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Performance Specification for a Defense and Disaster Deployable Turbine (D3T) Based in a 20ft Container

EE-4W Wind Energy Technology Office
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NOTE: This document was created to be a comprehensive procurement specification template for a deployable turbine system. It was designed to be adaptable for turbines of all sizes and transportable by various methods. Covered in this document are possible regulations that could apply to the system, power generation and control specifications, physical dimension requirements, and details on the commissioning procedure. As a result, this document might contain specifications that do not apply to a particular acquisition and should be omitted from the procurement specification.

Remove all bracketed text areas along with any requirements that are not necessary for the procurement.

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1. SCOPE

1.1 Scope. This performance specification template covers the requirements for a Defense and Disaster Deployable Turbine (D3T) that is housed in a 20ft container. All requirements listed are suggestive based on common Department of Defense (DoD) standards and test operation procedures. The procurer should verify that the suggestive requirements match their system requirements.

1.2 Requirement Levels. This specification lists multiple values for certain performance parameters. Threshold (T) is the minimum acceptable level. The objective (O) is the desired level at which performance of the D3T results in an operationally significant increase in capabilities. When only one requirement is stated, it is the threshold requirement.

2. APPLICABLE DOCUMENTS

2.1 General. Sections 3 and 4 of this procurement list the requirements and verifications for the deployable wind turbine, respectfully. Section 2 list all known specified requirements that pertain to the deployable turbine. Section 3 list the performance requirements for the turbine. Section 4 contains the verification of the performance requirements and a checklist for completion and verification. Appendix A lists definitions for terms used in the document.

2.2 Regulations

2.2.1 Government Specifications, Standards, and Handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

Department of Defense Standards

AMERICAN WIND ENERGY ASSOCIATION

AWEA SWT-1	(2016) Small Wind Turbine Standard

ASTM INTERNATIONAL (ASTM)

ASTM D 3591	Standard Practice for Commercial Packaging

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 1547	(2018) Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 61400	Wind Turbine Standard

MILITARY STANDARDS

ATP 4-12	Army Container Operations
FM 55-17	(1991) Army Cargo Specialists' Handbook
MIL-STD-129R-CHG-2	Department of Defense Standard Practice: Military Marking for Shipment and Storage
MIL-STD-130N	Department of Defense Standard Practice: Identification Marking of U.S. Military Property
MIL-STD-209K	Department of Defense Interface Standard for Lifting and Tie Down Provisions
MIL-STD-461G	Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment
MIL-STD-705D	Military Standard Generator Set
MIL-STD-810H	Environmental Engineering Considerations and Laboratory Testing
MIL-STD-889C	Department of Defense Standard Practice: Dissimilar Metals

MIL-STD-913A	Requirements for the Certification of Sling Loaded Military Equipment for External Transportation by Department of Defense Helicopters
MIL-STD-1332B	Military Standard: Definitions of Tactical, Prime, Precise, and Utility Terminologies for Classification of the DoD Mobile Electric Power Engine Generator Set Family
MIL-STD-1366E	Department of Defense: Interface Standard for Transportability Criteria
MIL-STD-1472G	Department of Defense Design Criteria Standard: Human Engineering
MIL-STD-1474E	Department of Defense Design Criteria Standard: Noise Limits
MIL-STD-1791C	Department of Defense Interface Standard: Designing for Internal Aerial Delivery in Fixed Wing Aircraft
MIL-STD-7179B	Department of Defense Standard Practice: Finishes, Coatings, and Sealants, for the Protection of Aerospace Weapons Systems
MIS-STD-1275E	Department of Defense Interface Standard: Characteristics of 28 Volt DC Input Power to Utilization Equipment in Military Vehicles
MIL-HDBK-729	Military Handbook: Corrosion and Corrosion Prevention Metals
MIL-PRF-32565B	Performance Specification: Battery, Rechargeable, Sealed, 6T Lithium-Ion
AFIM 24-204	(2018) Air Force Interservice: Preparing Hazardous Materials for Military Air Shipments

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2018) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code
NFPA 70E	(2018; TIA 18-1; TIA 81-2) Standard for Electrical Safety in the Workplace

UNDERWRITERS LABORATORIES (UL)

UL 1741	(2010; Reprint Jan 2015) UL Standard for Safety Inverters, Converters, Controllers, and Interconnection System Equipment for Use with Distributed Energy Resources

2.3 Order of Precedence. All requirements must be held to all applicable laws and regulations. If there is a conflict with a requirement and a law, standard, or regulations, document the conflict and report to the purchaser.

3. REQUIREMENTS

3.1 System Overview

The goal of this performance specification is to maximize the power generation while restricting the deployability to a 20ft shipping container. The container can be modified within the scope of the specification. The wind turbine can be mechanically attached to the container, or it should be able to fit inside a standard 20ft container.

The 20ft container was selected because this is largest standard unit that the U.S Military can rapidly ship. A single M1120 HEMTT truck can load, transport, an offload a 20ft container through rugged terrain with a crew of two. Containers larger than 20ft require less maneuverable vehicles, better roads, a secondary vehicle to offload the container, and a larger crew. The 20ft containers can also be transported by various helicopters and fixed wing aircraft to make it more deployable.

For power generation, the D3T shall contain a wind turbine generator, power inverters, energy storage, a control system, a human-machine interface (HMI), and military standard power connectors.

3.2 Performance Requirements

3.2.1 Interfacing. All components in the D3T package shall interface electrically. This includes the wind turbine, any other power generation or energy storage included, the control system, and Human Machine Interface (HMI).

3.2.2 Power Output. The wind turbine should come with a power curve that shows the turbines capabilities at various wind speeds.

3.2.2.1 Wind Turbine Generator Rating. The D3T should utilized the largest wind turbine possible, while still meeting the 20ft container requirement.

3.2.2.2 Energy Storage Capacity. The D3T shall have energy storage output capacity equal to that of the turbine rating that is capable of providing power to the load for at least four hours.

3.2.3 AC Power Quality. The D3T shall meet the Power Quality and Efficiency Testing of Tactical Hybrid Power Sources Test Operating Procedure (TOP) 09-2-290. The D3T must maintain the limits defined in the table for frequency, voltage, and power output. Figures 1 and 2 show the performance boundaries that voltage and frequency shall remain within. Table 1 shows the test procedure. Table 2 shows the allowable results. The turbine shall meet Hybrid Utility Class 2A-H requirements.

3.2.3.1 Regulation and Stability. The D3T system shall operate within the boundaries for frequency and voltage shown in Figure 1.

3.2.3.2 Transient Response. The D3T system shall operate within the boundaries for frequency and voltage shown in Figure 1.

3.2.3.3 Long-term Stability. The D3T system shall operate within the boundaries for frequency and voltage shown in Figure 1.

3.2.3.4 Source Switching. The D3T system shall operate within the boundaries for frequency and voltage shown in Figure 1.

3.2.3.5 Frequency Range. The D3T system shall operate within the boundaries for frequency and voltage shown in Figure 1.

3.2.3.6 Waveform Characteristics. The D3T system shall operate within the boundaries for frequency and voltage shown in Figure 1.

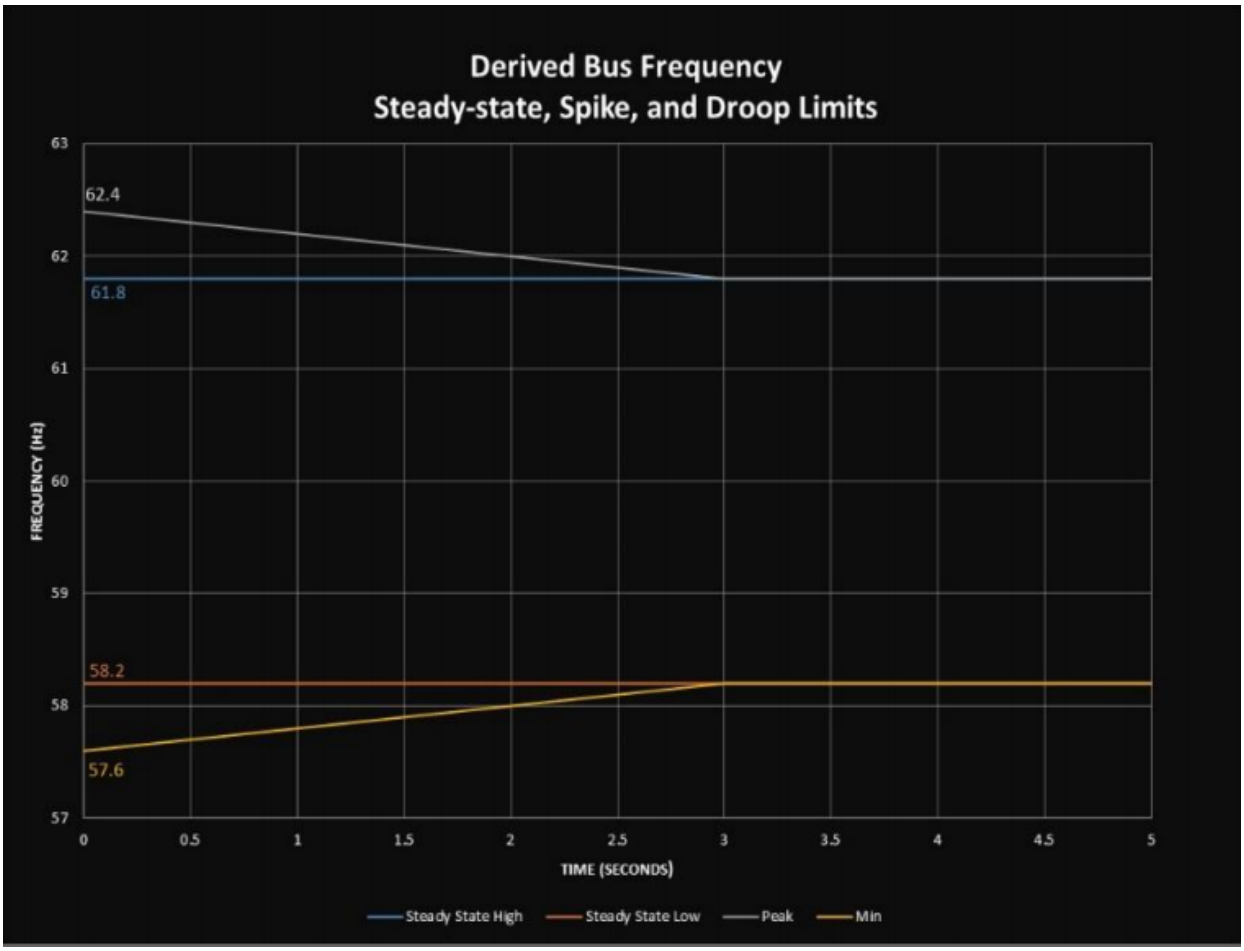

Figure 1. Voltage steady-state, dip, and rise envelope.

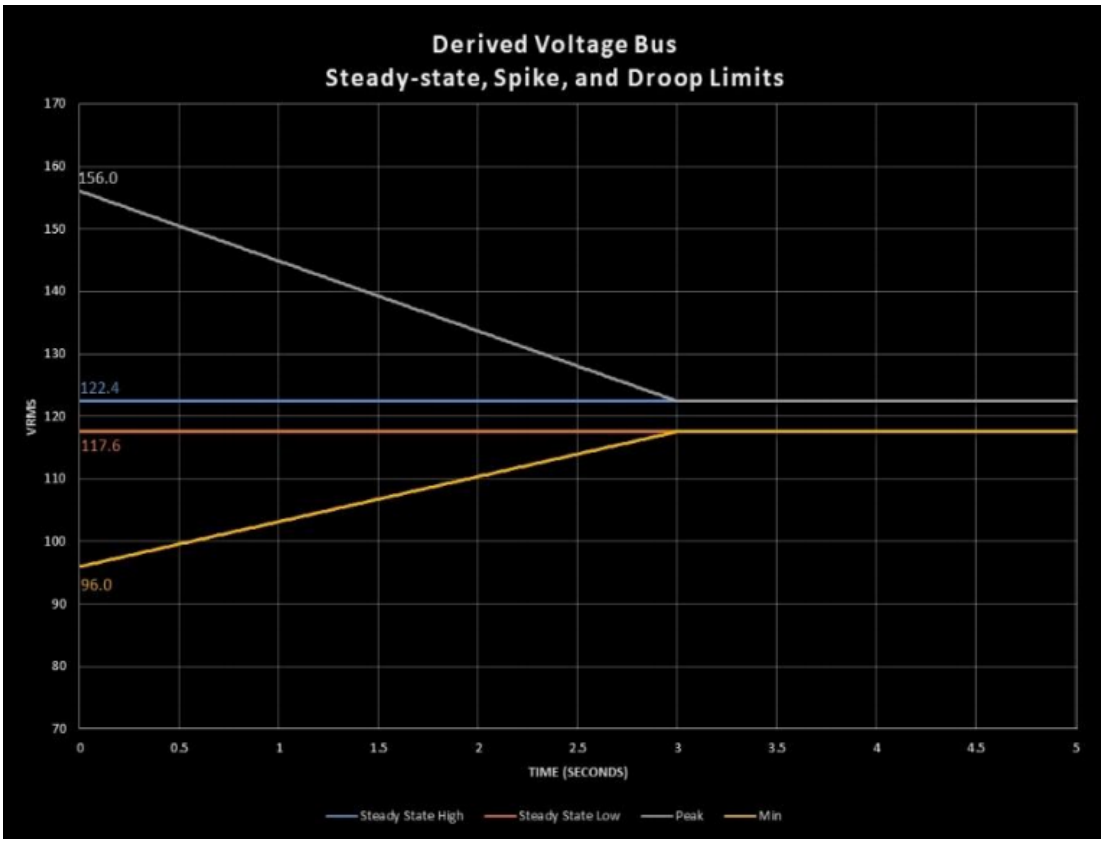

Figure 2. Frequency steady-state, undershoot, and overshoot envelope.

Table 1. Load conditions for regulation and stability and transient response test.

STEP NO.	LOAD CONDITION	STEP NO.	LOAD CONDITION	STEP NO.	LOAD CONDITION
1	RL to No Load (NL)	11	75% to NL	21	25% to NL
2	NL to RL	12	NL to 75%	22	NL to 25%
3	RL to NL	13[a]	50% to NL	23	25% to NL
4	NL to RL	14	NL to 50%	24	NL to 25%
5	RL to NL	15	50% to NL	25[a]	RL to NL
6	NL to RL	16	NL to 50%	26	NL to RL
7[a]	75% to NL	17	50% to NL	27	RL to NL
8	NL to 75%	18	NL to 50%	28	NL to RL
9	75% to NL	19[a]	25% to NL	29	RL to NL
10	NL to 75%	20	NL to 25%	30	NL to RL

Table 1. Derived parameters for tactical hybrid power sources.

CHARACTERISTIC PARAMETER	HYBRID PRECISE CLASS 1-H	HYBRID UTILITY		
		CLASS 2A-H	CLASS 2B-H	CLASS 2C-H
a. Voltage Characteristics				
1. Regulation and stability (bandwidth % from nominal)	2	2	4	4
2. Transient Performance				
(a) Application of Rated Load				
(1) Dip	15	20	20	30
(2) Recovery (s)	0.5	3	3	3
(b) Rejection of Rated Load				
(1) Dip	15	30	30	30
(2) Recovery (s)	0.5	3	3	3
b. Frequency Characteristics				
1. Regulation and stability (bandwidth %)	1	1	3	4
2. Transient Performance				
(a) Application of Rated Load				
(1) Dip	4	4	4	4
(2) Recovery (s)	2	4	4	4
(b) Rejection of Rated Load				
(1) Dip	4	4	4	5
(2) Recovery (s)	2	4	4	6

NOTE: *Figures 1 and 2 and Tables 1 and 2 are given in TOP 09-2-290.*

3.3 Physical Requirements

3.3.1 System Dimensions. The D3T shall be designed to be transported quickly with standard military equipment.

3.3.1.1 Maximum Weight. The maximum weight to transport a 20-ft container is 20,000lbs (10 tons).

3.3.1.2 Maximum Dimensions in Storage. Maximum dimension while the unit is in transport or storage 20ft x 8ft. (O) The maximum width for a vehicle transportation is 8.5ft if the outriggers need to be permanently attached to the sides. (O) The maximum length is 20ft and the HEMTT transport mounts do not allow extra room in front of the unit. (T)

3.3.1.3 Maximum Dimensions While Deployed. The maximum height 65ft (O) and footprint 700sq/ft (O) while the unit is deployed.

3.3.2 Color, Markings, and Labels. MIL-STD-129 and MIL-STD-130 both mandates how units are marked for shipping, storage, and safety.

3.3.2.1 Color. D3T units shall be a standard color of green, tan, or black.

3.3.2.2 Component Labels. The D3T component shall all contain a label with the following information:

- Component name
- Component part number
- Component serial number
- Manufacturing company name
- Date of manufacture
- Component weight, if the component is over 50 lbs.
- Component lift requirement, if over 1 person.

3.3.2.3 System Level Data Plate. The D3T shall have two data plates: one easily observable on the exterior, and a secondary mounted internally. The data plate shall contain the following:

- Equipment name and model number
- Equipment serial number
- Commercial and Government Entity (CAGE) code
- Unique Item Identification (UII) Data Matrix Symbol
- Government ownership designation.

3.3.2.4 Electrical Diagrams. The D3T shall be equipped with electrical drawing for all components and interfaces, with all wired connections labeled. These should be available in paper and electronic form.

3.3.2.5 Label Permanence and Durability. All labels and markings on all components of the system shall show no evidence of

blistering, delamination, separation, discoloration, chipping, dissolving, softening, illegibility, corrosion, loosening, splitting, flaking, cracking, peeling, warping, or fading after independent government testing of all requirements of this specification.

3.3.3 Site Preparation. The D3T will be deployed to areas with damaged infrastructure and uneven terrain and shall have adjustable footing to allow it to adapt to a range of geographic obstacles.

3.3.3.1 Maximum Footprint for Assembly. To assemble the D3T from storage/transport configuration the unit needs an area of 4,000 sq/ft. (O) This is the space required for all equipment operations (e.g., forklifts, container, truck access).

3.3.3.2 Safety Perimeter to Other Objects. The D3T shall have a radial clearance that is equal to the maximum height of the blades when the tower is erected.

3.3.3.3 Minimum Slope Allowed. The D3T shall be able to accommodate a slope of 5 percent, (T) and optimally over 7 percent. (O)

3.3.3.4 Expected Terrain. The unit is expected to operate in snow, sand, dirt, gravel, asphalt and shall have footings that adapt to these environments.

3.3.3.5 Resource Assessment. The location where the unit is being deployed should have a resource assessment prior to deployment to verify that D3T will meet the demands of the mission.

3.3.4 Set-up and Teardown. The D3T shall be a temporary system. It shall be set up in a given time frame and broken down for transport and storage within a given time frame. All parts should be reusable, and the site should not have any existing markings when deployment is complete (e.g., concrete, ground support).

3.3.4.1 Tools Required. All tools required for assembly shall be contained in the container. All tools required shall have Commercial Off the Shelf (COTS) availability.

3.3.4.2 Equipment Required. The D3T shall be assembled and disassembled with only hand tools and human power as no

other equipment will be available when air dropped. (T) Cranes such as the one mounted on the HEMTT could be available to assist in set up if ground logistics are available. (O)

3.3.4.3 Set-up Time. With the D3T at the installation site, still in storage/transport configuration, it shall take a team of _____ (T) ____(O) individuals ____ (T)___(O) hours to take the unit out of its storage configuration and have it able to produce power. This should include time to inspect and deem safe all electrical connections and mechanical components.

3.3.4.4 Tear-down Time. With the D3T set up and producing power, it shall take a team of _____ individuals (T) ____(O) no more than _____(T)____ (O) to tear the unit down and have it ready for storage/transport.

3.3.5 Storage. The D3T is a mobile power generation system that will be transported by land, air, and sea. It shall be packaged in such a way that it functions when it arrives on site.

3.3.5.1 Stackable. The 20ft container should be stackable with standard 20ft containers (O) or other D3T containers (T) when it is in storage.

3.3.5.2 Lift Point. The 20ft container shall have designated overhead lift points and forklift pockets.

3.3.5.3 Storage Preparation. Preparation for storage by___ personnel shall be less than or equal to ___hours for all system components. (T) This time includes any action that needs to be performed to prepare the system to be stored in an unused state for periods greater than 1 year.

3.3.5.4 Removal from Storage. It shall take less than ___hour for ___ personnel to make the system provide full output power after storage. This excludes the time required to recharge the energy storage and preform pre-deployment inspections. (T) This time includes any action that needs to be performed to ready the system to provide full output power starting from the state described in Section 3.8.1.

3.3.5.5 Storage Temperature. The D3T system will be transported and stored in conditions ranging from -40°F to 160°F, the system shall not degrade in these conditions.

3.3.5.6 Climate Protection. During storage and transport the D3T could be susceptible to rain, snow, sand, ice, or salt spray as defined in MIL-STD-810D. The 20ft container needs to protect against the elements and meet all MIL-STD-810D standards.

3.4 Transportation

3.4.1 Transportability. The D3T system specializes in being deployable, and depending on the configuration and transport method, it will be held to different standards. The most basic transport standard is MIL-STD-1366E, “Interface Standard Transportability Criteria,” guidance on transportability. This standard contains the requirements for all modes of transportation in the Defense Transportation System (DTS). This includes transportation testing, over the road requirements, rotary and fixed wing aircraft requirements, as well as tie down and lifting requirement.

3.4.2 Transport Configuration. While in transport, all hatches/dust covers/cable access/and screens should have a locking mechanism to secure them. The unit should be powered down with the energy storage system isolated.

3.4.3 Transport Turbulence. The D3T shall be designed to meet MIL-STD-810H, Method 514.8, Annex C, Category 4 Vibration Testing without a loss of performance.

3.4.4 Secured Cargo Transport. The D3T transport container shall prevent the unit from shifting, rattling, or receiving damage while in transit.

3.4.5 Forklift Transport. The military operates forklifts to maneuver 20ft containers at most bases. The D3T container shall have clearly identifiable forklift pockets.

3.4.6 Highway Transport. The D3T shall be transported with all military vehicles able to meet the 20ft container requirements. Equipment examples include the M870 on highway trailer and the HEMMT trucks for rough terrain.

3.4.7 Fixed Wing Air Transport. A 20ft container can be transported by air using the C-130 and C-17 aircraft. Therefore, the D3T shall meet MIL-STD-1791C Internal Aerial Delivery in Fixed Wing Aircraft.

3.4.8 External Helicopter Transport. A 20ft container can be transported by air using the CH-53 and MV-22 helicopters. Therefore, the D3T shall meet MIL-STD-209K Lifting and Tie Down Provisions for helicopter sling loads.

3.4.9 Rail Transport. To transport a 20ft container by rail it shall meet MIL-STD 1366E. this standard provides guidance and regulation on shipping to USA and NATO countries by railway. A 20ft container is standard equipment if the weight limit is not exceeded. Additionally, the dimensional requirements for railway cargo are available in the Association of the American Railroads.

3.4.10 Trailer Considerations. Trail mounted units shall have at pinnal hitch, standard trailer lights, and a max rated speed label.

3.5 Interface Requirements

3.5.1 Main Display Screen. The HMI main screen for D3T shall display the following:

- Isolation and connection status to indicate whether the system is electrically isolated from the load/grid.
- System output voltage and current for each phase.
- Fault status.
- Generator power production level.
- Energy storage system power availability.
- Operating mode.
- Time until maintenance required.

3.5.2 Paralleling. The D3T controller shall be capable of operating in parallel with other Distributed Energy Resources as the Tactical Microgrid Standard or IEEE 1547 regulate.

3.5.3 System Integration. D3T shall be designed meet IEEE 1547 and adapt to the Tactical Microgrid Standard. This will allow the system to alleviate

the load on fossil fuel generators when used in a multiple generator setting.

3.5.4 Self-Correction. When the D3T is deployed and producing power, it shall react to the wind resource and load alterations without human interaction.

3.5.5 Advanced User Settings. The system should have a normal operation setting, and a password-protected advanced setting. The advanced setting should control the output voltage, frequency, and serve as an advanced lock out/tag out for maintenance.

3.5.6 Secondary Display Screens. The D3T should have a secondary display. This could be used for trouble shooting and in case of primary screen failure. This secondary display can be smaller than the primary and located in an internal compartment until needed.

3.5.7 Remote Monitoring and Control. The D3T should have a method for remote monitoring and control. This remote connection should have the same controls and the standard HMI.

3.5.8 Software/Firmware Version Display. The HMI shall display the latest software version at startup.

3.5.9 Visibility. The D3T user interface and screens shall be visible in all-weather condition.

3.5.10 Color Perception. The controls and HMI should be interpreted by methods other than color alone.

3.5.11 Display Blackout. The unit should have the ability to operate without producing light.

3.5.12 Night Vision Compatibility. With the controls in blackout, the D3T controls should be visible with night-vision equipment.

3.5.13 Display Cover. All controls and displays on the D3T shall have a cover for protection during transit and have tinted finishes on screens and windows that reduce glare.

3.5.14 Adverse Gear Consideration. The controls and interfaces on D3T should be accessible and easily manipulated in all gear (e.g., cold weather cloves, MOPP gear, latex gloves, combat gear).

3.5.15 Breaker Protection. The positioning of all breakers and switches should be orientated in such a way that they are not accidentally manipulated during maintenance, repairs, or normal operation.

3.5.16 Controls Visibility. With transportation covers and weather proofing removed, the controls, touchscreen, switches, and breakers on the control panel should be orientated to be easily identifiable for a person of a height between 5ft and 6ft from a distance of 2ft away.

3.5.17 Controls Access. The controls, touchscreen, switches, and breakers shall be located in a way that access is obstructed while the device is operating normally. Contact with the electrical control items should only happen intentionally.

3.5.18 Electrical Traceability. All wire connections are shall have a label or stamp near both ends that lists connection terminal.

3.5.19 Component Modularity. If components, such as bolts, electrical connectors, and other hardware are similar in size, every effort should be made to conform them to one design to ease the logistical strain of replacement parts. All hardware should have Commercial Off the Shelf (COTS) compatibility.

3.6 Power Generation

3.6.1 Wind Turbine Rating. The D3T should contain a turbine that is capable of producing at least 10kW of power. An analysis completed by National Renewable Energy Lab (NREL) indicates that a wind turbine house in a 20ft container could produce 30kW of power. This is based on the blade, tower, and nacelle dimensions that a 20ft container would support.

3.6.2 Wind Turbine Control. Once the turbine has been completely assembled with all electrical connections complete, the isolation device can be closed in and electrically energized. At this time, the D3T control system shall be self-operational. No human interaction shall be needed as the wind resource and loads vary. If unsafe conditions arise (faults, warnings, and alarms) the turbine will shut down automatically.

3.6.3 Wind Turbine Modularity. The D3T shall have lug connection that accept 100 Amp cable. The turbine should use the MIL-DTL-22992 100Amp plug. This plug is widely used in existing distribution equipment and with the AMMPS family of generators.

3.6.4 Wind Turbine Controller Battery. The wind turbine shall have a battery to power the HMI, controller, and monitoring system. This battery shall automatically charge back to full when the turbine is generating power. This battery shall be separate from the bulk energy storage system. This shall be the 6T battery that is standard for military vehicles.

3.6.5 PV Generation. PV is not required in the D3T system. If PV is added to the D3T system, all electrical requirements in Section 3 apply. The D3T will support the ability to parallel multiple generating assets.

3.6.6 Diesel Generation. A diesel generator is not required in the D3T system. If a diesel fuel generator is added internally to the D3T system, all electrical requirements in Section 3 apply. The D3T will support the ability to parallel multiple generating assets.

3.7 Energy Storage

3.7.1 Battery Type. The standard battery for the military is the 6T battery and it should be used on the D3T where possible. This battery is a 24V with 108Ah constructed with LiFePo4.

3.7.2 Power Output. The bulk energy storage device should have a minimum a storage capacity that can support a load equal to that of the turbine rating for four hours with no wind resources available from a complete charge. (T) If the turbine is able to produce 30kW of power, the battery would need to be rated for 30kW and 120kWh. The power storage should also be capable of isolating from the turbine while still providing power to the load while the turbine is being assembled or undergoes maintenance.

3.7.3 Maximum Weight. The D3T systems ability to be transportable should not be impacted by the weight of the battery. It is preferred that the turbine and bulk energy storage be contained in one container, but a separate container for energy storage is acceptable. The maximum weight to transport a 20ft container is 20,000 lbs. the maximum weight of 20,000 lbs. is based on the HEMTT M3 Container Roll in/Off Platform with a maximum capacity of 20,000 lbs.

3.7.4 Deployability. The D3T energy storage system shall meet all transport, setup, and tear down, and storage requirements apply if the energy storage is in a separate container.

3.7.5 System Integration. If the energy storage is not controlled by the D3T controller, the energy storage controller shall meet all power output requirements such as IEEE 1547 and Power Quality and Efficiency

Testing of Tactical Hybrid Power Sources Test Operating Procedure (TOP) 09-2-290.

3.8 Power Delivery

3.8.1 Power Output Control. The connection between the generator and load shall have the ability to isolate. At start up, this connection is open. The only way to engage this connection is with the touch of a physical switch. The control to engage this connection is not on the HMI nor on the remote access link. Only after startup has commenced and the voltage and frequency are within acceptable ranges will the connection to the load be allowed. The ability to open this connection should be available on the HMI.

3.8.2 Output Power Indicator. The system shall have an indicator that show the status of the generator to load connection. This shall be available on the HMI and the isolation device itself.

3.8.3 Energy Isolation. The wind turbine and energy storage system shall have easy access lock out/tag out points for maintenance and repair purposes.

3.8.4 Main Power Output Connection. The main power output from the inverter shall be the MIL-DTL-22992 100Amp plug. This plug is widely used in existing distribution equipment and with the AMMPS family of generators.

3.8.5 AC Power Rating. The D3T system shall output 480V AC 60-Hz 3-phase power.

3.8.6 DC Power Output. The system should provide 28-Volts nominal DC output power with quality that meets the requirements in MIL-STD-1275E. (O)

3.8.7 Fuses. Fuses can be used for internal power for sensors, indicators, and motors, but for primary overcurrent protection on the outgoing bus a non-resettable fuse shall not be used. Fuses must meet MIL-STD-1360

3.8.8 Convenience Receptacles. The unit itself shall have two 120 VAC NEMA 5-15 connectors, (O) and two USB-C convenience receptacles. (O) The outlets are required to be UL 953 Class A, Ground Fault Circuit Interrupter (GFCI) protected. (T)

3.8.9 System Operational Modes. The D3T system is designed to support large bases, forward operating bases, training exercises, disaster recovery, and other deployments. To achieve all these task multiple modes could be needed:

- Normal operation mode will produce the maximum power available from wind resources. This is useful to offset the fuel usage in fossil fuel generators.
- Silent watch mode will reduce the max speed of the turbine, reducing its noise and electromagnetic signature. This will also reduce the height of the turbine to obscure the view.
- Extreme use mode will ignore most faults and keep the turbine operational as long as possible. This is meant for extreme cases when loss of power could result in loss of life.

3.9 Protection Systems

3.9.1 Physical Emergency Stop Switch. The system shall have two Emergency Stop switches: one at the control interface and one at the opposite end of the unit, easily identifiable with “Emergency Stop” and “Push to Stop” markings. This switch will isolate generator from the load within 150 milliseconds. When the emergency stop is pushed, the unit will not be able to restart until the switch is put back to the normal position.

3.9.2 HMI Emergency Stop. All HMI’s shall have the ability to emergency stop the unit, either unit mounted or remote HMI’s.

3.9.3 Fault Detection. The D3T shall have the ability to monitor itself for faults and display them on the HMI if they occur. This includes monitoring the wind turbine generator, structure, energy storage system, and electrical output.

3.9.4 System Shutdown. The system should have wind monitoring and fault detection that automatically shut down the D3T if it detects a scenario that could result in damage to the turbine if the turbine continues running.

3.9.5 Output Power Indicator. The system requires an indicator that show the status of the generator to load connection. This should be available on the HMI and the isolation device itself.

3.9.6 Energy Isolation. The wind turbine and energy storage system should have easy access lock out/tag out points for maintenance and repair purposes.

3.10 Electrical Output

3.10.1 Inverter. The recommended inverter is the Intergrid IG-25-240. This inverter was designed for deployable wind turbine applications. It is a single phase 25kW inverter. Other recommended inverters are the Oztek family of inverters.

3.10.2 Over/Under Voltage. The electrical control and monitoring system shall monitor under/over voltage at the isolation device. The D3T should isolate itself if the voltage varies more than 0.9167 per-unit to 1.0583 per-unit voltage, as required by IEEE 1547.

3.10.3 Overload. The turbine shall have a current measuring device that monitors power output. The control system shall isolate from the load if the output current is in danger of damaging internal or external components, switchgear, or cable. MIL-STD-705D contains more information on standard generator and breaker controls.

3.10.4 External Short Circuit. The system shall monitor the load and detect a short circuit. If the current is ever spiked more an 100%, the load shall isolate instantly. MIL-STD-705D contains more information on standard generator and breaker controls.

3.10.5 Internal Short Circuit. The D3T monitoring and control shall protect against faults that occur on the generator side of the isolation device and shut down when fault currents are detected. MIL-STD-705D contains more information on standard generator and breaker controls.

3.10.6 National Electric Code (NEC). The D3T system shall meet National Electric Code Articles 445, “Generators,” 705, “Interconnected Electrical Power Production,” and 706, “Energy Storage Systems” for safety standards.

3.10.7 Grounding. In all applications, the D3T shall be grounded before it is energized in accordance with IAW NEC Article 250 for grounding and bonding, and MIL-HDBK-419A Grounding, Bonding, and Shielding for Electrical Equipment’s and Facilities.

3.11 Paralleling

3.11.1 Secondary Power Generation Connections. The D3T system shall have connection to allow a secondary generation source or energy storage to connect to the D3T and assist with providing power to the load (e.g., PV, diesel, and battery).

To accomplish this, the controller must be able to synchronize voltage, frequency, and relative phase angle and control the transfer of load. This shall be completed without interrupting power to the load.

3.11.1.1 Input AC Connectors. The interconnections between the D3T and the paralleling units and the load shall be the MIL-DTL-22992 100Amp plug. This plug is widely used in existing distribution equipment and with the AMMPS family of generators.

3.11.1.2 Paralleling. The D3T controller shall be capable of operating in parallel with other DER equipment as IEEE1547 and the Tactical Microgrid Standard regulate.

3.11.1.3 Automatic Generator Control of Secondary Generation. The controller of the D3T unit should have the ability to command start of the secondary generation unit if it is needed to support the load.

3.11.1.4 Generator Feedback Protection. When one of the generators is offline, the protection systems need to prevent one generator from back feeding the other.

3.12 Maintainability

3.12.1 Reliability. D3T shall operate a minimum of ____ hours (T) / ____ hours (O) between system failure (see Appendix A).

3.12.2 Average Repair Time. The average repair time for the D3T after a system failure shall take no more than _____ hours. (T) This specification is not for preventative maintenance times, but only for system failure (see Appendix A).

3.12.3 Preventive Maintenance Personnel. All standard preventative maintenance and inspections should be able to be completed by E-4 and lower.

3.12.4 Preventive Maintenance Interval. The minimum time between preventative maintenance (see Appendix A) intervals should not to be less than every _____ hours. (O)

3.12.5 Preventive Maintenance Shutdowns. The minimum time between shutdowns should be _____ hours. (O)

3.12.6 Scheduled Maintenance Interval. Scheduled maintenance (see Appendix A) to replace large components should have a minimum interval of _____ hours. (O)

3.12.7 Scheduled Maintenance Time. Scheduled maintenance should take less than or ____hours to complete. (O)

3.12.8 Tool Usage – Set Up/Tear Down. All tools and equipment need to set up and tear down equipment shall be listed and contained in the unit.

3.12.9 Tool Usage –Maintenance. All tools and equipment need for maintenance shall be listed and contained in the unit.

3.12.10 Internal Component Access. To access the turbine, controller, wiring, and any storage compartment on the D3T, only COTS hardware shall be used.

3.12.1 Universal Serial Bus (USB) Upgrade Port. The control system for the D3T shall be able to accept updates if needed. This should be done with a USB-C connection. This port should not be easily accessible from the control panel but located inside of the unit under a cover or body panel.

3.12.2 Data Acquisition and Storage. The control and monitoring system on the D3T shall log all faults, warning, starts, shutdowns, scheduled maintenance, and other operational data.

3.12.2.1 Fault Logs. The fault log shall include the time and date of the event and the event type. The system should be able to store faults for 3,600 hours.

3.12.2.2 Scheduled Maintenance. There shall be a maintenance timer that monitors the hour usage since the last maintenance was performed. It will indicate when maintenance is due. The maintenance log shall store the time, date, duration of outage, and document the technician who performed the maintenance.

3.13 Safety

3.13.1 Warning Labels. The D3T shall contain warnings for pinch points, rotating components, electrical hazards, and possibly more. All areas of warning need to be labels in accordance with IAW MIL-STD-1472G.

All lifting points shall be mark properly, and all identification numbers and weight labels shall be clearly labeled.

3.13.2 Caution Labels. All components that could be compromised though specific actions shall be labeled and identified.

3.13.3 Warning for Silent Energy System. The D3T operates with far-less sound than traditional generators. People who are unfamiliar with the unit may assume it is off and deenergized. On the face of the isolation system, the warning label shall indicate this is a silent energy source. All external energy storage and solar generation shall also be labeled silent energy source.

3.13.4 Shock Hazard. All electrical systems shall be covered and protected to prevent a shock hazard.

3.13.5 Fault Protection. The control system for the D3T shall self-detect faults, notify the user, and shut down and isolate the load if necessary.

3.13.5.1 Fault Display. The faults shall be displayed on unit, remote monitoring connection, and have an additional alarm indicator on the control interface.

3.13.5.2 Turbine Faults. The HMI of the D3T shall show all turbine faults and warnings. This includes generator faults, structural faults, wind speed faults.

3.13.5.3 Electrical Faults. The HMI of the D3Tshall show all electrical faults and warnings. This includes voltage, current, and frequency faults.

3.13.5.4 Fault Warning. The unit should be able to detect a variety of faults conditions that could cause harm to the unit if they persist. Example of faults could be raising internal temperature, shift in level, or dangerous winds. These warning should notify the user that the system could potentially shut down.

3.13.5.5 Fault Shutdown. If a fault persists to the point of damaging the D3T, the unit shall shut itself down.

3.13.5.6 Fault Reset. After the system has shut down, it should not start without resetting the fault warning on the HMI. This can be done on the remote access terminal.

3.13.5.7 Critical Fault Persistence. If a similar fault is reoccurring in a short time span, the systems should shut down and require an override password that only a senior technician should have. (O)

3.14 Environmental

3.14.1 Weather Testing. The unit shall meet the MIL-STD-810D environmental testing.

3.14.1.1 Operational Temperature. The D3T system shall operate in a temperature between -25°F and 125°F.

3.14.1.2 Altitude. The D3T system will be deployed at elevations ranging from 0 to 4,000 feet above sea level and shall maintain performance with that elevation range.

3.14.1.3 Humidity. The unit is expected operate in all humidity conditions within the desired temperature range as specified in MIL-STD-810D.

3.14.1.4 Rain Resistance. The system is expected to operate in rain without resulting in damage as specified in MIL-STD-810D.

3.14.1.5 Salt Fog. The system is designed to be deployed, transported, and stored in coastal areas and shall not receive damage from salt fog as specified in MIL-STD-810D.

3.14.1.6 Sand and Dust. The system shall not be degraded due to blowing sand and dust as specified in MIL-STD-810D.

3.14.2 Dissimilar Metals. Electrolysis can from contact of dissimilar metals and result in corrosion, this would degrade the system. Dissimilar metals are not to directly touch each other as specified in MIL-STD-889B.

3.14.3 Corrosion. The system shall meet the requirements for MIL-STD-889B and MIL-STD-7179B. These standards regulate processes for metallic parts and protective coatings.

3.15 Electromagnetic Interference (EMI)

3.15.1 Radiated Emissions. The system shall comply with MIL-STD-461G and not exceed the allowable RE102 Ground, Navy Mobile, and Army radiated emission levels.

3.15.2 Radiated Magnetic Susceptibility. The system shall comply with MIL-STD-416G and Navy requirements RS101. When subjected to a radiated magnetic field, the performance of the system shall not degrade.

3.15.3 Radiated Electric Susceptibility. The system shall comply with MIL-STD-461G and the Navy Ground requirements of RS103 and shall maintain performance when in the presence of radiated electric fields in the 2 MHz to 18 GHz range.

3.15.4 Conducted Susceptibility Bulk Cable Injection Frequency Range. The system shall comply with MIL-STD-461G, the Navy Ground requirement of CS114, and shall maintain performance when subjected to injected probe drive IAW.

3.15.5 Conducted Susceptibility Bulk Cable Injection Impulse Excitation. The system shall comply with MIL-STD-461G and shall maintain performance when subjected to CS115.

3.15.6 Conducted Susceptibility, Damped Sinusoidal Transients. The system shall comply with MIL-STD-461G and shall maintain performance when subjected to CS116.

3.15.7 Chemical, Biological, Radiological, and Nuclear (CBRN) Attack. The system shall be able withstand cleaning as specified in FM 3-11.5 Chapter IV to decontaminate the unit.

4. VERIFICATION

4.1 Verification Checklist. The checklist provided in Table 3 steps through each performance requirement and list the required method of verification. This check list is intended to be completed by the reviewing party during the testing phase.

Table 3. Performance requirements.

Requirements		**Method of Verification**				
Number	**Name**	**Demonstrate**	**Analyze**	**Inspect**	**Test**	**Description of Test**
3.1	System Overview			x		
3.2	Performance Requirements					N/A
3.2.1	Interfacing	x				
3.2.2	Power Output			x		

3.2.2.1	Wind Turbine Generator Rating			x		
3.2.2.2	Energy Storage Capacity			x		
3.2.3	AC Power Quality				x	TOP 09-2-290, section 4.1
3.2.3.1	Regulation and Stability				x	TOP 09-2-290, Section 4.1.1, limits of Table 3 CLASS 2B-H
3.2.3.2	Transient Response				x	TOP 09-2-290, Section 4.1.1, limits of Table 3 CLASS 2B-H
3.2.3.3	Long-term Stability				x	TOP 09-2-290, Section 4.1.1, limits of Table 3 CLASS 2B-H
3.2.3.4	Source Switching				x	TOP 09-2-290, Section 4.1.1, limits of Table 3 CLASS 2B-H
3.2.3.5	Frequency Range				x	TOP 09-2-290, Section 4.1.1, limits of Table 3 CLASS 2B-H
3.2.3.6	Waveform Characteristics				x	TOP 09-2-290, Section 4.1.1, limits of Table 3 CLASS 2B-H
3.3	Physical Requirements					N/A
3.3.1	System Dimensions					N/A
3.3.1.1	Maximum Weight			x		
3.3.1.2	Maximum Dimensions in Storage			x		
3.3.1.3	Maximum Dimensions While Deployed			x		
3.3.2	Color, Markings and Labels		x			MIL-STD-129, **MIL-STD-130**
3.3.2.1	Color			x		
3.3.2.2	Component Labels			x		
3.3.2.3	System Level Data Plate			x		
3.3.2.4	Electrical Diagrams			x		
3.3.2.5	Label Permanence and Durability			x		
3.3.3	Site Preparation					N/A
3.3.3.1	Maximum Footprint for Assembly.				x	

3.3.3.2	Safety Perimeter to Other Objects			x		
3.3.3.3	Maximum Slope Allowed				x	
3.3.3.4	Expected Terrain				x	
3.3.3.5	Resource Assessment		x			
3.3.4	Set-up and Teardown			x		
3.3.4.1	Tools Required			x		
3.3.4.2	Equipment Required			x		
3.3.4.3	Set-up Time	x				With the unit in transport configuration, the required number of people will assemble the unit in the allotted time.
3.3.4.4	Tear-down Time	x				The minimum crew shall disassemble the unit in the allotted time,
3.3.5	Storage					N/A
3.3.5.1	Stackable	x				
3.3.5.2	Lift Point			x		
3.3.5.3	Storage Preparation	x				The minimum crew shall prepare the disassembled unit for long term storage in the allotted time.
3.3.5.4	Removal from Storage	x				The minimum crew shall unpackage the stored unit for long transport in the allotted time.
3.3.5.5	Storage Temperature			x		
3.3.5.6	Climate Protection			x		MIL-STD-810D
3.4	Transportation					N/A
3.4.1	Transportability		x			MIL-STD-1366E
3.4.2	Transport Configuration	x				
3.4.3	Transport Turbulence	x				MIL-STD-810H, Method 514.8, Annex C, Category 4 Vibration Testing
3.4.4	Secured Cargo Transport	x				
3.4.5	Forklift Transport			x		
3.4.6	Highway Transport			x		

3.4.7	Fixed Wing Aircraft Transport			x		MIL-STD-1791C
3.4.8	External Helicopter Transport			x		MIL-STD209K and MIL-STD209K
3.4.9	Rail Transport			x		MIL-STD 1366E
3.4.10	Trailer Considerations		x			
3.5	Interface Requirements					N/A
3.5.1	Main Display Screen	x				
3.5.2	Paralleling	x				Tactical Microgrid Standard or IEEE1547
3.5.3	System Integration	x				IEEE1547
3.5.4	Self-Correction	x				
3.5.5	Advanced User Settings		x			
3.5.6	Secondary Display Screens		x			
3.5.7	Remote Monitoring and Control	x				
3.5.8	Software/Firmware Version Display		x			
3.5.9	Visibility		x			
3.5.10	Color Perception		x			
3.5.11	Display Blackout	x				
3.5.12	Night Vision Compatibility	x				
3.5.13	Display Cover		x			
3.5.14	Adverse Gear Consideration	x				
3.5.15	Breaker Protection		x			
3.5.16	Controls Visibility		x			
3.5.17	Controls Access		x			
3.5.18	Electrical Traceability		x			
3.5.19	Component Modularity		x			
3.6	Power Generation					N/A
3.6.1	Wind Turbine Rating			x		
3.6.2	Wind Turbine Control		x			
3.6.3	Wind Turbine Modularity		x			MIL-DTL-22992
3.6.4	Wind Turbine Controller Battery		x			
3.6.5	PV Generation			x		
3.6.6	Diesel Generation			x		
3.7	Energy Storage					N/A
3.7.1	Battery Type			x		
3.7.2	Power Output		x			

3.7.3	Maximum Weight			x		
3.7.4	Deployability		x			
3.7.5	System Integration	x				TOP **09-2-290, IEEE1547**
3.8	Power Delivery					N/A
3.8.1	Power Output Control		x			MIL-STD-1275E
3.8.2	Output Power Indicator		x			
3.8.3	Energy Isolation					
3.8.4	Main Power Output Connection			x		MIL-DTL-22992
3.8.5	AC Power Rating			x		MIL-STD-705D
3.8.6	DC Power Output			x		MIL-STD-1275E
3.8.7	Fuses		x	x		MIL-STD-1360
3.8.8	Convenience Receptacles			x		
3.8.9	System Operational Modes		x			
3.9	Protection Systems					N/A
3.9.1	Physical Emergency Stop Switch			x		
3.9.2	HMI Emergency Stop Switch			x		
3.9.3	Fault Detection		x			
3.9.4	System Shutdown		x			
3.9.5	Output Power Indicator	x				
3.9.6	Energy Isolation		x			
3.10	Electrical Output					N/A
3.10.1	Inverter		x			
3.10.2	Under/Over Voltage				x	IEEE 1547
3.10.3	Overload				x	MIL-STD-705D
3.10.4	External Short Circuit				x	MIL-STD-705D
3.10.5	Internal Short Circuit				x	MIL-STD-705D
3.10.6	National Electric Code (NEC)				x	NEC 705, NEC 706
3.10.7	Grounding			x		MIL-HDBK-419A
3.11	Paralleling					N/A
3.11.1	Secondary Power Generation Connection			x		
3.11.1.1	Input AC Connectors			x		MIL-DTL-22992
3.11.1.2	Paralleling	x				IEEE 1547, MIL-STD-705D
3.11.1.3	Automatic Generator Control of Secondary Generations	x				

3.11.1.4	Generator Feedback Protection		x			
3.12	Maintainability					N/A
3.12.1	Reliability			x		
3.12.2	Average Repair Time		x			
3.12.3	Preventive Maintenance Interval		x			
3.12.4	Preventive Maintenance Shutdowns		x			
3.12.5	Preventive Maintenance Time		x			
3.12.6	Scheduled Maintenance Interval		x			
3.12.7	Scheduled Maintenance Time		x			
3.12.8	Tool Usage – Set Up/ Tear Down			x		
3.12.9	Tool Usage – Maintenance			x		
3.12.10	Internal Component Access			x		
3.12.11	Universal Serial Bus (USB) Upgrade Port			x		
3.12.12	Data Acquisition and Storage		x			
3.12.12.1	Fault Logs		x			
3.12.12.2	Scheduled Maintenance		x			
3.13	Safety					N/A
3.13.1	Warning Labels			x		MIL-STD-1472G
3.13.2	Caution Labels			x		
3.13.3	Warning for Silent Energy System			x		
3.13.4	Shock Hazard			x		
3.13.5	Fault Protection			x		
3.13.5.1	Fault Display			x		
3.13.5.2	Turbine Faults			x		
3.13.5.3	Electrical Faults			x		
3.13.5.4	Fault Warnings			x		
3.13.5.5	Fault Shutdown			x		
3.13.5.6	Fault Reset			x		
3.13.5.7	Critical Fault Persistence			x		
3.14	Environmental		x			N/A
3.14.1	Weather Testing	x				MIL-STD-810

3.14.1.1	Operational Temperature	x				
3.14.1.2	Altitude		x			
3.14.1.3	Humidity				x	MIL-STD-810D
3.14.1.4	Rain Resistance				x	MIL-STD-810D
3.14.1.5	Salt Fog				x	MIL-STD-810D
3.14.1.6	Sand and Dust				x	MIL-STD-810D
3.14.2	Dissimilar Metals	x			x	MIL-STD-889B
3.14.3	Corrosion	x				MIL-STD-7179B
3.15	Electromagnetic Interference (EMI)					N/A
3.15.1	Radiated Emissions					MIL-STD-461G
3.15.2	Radiated magnetic susceptibility			x		MIL-STD-461G
3.15.3	Radiated electric susceptibility			x		MIL-STD-461G
3.15.4	Conducted susceptibility bulk cable injection frequency range.			x		MIL-STD-461G

4.2 Test Procedures

4.2.1 Reliability Testing. For testing the electrical generation and protection systems, a proper wind resource must be available. The generator test is listed in TOP 09-2-290 and MIl-STD-705. The set up and tear down times should be tested with individuals that have training on the unit. After all the inspections are completed, the unit shall run _____ hours (T) for continual monitoring. The unit will also be required to be set up and tear down every____(T) hours.

Appendix A

Definitions

Deployable. An asset that can be transported and installed for operation within a defined time window. When no longer needed, the unit can be disassembled for storage and transportation.

Assembled. The process of taking a turbine out of storage and preparing it for use.

Disassemble. The process of taking a functioning turbine, safely disconnecting it from the grid, and packaging up all parts of the system needed for reassembly.

Transport. The process of safely moving large units by truck, train, ships, and air. The large unit should be securely packed so that under normal condition it functions normally when delivered and assembled.

Purchaser. The individuals filing the performance specification and or the individuals that will verify operation.

Threshold Requirement. The threshold (T) is the minimum level of compliance that must be met.

Objective Requirement. The objective (O) is the preferred level of compliance to be met.

System Failure. The D3T system is considered to be in a failed state when issues arise that prevent power from being generated. This does not include loss of power due to lack of wind resource.

Preventative Maintenance. Maintenance that is required periodically to eliminate large costly repairs