fault codes, and lifetime hours of operation. It should display frequency, voltage, current, and power at the AC outlet. It is desirable to display battery module(s) temperature, voltage, and current.

The WESUS should be able to strip-record operating parameters (quantity of samples and type of data tbd) for later analysis by the operators, LCMM, and maintenance contractors.

WESUS diagnostics and strip-records shall be downloadable by a computer connection or removable memory device (device type and exported software format tbd). Wi-Fi, Bluetooth, or cellular diagnostics are permitted for the WESU but are not requested or desired. Uploads of new firmware/software will be by the same access points.

The WESUS shall be small and light enough for a one-person carry.

<u>WESU Large (WESUL)</u>

WESUL charging sources shall include 60 Hz 120 V and 240 V single-phase, 24 V DC, and 12 V DC. 50 Hz equivalents are desired for non-North American operations. 208 V three-phase and additional sources are acceptable. A multi-voltage plug on the supply cord is acceptable; there is no requirement to have separate 120/240 V ports on the WESUL itself.

WESUL maximum charge time from full discharge (using 120 V, 20 A receptacle) shall be under five hours. It is desirable to be under three hours.

WESUL output waveforms shall include single phase 60 Hz 120 V with at least one integral NEMA 5-15 or 5-20 receptacle. It shall also include three-phase 60 Hz 208 V and 416 V outputs with quick-connect pin and sleeve connectors (same connector as WGL and GGL) to the distribution system. It is desirable to include 50 Hz equivalents for international use.

DC power output shall include 5 V DC with at least five USB charge ports and at least one 24 V DC military jumper receptacle. It is desirable to include a 12 V (automotive) connector.

When in 'operation' mode, WESUL shall operate with WGL or GGL to provide power to a load. It shall be able to cycle the generator on/off when it requires charging via operator setpoints (one paired system) or via the PMM (larger systems).

WESUL output waveform shall be selectable by a switch or a keypad and shall only provide power to the proper connection to that waveform. There shall be an indicator or display which indicates the output waveform chosen.

WESUL shall have means to intentionally discharge the batteries to appropriate levels for transport by military and commercial aircraft or other carriers with cargo restrictions. This discharge feature may also be used for maintenance purposes, storage, or other uses. The desired method is via an internal feature, but an external device is acceptable if it results in significant weight/space savings.

WESUL shall be able to strip-record operating parameters (quantity of samples and type of data tbd) for later analysis by the operators, LCMM, and maintenance contractors.

WESUL diagnostics and strip-records shall be downloadable by a computer connection or removable memory device (device type and exported software format tbd). Uploads of new firmware/software will be by the same access point.

The WESUL HMI shall be able to display the following information: charging status (charging only/discharging only/normal operation), power remaining, lifetime hours, self-test/diagnosis results, and warning/fault codes. The HMI shall be able to display frequency, voltage, current, and power on all three legs of power. It is desirable to display battery module(s) temperature, voltage, and current plus ambient temperature.

The ESU is should be small enough for a four-person carry, but mechanical assistance is acceptable if this is not feasible. If mech assistance is needed, the ESU may be left on the truck frequently, so ensure that longer connection cords and power cables are provided.

5.3.3 Survivability

WESU shall be protected from weather to allow outdoor operation. This does not preclude specialized boxes/shelters to house larger WESU. All plugs and sockets shall have weather resistant covers.

WESU electromagnetic emissions shall comply with applicable Industry Canada and FCC emissions regulations. It is desired they comply with NATO EMI emission standards.

WESU colours to be olive drab, with potential of some desert tan variants.

Cyber-resilience of equipment is still in the early stages within the CAF and is currently being developed by the Land Cyber-Mission Task Force and other organizations. TPS will examine the potential to implement some draft processes and safeguards through the definition and implementation phases to assist the TF. This includes WESU fleets.

Once WESU is fielded, cyber-security shall incorporate SOP and TTPs such as limiting data entry points and control of user privileges. Wi-Fi, Bluetooth, or cellular diagnostics are permitted for the WESU, but not desired.

WESU control cables and connectors between generators, WESU, and distribution systems shall be designed and labelled to reduce the chance of confusion.

WESU plugs and sockets shall have weather resistant covers.

WESU should pass the NATO Road/Cross Country Vibration Test Mil Std 810E and the Rail Impact Test. WESU are unlikely to have been tested to a NATO standard, but there may be similar or equitable civilian standards which subject the equipment to repeated shock and vibration.

WESUS shall be designed to allow indoor storage without requiring infrastructure modifications for safety reasons. This is intended to prevent the need for specialized ventilation, fireproofing, etc. of storage areas. The intent is it can be stored in any room on any shelf with no concerns, and there is no requirement to concentrate all WESUS in one specific location.

WESUL shall be designed to allow indoor storage without requiring infrastructure modifications for safety reasons. It should be designed to allow cold storage and outdoor storage during winter conditions. The use of a 60 Hz 120 V power source is permitted if needed. Because of larger size, exterior storage is desired, and power is permitted in case there is a requirement for battery warmers, trickle charging, etc. while in cold temperatures for several months.

WESU shall be designed to allow indoor recharging without requiring infrastructure modifications for safety reasons. As with storage, this is to prevent the need for specialized ventilation, drainage systems, and fireproofing during charging. The option of using 240 V charging is not safety related; it only allows faster charging and is therefore optional for any unit holding WESU.

5.3.4 Maintainability

See section 4.4.

WESU routine operator inspections and maintenance shall be no more than 5 minutes.

WEU scheduled first line maintenance shall take no more than 15 minutes.

WESU unscheduled first line maintenance shall take no more than two hours.

WESU shall be designed to facilitate rapid replacement of battery modules (plug and play). This is an expansion of section 4 but expected to greatly assist any field troubleshooting that it is explicitly stated here.

5.3.5 Availability

See section 4.5.

WESU shall have an availability of at least 0.99.

5.3.6 Reliability

See section 4.6.

Tentative MTBF values shall be a minimum of 5 000 hr and at least 2000 operating cycles.

WESU expected use is 13 weeks (2200 hours) equivalent per year

5.3.9 Safety and Health

See section 4.9 for general requirements.

WESU shall be designed to minimize spreading of a battery fire. They should be designed to prevent spreading of a battery fire. This is already largely covered if the ESU meets CSA standards.

WESU shall be designed to allow transport on commercial and military aircraft. This may require fire-resistant or fire-proof design, battery modules which can be physically removed and stored in specialized cases, or other solutions in addition to the discharge feature mentioned under Operability.

WESU requiring more than one person to move shall be fitted with removable wheels to assist in movement over floors or hard-packed surfaces.

5.4 Energy Storage Units (Green/MOTS)

5.4.1 General Requirements

<u>Green ESU (GESU)</u>

As per white requirements unless modified below.

Nil.

5.4.2 Operability

As per white requirements unless modified below.

<u>GESU Small (GESUS)</u>

Add: GESUS shall accept 50 Hz, 240 V power (vice should accept for WESUS).

Add: GESUS should also produce output waveform of 50 Hz, 240 V power. Should was used (vice shall) for the same reasons as the small generators.

GESU Large (GESUL)

Add: GESUL shall accept 50 Hz, 240/416 V power (vice should accept).

Add: GESUL shall produce 50 Hz, 240/416 V power (vice should produce).

5.4.3 Survivability

As per white requirements unless modified below.

GESU

Add: GESU shall conform/pass the NATO Rail Impact Test and NATO Road/Cross Country Vibration Test.

Add: GESU EMI and RF emissions standards shall meet current NATO standards. This provides additional protection against detection and EMP pulses, while still ensuring it does not adversely affect nearby users of the EM spectrum.

Add: GESU large metal exterior surfaces shall be coated with CARC. Any shiny or reflective surface shall have the ability to be covered. This is in case any large shields or enclosures is included. It is not required for small metal components, bolts, etc. when the remainder of the packaging is plastic or other materials.

Add: GESU plugs and sockets shall have military grade weather resistant covers (vice weather resistant covers).

Add: Wi-Fi, Bluetooth, and cellular diagnostics shall not be permitted for the GESU. This reduces the EM signature and provides protection against cyber-warfare/hacking.

5.4.4 Maintainability

As per white requirements unless modified below.

Nil.

5.4.5 Availability

As per white requirements unless modified below.

Nil.

5.4.6 Reliability

As per white requirements unless modified below.

GESU expected use is 26 weeks (4400 hours) equivalent per year.
Nil.

5.4.7 Environmental Sustainability

As per white requirements unless modified below.

Nil.

5.5 Distribution System (White/COTS)

5.5.1 General Requirements

Small generators and small ESU shall use extension cords. TPS shall provide by exception only since they are already widely found throughout the CAF.

This section covers distribution for larger generators (WGL and GGL) and ESU (WESUL, GESUL) where a three-phase modular distribution system is required.

Due to CSA safety accreditation and approvals, the distribution system shall only be able to accommodate North American voltages/frequencies. When Canada is generating power to nations using 50 Hz systems, the generators, ESU, and PMM remain compatible but those nations must supply their own distribution system components iaw their national safety authority.

The user requirement is access to power with sufficient receptacles to connect their equipment. When using HQSS equipment, the three-phase power demand may range from 15 kW to over 165 kW, often using more than one generator. It is very feasible that more than one HQSS system may be co-located, especially in a Brigade Administrative Area. For initial planning purposes, a micro-grid may have up to 400 kW (Based on a Brigade HQ of 165 kW plus two Unit HQ at 105 kW each in proximity). It is assumed situations requiring more than 400 kW will set up a second micro-grid to avoid excessive cable gauges. These values are flexible. If dropping the maximum power on a micro-grid to a slightly lower number will allow fewer varieties of cables and boxes, plus save significant weight (and costs), it shall be examined. Conversely, if more power can be accommodated without cost increases, it shall also be examined.

This poses a major challenge since one size of cable and distribution box cannot fit all requirements unless it is extraordinarily robust, heavy, significant overkill for most uses, and expensive. The refined concept is there will be a series of cables and distribution boxes which become progressively smaller until they terminate in (single phase) receptacles for users. This allows lower level distribution equipment to mate with lower level power sources. In some situations, step-down transformers may be required to allow longer runs at higher voltages with minimal losses.

This is the same concept as most distribution systems including the in-service Central Power Distribution System (CPDS), but names have been deliberately changed to avoid linking TPS deliverables to existing CPDS designs and products. This forces a fresh look at solutions vice simply re-issuing old specifications. Components may be compatible with CPDS where feasible; but it is not a requirement.

The distribution system shall be compatible with and carry signals to/from the PMM to allow control of devices within the micro-grid.

Distribution systems shall be packaged as standardized kits. More than one type of kit may be created to allow a better match to various generator sizes. It is expected that there will be one distribution kit designed for each type of of HQSS.

5.5.2 Operability

Cables

Cables have been designated the following nomenclature for explanation and initial planning/design purposes, but capacities or breakdown may change during definition. For planning purposes, cable ampacity decreases by a factor approximately three for most levels. In descending order of size:

Cable 400 series (C400). Shall carry three-phase power. May be directly hooked up with a pin and sleeve connector to generators/farms in the 100-400 kW range and used as a main power line within a camp. Largest and heaviest cables before moving to Camp Sustain assets or civilian power lines.

Cable 300 series (C300). Shall carry three-phase power. Can be directly hooked up with a pin and sleeve connector into generators/ESU in the 30-120 KW range but also used to continue distribution from higher power cables (C400) and boxes.

Cable 200 series (C200). Shall carry three-phase power. Could be directly hooked up with a pin and sleeve connector into generators/ESU in the 12-50 kW range, but also used to continue distribution from higher power cables (C300) and boxes.

Cable 100 series (C100). Shall carry three-phase power leading to the final boxes where users connect their equipment. Unlikely to be hooked directly into a generator. Lightest and smallest cable. Pin and sleeve connectors are desired, but if other connection types are more appropriate for the low ampacity/voltage, they will be considered.

Cables shall be available in multiple lengths. Expected lengths shall be long (25 m), medium (10 m), short (5 m), and very short (2.5 m). Not every cable may be available in every length.

Cables shall have quick-connect pin and sleeve connector fittings at each end. Fittings shall be designed to alert operators of mis-matched ampacity (colour, shape, etc.). Fittings should be designed to physically prevent under-ampacity connections.

Special cables and disconnects shall be included to allow connection into existing civilian power grids. Expected to be use very rarely and will require engineer assistance to connect but kept as a requirement for now. Allows the PMM to monitor and control whether local power or TPS power is used.

Cables shall remain flexible (1:5 bend ratio) to -40°C. It is desirable to be flexible at -50°C. No impact on function, but easier for operators to handle and connect in cold weather.

Box Sizes

Boxes are designated using the following terms for explanation and planning purposes but may change during definition. Ampacity shall match the corresponding cables.

Box 400 (B400) series. Shall be fed by C400 cables. Some B400 variants may include stepdown transformers.

Box 300 (B300) series. Shall be fed by C300 cables. Some B300 variants may include stepdown transformers.

Box 200 (B200) series. Shall be fed by C200 cables. Some variants may include receptacles which are heavier duty than the B100 series for things like welders, air compressors, clothes dryers, or similar military loads.

Box 100 (B100) series. Shall be fed by C100 cables. This is the smallest box and the terminus of the system; it has receptacles for users to connect equipment or civilian extension cords. This box needs to split the three-phase power into single phase (with the exception of a few specialty boxes mentioned below)

Box Features and Functions

B100 Termination Boxes. The B100 series shall come in several variants to provide flexibility for operations. They shall include a loop/hole for a carabiner or cord to allow hanging or positioning of the box in convenient locations (connected to beams, poles, trees, etc.).

B100 series include the following: It is expected at least 95% will be B110, B120, and B130.

- B110: At least three 120 V duplex outlets (six NEMA 5-15 or 5-20 receptacles) plus at least six USB charging ports. It shall also have transient spike suppression as numerous electronics will be connected to it. B110 is the only box that shall not be rated for exterior use. This is to simplify issues within a headquarters or accommodations structure, where weatherproof covers become bothersome (and unnecessary), and numerous users are regularly plugging in adapters and small USB devices;
- B120: At least three 120 V duplex outlets (six NEMA 5-15 or 5-20 receptacles) plus at least three USB charging ports;
- B130: At least three 120 V duplex outlets (six NEMA 5-15 or 5-20 receptacles) with GFCI;
- B140: Converter/receptacle for systems requiring 24-28 V DC;
- B150: (Future) One receptacle (type tbd) for single-phase 240 V loads;
- B160: (Future) One receptacle (type tbd) for three-phase motors. Will normally require an Engr to create/connect an adapter in theatre; and
- B1XX (Future) Other future needs (inductive recharging centres, marine power, hazardous environments, small aircraft APU, etc.).

Normal Distribution Box (Various sizes except B100). This is the most common style of box with the expectation it will have one pin and sleeve connector input, two same size outputs, and a minimum of three smaller outputs. Fed from a generator/ESU or higher-level distribution box; allows ring or spine to continue, plus connecting to smaller scale cables.

Transformer Box (C400 and C300 inputs). Shall accept higher series cables (to minimize transmission losses) and then step down to connect to C100 and/or C200 as output.

Other boxes may be identified throughout definition.

The base of all boxes shall stand clear of the ground to prevent water, sand, etc. from entering or covering it. It is desirable to have folding or retractable legs to accomplish this. Boxes shall not tip over in windy conditions. This also makes them more visible to pedestrians and vehicles.

Smart Boxes and PMM Linkage. Some boxes shall include the ability to be controlled by signals from the PMM. Ideally, all boxes would have this feature, but realistically (for cost-savings) having this capability on B400 and B300 boxes (tbd) is expected to be sufficient.

Should no PMM be attached to the system, the boxes shall revert to 'dumb' mode and simply carry power between the connections. Boxes without the PMM linkage shall always be considered 'dumb'.

When the PMM is connected, it shall have the ability to turn on/off smart boxes to control what lower circuits receive power. This includes measurement of operating parameters (specifically the current on each leg).

Smart boxes shall have a weatherproof means to insert a temporary identifier (index card, etc.) to allow the operator to visually identify it without needing the PMM or other reader. Since all boxes look identical to humans, this allows operators to label a box as Box #X, Kitchen, Ops Tent, etc. to aid in identifying a specific box and input/outputs

Support Equipment.

Grounding rods/plates/wires and installation/removal tools shall be included at an appropriate scale. This is in addition to the rods/plates/wires supplied with generators.

Cable and box sets shall be complete with appropriate storage device to protect cables from the environment and damage when not in use. This could be a sea-can (including bi-con and quad-con variants), a tri-wall, specifically designed cabinet, etc.

The storage device shall be designed to allow easy identification and storage of cables and boxes for personnel during set-up and tear-down.

The long variants of C400 and C300 shall come with an integral spool/roll to store it securely and neatly.

The spools shall fit interchangeably onto a (human-powered) cable-cart to allow easier transport and laying and recovery of heavy cables over longer distances. A simple shop-cart or heavy-duty garden wagon is envisioned; there is no requirement to design a specialized cart, but it is permitted.

Heavy duty cable protectors shall be provided to permit vehicles to drive over cables safely. They shall be a high visibility colour. Quantity and size tbd during definition. In a tactical setting, they can be covered with earth or simply not used.

HMI

The operator interface is extremely limited and consists of inserting or removing cables into boxes, resetting circuit breakers, and looking at the display to ensure power is present. Indicators and controls have already been covered above.

User acceptance is not expected to be an issue as distribution shall be very similar to the current system.

5.5.3 Survivability

Most aspects are covered under 5.5.2

Distribution System emissions shall comply with applicable Industry Canada, FCC, and NATO emission standards. Though largely wire and boxes, there is a minor amount of electronics such as the power/voltage indicator and switching gear to control loads.

If metal boxes are used, they shall be painted using olive drab or desert tan paint. Any shiny or reflective surface shall have the ability to be covered.

Boxes shall pass the NATO Road/Cross Country Vibration Test Mil Std 810E.

5.5.4 Maintainability

See section 4.4.

Distribution system routine operator inspections and maintenance shall be no more than 15 minutes, 95% of the time.

Distribution system scheduled first line maintenance shall take no more than 30 minutes, 95% of the time.

Distribution system unscheduled first line maintenance shall take no more than one hour, 95% of the time.

There shall be appropriately sized circuit-tester plugs which connect to the outputs of distribution boxes. These testers shall confirm the voltage(s) polarity/wiring without needing to use a multimeter. this is for operators to quickly locate/troubleshoot most distribution system issues prior to the arrival of maintainers to correct the fault/repair equipment. Similar to a household circuit tester or automotive trailer connector tester.

5.5.5 Availability

See section 4.5.

Availability of the distribution system shall be at least 0.98.

5.5.6 Reliability

See section 4.6.

It is expected the distribution system shall have a MTBF of at least 5 000 hours.

Expected use is at least 26 weeks (4400 hours) per year.

5.5.9 Safety and Health

See section 4.9 for general requirements and 5.5.2 as many safety factors are also operability requirements.

Each box shall have indicator lights or a digital display on the incoming line to show when power is present and what voltage it is.

Each box shall have an appropriately sized circuit breaker for each output connection.

B400 to B200 access covers (if used) shall have locking hasps to allow padlocking for safety and to prevent unauthorized access. B100 series may be sealed with screws or bolts in lieu of hasps and locks if the circuit breakers are protected from the elements.

Distribution storage cases requiring more than one person to move shall be fitted with removable wheels to assist in movement over floors or hard-packed surfaces.

5.6 Distribution System (Green/MOTS)

5.6.1 General Requirements

As per white requirements unless modified below.

Nil.

5.6.2 Operability

As per white requirements unless modified below.

Nil.

5.6.3 Survivability

As per white requirements unless modified below.

There is no requirement to use CARC paints on the distribution system components. Most materials are expected to be non-metallic and no operational advantages are expected despite adding cost, complexity, and limiting suppliers.

5.6.4 Maintainability

As per white requirements unless modified below.

Nil

5.6.5 Availability

As per white requirements unless modified below.

Nil.

5.6.6 Reliability

As per white requirements unless modified below.

Nil.

5.7 PMM (White/COTS)

5.7.1 General Requirements

At this time, there is no expectation two different fleets (white and green) of PMM are needed, therefore, the singular acronym PMM is used, vice WPMM and GPMM designators. Should this change during definition, the SOR will be adjusted accordingly.

The PMM is the brain behind the micro-grid, which is an assortment of power sources (generators and ESU), distribution system, and various loads. It controls which power sources are active at any given time and can turn off selected loads within the distribution system. Its primarily focus is to increase efficiencies by reducing fuel consumption, but also has benefits for safety and maintenance as unsafe or irregular operating parameters can be identified rapidly and shut down or corrected before an incident occurs.

The PMM acts as the interface to the human operator who monitors and controls the system. For systems with a few generators and relatively constant loads, the operator may choose to simply synchronize them directly without PMM, or to use the PMM. However, PMM provides additional information and control of the system, and the larger the system becomes, the higher the benefit.

The PMM shall be based on a software/microprocessor system. There is no preference between using a DND computer (normally a ruggedized laptop) or manufacturer designed control panel (or both).

The PMM shall use the power conductors as a carrier for control signals (in lieu of duplicating the distribution system layout for control cables).

The PMM shall be designed to control a three-phase system. One PMM shall only control one frequency (50 or 60 Hz) at any given time. If both are desired simultaneously, a second micro-grid is required.

The PMM shall also be able to control DC components capable of outputting AC waveforms (ESU or similar sources). This is to allow expansion to other storage mediums (renewables, etc.) should DND wish to acquire them in the future.

It should be expandable to control either a DC-only or a single-phase AC microgrid in the future should DND wish to acquire that capability. A DC-only microgrid could occur if significant renewable energy systems and ESU are used in the future. A single-phase AC microgrid is extremely unlikely but mentioned to allow commonality of PMM software should it occur.

5.7.2 Operability

Functions

The PMM shall include (but is not limited to) the following functions:

Load prioritization. In cases where not enough power exists, loads shall be shed by turning off various distribution boxes until it returns to within generator/ESU capacity.

Phase balancing. If loads are not balanced between the three phases, the condition shall be indicated to the operator to allow manual intervention. It is desired that the PMM will be able to automatically balance the system (with man-in-the-loop acknowledgement before action is taken).

Load transfer. One generator (or set of generators) is designated the main power source, and another as backup. If the main system fails, the backup system shall come on line.

Paralleling of two or more WGL or GGL. This shall allow the second and subsequent power sources to be manually or automatically started/connected to the grid, at pre-set thresholds. If variable speed generators are used, it shall also control the output.

Paralleling of two or more WGL or GGL with addition of WESUL or GESUL. Similar to above, but the ESU will absorb initial demands, allowing the second (or subsequent) generator to remain off for longer periods. If certain parameters are exceeded the PMM shall instruct the second (or subsequent) generator to start and contribute. When the load drops below the threshold, the second or subsequent generator shall shut down and let the other generator re-assume the load.

Sequential start-up and shutdown. The PMM shall allow a gradual start-up and shut down of micro-grid components and loads.

Load Prediction. The PMM shall have the capability to predict loading based on previous history of that specific micro-grid and adjust operating parameters as required.

Health Status Monitoring. The PMM shall display the health of all generators, ESU, and distribution boxes. It shall alert the operator to abnormal conditions for investigation or correction. This includes the option to automatically shut down components.

Training. The PMM shall be able to be used in training mode to create, operate, and troubleshoot various micro-grids. This includes connection or downloads of instructor generated systems and scenarios where the instructor can program or inject faults or improper operating conditions and then observe and obtain history on how the student responded.

Demonstration. There should be a demonstration mode(s) with an artificial grid (no connection to any real components) which can be used to help reinforce training and provide a limited awareness of the TPS capability to non-operators (including other troops, commanders, allies, industry, media, and dog and pony events).

Training and Demonstration modes shall have a clear means of differentiating those modes from real-life programming, operations, and fault-finding. Expectation is far more than just an icon or the word 'training' at the top of the screen. It could be different screen colours and fonts, a large border around the screen, etc. There must be a clear way to exit these modes back to reality.

Linkages

The PMM shall receive data from the following: WGL, GGL, WESUL, GESUL, and smart distribution boxes. It is desirable to receive data from WESUS and GESUS.

The PMM should also be able to receive data from an external grid used to feed the micro-grid. This is for when a host-nation has power which is somewhat dependable, but still requires a TPS back-up. It allows monitoring of the civilian grid connection, and then a start-up of TPS assets when it fails. When power is restored, the ESUs recharge and the TPS generators are shut down.

The PMM shall be capable of sending signals to control most operations and output of WGL, GGL, WESUL, GESUL, and selected distribution boxes. It is desirable to send control signals to WESUS and GESUS.

The PMM software and firmware shall be able to download diagnostics and strip-records by a removable (type tbd) memory device or connection to a computer. There shall be no Wi-Fi, Bluetooth, or cellular connections. The same connection shall be used to allow upgrades to software and firmware.

Controller and HMI

The PMM shall have an internal power source/battery for diagnostics memory and operator programming of proposed systems without requiring a connection to a live system.

During operation, the PMM shall connect at any point in the system to either 60 Hz 120 V or 50 Hz 240 V to read or feed control signals into the micro-grid and obtain additional power.

It is desirable to have more than one PMM access point (for a slave connection) to assist with monitoring larger micro-grids. This remote connection does not require access to memory/stored information from the master, only to real-time readings and controls. This allow the master to remain in one location running the system, yet the operator can move and read or /control devices elsewhere.

The PMM shall detect all component IDs upon connection to a micro-grid.

The PMM shall detect when other components are added/removed from the system and notify the operator.

The PMM shall allow the operator to temporarily nick-name the incoming device IDs in the vernacular (e.g. C-Coy generator, B400 Nord, B200 Laundry, etc.).

The PMM HMI shall allow the operator to organize and link the detected components to create a schematic of the system. Ideally, it will be able to create the schematic itself.

The PMM should allow the operator to create a physical representation of the system. This provides an easily understandable depiction of what is where in real life, vice a schematic focused on the flow of power in an easy to read format.

The PMM shall store at least three different micro-grids to minimize setup/programming after each move. The PMM should allow an operator to program many details of the system before connection.

The incoming data shall include device ID, type of device, and various status indicators about the device itself as well as information about the power from/into it (by phase). This shall include (but is not limited to): on/off, plus engine and ESU parameters from other sections, current, voltage, frequency, power produced, and actual power load/demand.

PMM faults or warnings shall be visibly and audibly overlaid to the appropriate equipment icon. Other screens or sub-menus shall allow further investigation.

The PMM HMI shall have a history screen which can display recent operating parameters and history.

The PMM HMI shall have a screen to allow the creation of strip-records (sample rate, desired parameters, etc.). This screen is used prior to gathering the data so it is available. Other screens will manage the data after it has been collected.

Help. There shall be a help function to assist operators with the features and controls of the PMM should they forget how to utilize the system.

5.7.3 Survivability

PMM modules shall be protected from weather to allow outdoor operation. All plugs and sockets shall have weather resistant covers. PMM hardware shall meet environmental requirements of section 4.3.

PMM electromagnetic emissions shall comply with applicable Industry Canada, FCC, and NATO emission standards.

PMM colours to be olive drab, with potential of some desert tan variants.

Cyber-resilience of equipment is still in the early stages within the CAF and is currently being developed by the Land Cyber-Mission Task Force and other organizations. TPS will examine the potential to implement some draft processes and safeguards through the definition and implementation phases to assist the TF. This includes the PMM.

Once PMM is fielded, cyber-security shall incorporate SOP and TTPs such as limiting data entry points and control of user privileges. Wi-Fi, Bluetooth, or cellular diagnostics are not permitted for the PMM.

PMM modules (if not DND laptops) shall pass the NATO Road/Cross Country Vibration Test Mil Std 810E.

Should the PMM fail for whatever reason, the micro-grid shall revert to a fail-safe state, where generators shall be isolated from the distribution system and shut down. ESU shall continue to provide power and distribution boxes shall revert to 'dumb' status. This protects the generators, but still allows limited power into the system to continue operations. At that time, SOPs/TTPs would take over to shut down unnecessary loads and maximize ESU run-time while trouble-shooting and corrective action commence.

5.7.4. Maintainability

See section 4.4.

DND shall have little to no maintainability of the PMM itself other than conducting updates to software and firmware. If required, routine operator inspections and maintenance shall be 3 minutes or less.

No first line maintenance is anticipated for the PMM. All repairs shall be executed under the In-Service Support contract that will be established.

There shall be a maintenance module/screen designed for maintenance staff (vice operators) which provides additional depth of operating parameters, faults, and diagnostics, including strip-records of the generators, ESU, and distribution components. While this is technically for other components, because it is obtained via the PMM, it is included here.

The PMM shall be designed with enough flexibility that changes (including software/firmware updates) in generators, ESU, or renewable components from other manufacturers can be incorporated with minimal software upgrades/conversions. Ideally, there will be no conversions required; it will be brand agnostic.

5.7.5 Availability

See section 4.5.

PMM availability shall be at least 0.999.

5.7.6 Reliability

See section 4.6.
It is expected the PMM shall have a MTBF of at least 5 000 hours.

Expected use is at least 26 weeks (4400 hours) per year. Matches to distribution system.

5.7.9 Safety and Health

See section 4.9

While there are no safety issues of the PMM itself, it shall be used to help identify safety issues within the system that could create problems such as under/over-voltage, poor synchronization, intermittent connections, abnormal engine conditions (low oil, high temperature, etc.).

5.8 PMM (Green/MOTS)

There is not expected to be any difference between the white and green fleets for PMM, but this section is being kept as a placeholder during definition.

5.8.1 General Requirements

As per white requirements unless modified below.

Nil.

5.8.2 Operability

As per white requirements unless modified below.

Nil.

5.8.3 Survivability

As per white requirements unless modified below.

Nil.

5.8.4 Maintainability

As per white requirements unless modified below.

Nil.

5.8.5 Availability

As per white requirements unless modified below.

Nil.

5.8.6 Reliability

As per white requirements unless modified below.

Nil.

5.8.7 Environmental Sustainability

As per white requirements unless modified below.

Nil.

5.9 Containers, Pallets, Skids, and Trailers (White/COTS)

5.9.1 General Requirements

Containers, pallets, skids, and trailer requirements will be written in more detail once more detailed quantities and characteristics of the equipment are known during definition. This section is currently used as a placeholder to capture early requirements.

<u>Smaller Equipment</u>

Smaller equipment is expected to be carried or towed by virtually every land based vehicle in the CAF including MSVS, LVM(H), LVM(L), TAPV, LAV (and similar families), plus lighter vehicles such as the MOSV, LUV, civilian pickup-trucks and vans, and on occasion, snowmobiles (LOSV), quadrunners, and even pack-animals and by hand. Certain components may also be moved by helicopter or plane, or various ships and tenders.

Given the expected size and weights of small equipment, no requirements for specialized containers, pallets, skids, or trailers are planned. Instead, Section 4 ‘Fit for purpose’ shall be used to qualitatively judge any products.

Larger Equipment

Larger equipment is expected to be carried (or towed) by the MSVS (SMP and MILCOTS), LVM(H) and possibly the LVM(L).
All containers, pallets, skids, and trailers shall be of appropriate design to maintain stability and operational capability while transporting their maximum loads within the operating parameters of the prime movers. this includes factors such as centre of gravity, etc.

The primary means of moving and storing the large equipment shall be by sea-containers and/or ground-droppable pallets. Containers will allow equipment to be carried and shipped in the same manner as the HQSS module easing deployability/accountability of assets.

Notwithstanding the above, some generators shall come with integral skids or trailers, so supporting components shall need to be carried by other means.

5.9.2 Operability

Containers

The standard packaging for TPS HQSS components is desired to be a bi-con (10' ISO container). This allows the required mixture of generators, ESU, and distribution systems to be stored together. Most HQSS configurations require a mixture of at least two generators, an ESU, plus distribution components. A full 20' ISO container is also acceptable however it may occupy more space than required for most uses and requires larger equipment to handle. If a volumetric analysis demonstrates a bi-con is too small, this will be re-evaluated to a larger size.

The container shall be designed so that two can be connected together and handled as a regular sea-container for intermodal shipping purposes. This also requires that any protrusions, fittings, and brackets shall be easily removed.

ISO Container height shall be such that it can be carried by all prime movers on a pallet without causing damages to overpasses, bridges, and other road features.

The container shall be designed so that when two are connected together, each one may still be separately accessed and operated/maintained.

Containers shall have an appropriate-sized door(s) to allow operators/maintainers to enter/exit the container and to allow the removal/installation of equipment. This does not preclude the option of having the HMI accessible/operable from the exterior of the container.

Containers shall have appropriate openings for engine air-intake, exhaust, refuelling, and power connections without requiring man-doors to be kept open.

Containers shall have appropriate openings to allow ventilation/cooling of the container so operators/maintainers may work inside it.

Containers shall include LED lighting (white and red) to allow work inside the container. Lighting shall be operable when the generator is not running.

Containers shall be fitted for, but not with a fuel tank to allow longer generator run-times.

Pallets

Pallets dimensions and configuration shall be compatible with the pallet loading system for the associated vehicle including height restrictions. It shall also be compatible with the aircraft pallets for C130 and C17 aircraft.

Smaller pallets (under 20’ deck) shall have TPS equipment semi-permanently attached. Semi-permanent still allows maintainers to remove the equipment, or if operational requirements dictate, to break up the generator combination, but normally remains attached to the pallet.

Larger pallets (20’ deck and above) shall be designed to accept two bi-cons of equipment. This allows each bi-con to be moved independently once on the ground for better layout and to assist with dispersion of assets.

Larger pallets (20’ deck and above) may also be designed to allow equipment to be directly mounted to the pallet without an ISO container. This is not the preferred option as it creates non-standardized shipping sizes but does serve to reduce overall height for road transport.

The generators (and ESU when applicable) shall be capable of operating from the pallet at ground level and should be capable of operating when the pallet is mounted on the prime mover. They shall have sufficient clear area for operators and maintainers to perform their duties.

Skids

Skids shall be available for generators, ESUs, and distribution systems. It is desirable more than one component can be mounted and packaged on the same skid.

Generators and ESU shall have the ability to be removed from the skid for maintenance reasons using common hand tools (not expected to occur often).

Skid dimensions shall be a uniform size to allow ease of handling and shipping.

The skids shall be attachable to the trailer system.

Skids shall have forklift pockets in all four directions. Pockets shall remain accessible if the ground compresses 50 mm. 50 mm was chosen as 'reasonable' amount of settlement in most soils/ice/snow for heavy loads over a period of a week but could be changed. Normally wooden packing would be placed under the skid to prevent excessive settlement.

Skids shall have lifting point attachments for cables to allow movement by a crane, hoist, HIAB, or other similar equipment. While not a requirement to move by helicopter, this may allow some components to be slung thus providing additional capability.

Trailers

The preferred approach is to have a bare trailer frame, which allows the skid(s) of TPS equipment to be attached/interchanged on it. This allows rapid exchange of packages between different prime movers and allows use of the equipment if/when a trailer is non-serviceable by moving it to a different trailer frame. This shall be examined during definition, though the approach may be unaffordable with the current budget.

Trailers axle widths and tire sizes should match the prime mover. This may necessitate more than one trailer type.

Trailer tongues shall accept different inserts to allow connection to various civilian and military prime movers. This includes different heights and couplers (balls, pintles, etc.).

Trailer tongues shall have a jack system for levelling and connecting to prime movers. It shall be manually operated but is desirable to have an electric motor feature.

Trailer electrical systems shall include the ability to connect and operate with both 12 V civilian and 24 V military vehicle systems. This provides more flexibility to transport equipment with leased vehicles, as well as for OEM pickup/return.

5.9.3 Survivability

See section 4.3.

Containers

Containers shall have appropriate locations to store camouflage nets.

A short removable yardarm shall attach to the top connectors to allow stand-off distance for camouflage nets. ASUWPS SOW has details of this feature on its quad-cons so netting does not interfere with access panels and operator tasks.

Pallets

Nil.

Skids

Nil.

Trailers

Nil.

5.9.4 Maintainability

See section 4.4.

Routine operator inspections and maintenance shall be no more than 15 minutes, 95% of the time.

Scheduled first line maintenance shall take no more than 30 minutes, 95% of the time.

Unscheduled first line maintenance shall take no more than two hours, 95% of the time.

5.9.5 Availability

See section 4.5.

Container, pallet, and skid availability shall be at least 0.999.

Trailer availability shall be at least 0.95.

5.9.6 Reliability

See section 4.6.

Expected use is 26 weeks (4400 hours) equivalent per year.

MTBF to be determined during definition

<u>Containers</u>

Weights and dimensions shall be within maximum allowable capacity and distributions for the appropriate prime mover.

Containers shall come equipped with a fire extinguisher and/or blanket appropriate for the generator/ESU.

Containers shall include space for an appropriate spill kit for the generator. Current spill kits shall be re-used as old generators are replaced.

<u>Pallets</u>

As per containers.

<u>Skids</u>

Nil.

<u>Trailers</u>

Trailers shall be designed to match the performance specifications (roll-over angle, fording, air brake connections, lighting system, etc.) of the appropriate prime mover.

Trailers shall have storage/attachment points for wheel chocks, appropriate fire extinguisher, grounding rods/plates and installation/extraction tools, spill kit, and other accessories which may be determined.

Trailers shall be designed to prevent accidental roll-away (expected to be safety jacks and/or handbrakes, but other options may be feasible).

5.10 Containers, Pallets, Skids, and Trailers (Green/MOTS)

5.10.1 General Requirements

As per white requirements unless modified below.

Nil.

5.10.2 Operability

As per white requirements unless modified below.

Containers

Nil.

Pallets

Nil.

Skids

Nil.

Trailers

Add: Trailer axle widths and tire sizes shall match the size of the most common prime mover (vice ‘should match’ for the white fleet).

5.10.3 Survivability

As per white requirements unless modified below.

Add: Exterior coating for containers, skids, trailers, and other exposed metal surfaces shall be coated with Chemical Agent Resistant Coating (CARC). Any shiny or reflective surface shall have the ability to be covered.

5.10.4 Maintainability

As per white requirements unless modified below.

Nil.

5.10.5 Availability

As per white requirements unless modified below.

Nil.

5.10.6 Reliability

As per white requirements unless modified below.

Nil.

ACRONYMS & ABBREVIATIONS

Acronym/ Abbreviation	Description
AC	Alternating Current
ADM(Fin)	Associate Deputy Minister (Finance)
ADM(IE)	Associate Deputy Minister (Infrastructure and Environment)
ADM(Mat)	Assistant Deputy Minister (Materiel)
ADO	Adaptive Dispersed Operations
AEPI	Army Environmental Policy Institute
AHP	Analytical Hierarchy Process
ASSET	Advanced Sustainable Secure Energy Technologies
BCA	Business Case Analysis
C4ISR	Command, Control, Communications, Computer, Intelligence, Surveillance and
CA	Canadian Army
CAF	Canadian Armed Forces (Regular and Reserve Force)
CANSOFCOM	Canadian Special Operations Forces Command
CBP	Capability Based Planning

Acronym/ Abbreviation	Description
CIF	Capital Investment Fund
CISOE	Construction in Support of Equipment
CJOC	Canadian Joint Operations Command
COTS	Commercial Off-The-Shelf
CPDS	Central Power Distribution System
CSA	Canadian Standards Organization
CM	Conventional Munitions
DC	Direct Current
DEES	Defence Energy and Environment Strategy
DLFD	Directorate of Land Force Development
DND	Department of National Defence
DOMOP	Domestic Operation
DRDC	Defence Research and Development Canada
EMI	Electromagnetic Interference
ESU	Energy Storage Unit
EW	Electronic Warfare
FOB	Forward Operating Base
FOC	Full Operational Capability
FMV	Fair Market Value
GDS	Green Fleet Distribution System
GESU	Green Fleet Energy Storage Unit
GG	Green Fleet Generator
GOC	Government of Canada
HLMR	High Level Mandatory Requirement
HQSS	Headquarter and Shelter System
ILS	Integrated Logistic Support
IOC	Initial Operational Capability
IP	Intellectual Property

Acronym/ Abbreviation	Description
ICT	Initial Cadre Training
ISED	Department of Innovation, Science and Economic Development
ILS	Integrated Logistics Support
IOC	Initial Operational Capability
ISS	In-Service Support
ITB	Industrial and Technological Benefits
kW	Kilowatt
LCMM	Life Cycle Materiel Management
LOI	Letter of Interest
LVM	Logistics Vehicle Modernization
MND	Minister of National Defence
MOTS	Military Off-The-Shelf
MSVS	Medium Support Vehicle System
MTBF	Mean Time Between Failures
MTTF (or MTTR)	Mean Time to Fix (Repair)
NATO	North American Treaty Organization
NRCan	Natural Resources Canada
O&M	Operations and Maintenance
OEM	Original Equipment Manufacturer
OLA	Official Languages Act
PMM	Power Management Module
PSPC	Public Service and Procurement Canada
R&O	Repair and Overhaul
RCAF	Royal Canadian Air Force
RCEME	Royal Canadian Electrical Mechanical Engineers
RCN	Royal Canadian Navy
RFI	Request For Information

Acronym/ Abbreviation	Description
RMC	Royal Military College of Canada
ROM	Rough Order of Magnitude
SBCA	Sustainment Business Case Analysis
SCD	Strategic Context Document
SOP	Standard Operating Procedure
SSE	Strong, Secure, Engaged
STANAG	NATO definition - Standardization Agreement
TPS	Tactical Power Systems
USMC	United States Marine Corps
VCDS	Vice Chief of Defence Staff
WDS	White Fleet Distribution System
WESU	White Fleet Energy Storage Unit
WG	White Fleet Generator