



WEARABLE POWER PRIZE

RULES

August 12, 2008

*Office of the Director of Defense Research and Engineering
Prize Administration Office
875 North Randolph Street, Suite 150
Arlington, Virginia 22203-1766*

Rules Change Summary

Section	Change Description	Date Changed
Cover	Revision date changed.	8/12/08
2.1	Registration deadline time changed from 11:59 PM EST 30 November to 4:00 PM EST 30 November 2007.	9/19/07
3.3	Registration date changed from 8 October 2007 to 29 October 2007.	9/19/07
All	Rules document updated. Extensive changes made throughout entire document.	10/29/07
	Rules document updated. Minor changes and clarifications made throughout entire document.	8/12/08
5.0, 6.0	Added human powered systems as <i>ineligible</i> for competition	10/29/07
3.2	Corrected Tyco Part Number to: 211398-X	11/13/07
All	Editorial Changes made throughout document. References to prize officials changed to Competition Officials.	2/27/08
	Editorial Changes made throughout document.	8/12/08
2.2	Latest date to change to team leader and team member changed from 72 hours before competition to 3 June 2008.	2/27/08
2.2	Re-worded #4 under Additional Requirements/Restrictions/Allowances restricting participation of Federal Employees, Members of Armed Services, and employees of FFRDCs.	2/27/08
3.1	Removed In-initial weigh in language. Moved to section 3.2.3 "System Weigh in"	2/27/08
3.1, 3.2	Bench Test duration changed from 88 to 92 hours. Field test duration changed from 8 hours to 4 hours.	2/27/08
3.2	Added Numbered subsections: 3.2.1 Overall Competition Description 3.2.2 System Safety Check 3.2.3 System Weigh In 3.2.4 Bench Testing 3.2.5 Vest Thickness Measurement 3.2.6 Field Tests 3.2.7 Testing Schedule	2/27/08
3.2.2	New Section " <i>System Safety Check</i> "	2/27/08
3.2.2	System Safety Check renamed " <i>System Safety Evaluation</i> "	8/12/08
3.2.5	New Section " <i>Vest Thickness Measurement</i> "	2/27/08
3.3	New section 3.3 System Requirements added	8/12/08
3.4	Section 3.3 Competition Schedule renumbered to Section 3.4. Location of competition venue added. Expanded list of documentation due by 4:00 PM, EDT, 3 June 2008.	8/12/08
4.3	New Section "Prize Eligibility" added	8/12/08
4.4	New Section "Non Prize Eligibility" added	8/12/08

Section	Change Description	Date Changed
5.0	Included references to System Safety Evaluation, Section 3.2 and the System Description instructions and guidelines document. Added requirement for Proof of Insurance.	2/27/08
6.0	Included references to Fuel Plan instructions and guidelines.	2/27/08
8.0	Added Team Termination section 8.0.	2/27/08
8.0	Team Termination reworded “Team Disqualification” and additional information added	8/12/08
9.0	Section “Cancellation” renumbered from 8.0 to 9.0	2/27/08

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WEARABLE POWER COMPETITION RULES

1.0 INTRODUCTION

1.1 *Background*

Various types of DC dry cell primary batteries constitute the state-of-the-art power supply for dismounted warfighters. Primary batteries provide stored energy but are often discarded when only partially used. This precaution prevents soldiers from starting a life-endangering mission with half-charged batteries. New warfighter electronic equipment provides better capability, but also requires additional energy storage. Department of Defense (DoD) estimates that future warfighters will carry approximately 9 kilograms (almost 20 lbs) of batteries to complete a 96-hour mission.

Continuously, DoD has funded the development of individual energy components. Hybrid energy components for specialized applications are now in development. Optimizing the integration and management of these power generating, storage and distribution components is the final stage in obtaining a lighter weight system to meet future energy and power needs.

1.2 *Overview*

This prize program encourages innovation from a broad range of individuals, teams, and institutions to provide technical solutions for the individual energy needs of warfighters in the field. The prize objective is a wearable power system that lasts four days and cuts in half the weight of the batteries carried. Competitors will demonstrate flexible power systems that the DoD can tailor to its specific needs after the competition. Winning solutions may have commercial application in the fields of camping, hiking, and other extended outdoor activities.

1.3 *Goal*

Demonstrate a wearable electric power system providing 96 hours of equipment operation at less than half the current weight. The power system should attach to a garment (vest) and provide 20W average electric power for 96 hours with peak power requirements of up to 200W for short periods. All components, including the generation, storage, electronics, and connections must weigh 4kg or less, including the attachment system. The total minimum energy required is 1920 W-hr (20 W * 96 hr).

1.4 Prizes

The prize awards are 1st place - \$1,000,000.00 USD, 2nd place - \$500,000.00 USD, and 3rd place - \$250,000.00 USD for a total of \$1.75M in prizes for systems meeting or exceeding the performance criteria.

2.0 ELIGIBILITY REQUIREMENTS

2.1 Registration

Competitors must register to participate in the Wearable Power Prize (WPP) Competition by 4 PM EDT 30 November 2007. For those individuals/teams who register by the 30 November deadline, a final affirmation of intent to compete along with a preliminary system description in the WPP competition will be required by 4 PM EDT 3 June 2008. The Intent to Compete notification and System Description allows the Competition Officials to prepare suitable test venues and equipment for the competition. Submitting an Intent to Compete notification is mandatory for all registered team members and team leaders however the no penalties are assessed if an individual or team withdraws their team or individual membership from a team after June 3rd, 2008 from the Competition.

2.2 Eligibility

Competition entry is open to individuals and teams. Teams may include corporate or academic entities but are not limited to these. Each entry must meet the following eligibility requirements:

Individuals. An individual is considered one person with one entry into the competition. Individuals may sometimes be referred to as “Team Leaders” and will be the sole point of contact.

1. The individual must be a United States (U.S.) citizen on the date of Registration for the Prize Competition and must remain a citizen until the end of the competition. Proof of U.S. citizenship must be provided at the time of registration by:
 - (a) submitting a U.S. Passport number
or
 - (b) submitting notarized copies of both a current U.S. driver’s license issued from one of the 50 States or U.S. territories and a birth certificate. Notarized copies should be mailed to:
*Office of the Director of Defense Research and Engineering
Prize Administration Office
875 North Randolph Street, Suite 150
Arlington, Virginia 22203-1766*
2. The individual must be at least 21 years of age on the date of registration for the prize competition

3. An individual cannot participate on more than one team or compete with multiple entries.
4. The individual will be sole point of contact with the Competition Officials and must be present at the final competitive demonstration.

Teams. Teams are comprised of a team leader and team members.

1. The team leader must be a U.S. Citizen on the date of registration for the Prize Competition and must remain a citizen until the end of the competition. Proof of U.S. citizenship must be provided at the time of registration by:
 - (a) submitting a U.S. Passport number
or
 - (b) submitting notarized copies of both a current U.S. driver's license issued from one of the 50 States or U.S. territories and a birth certificate. Notarized copies should be mailed to:
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2. Teams may be comprised of members who are citizens of the U.S. and as well as non-citizens
3. The team leader must be at least 21 years of age on the date of Registration for the prize competition
4. Each team will designate a team leader who will be the sole point of contact with the Competition Officials and must be present at the final competition
5. Team members will be identified at the time of registration on the team roster. Team members may be on only one team roster.
6. Changes will be allowed for team leader, and team members until June 3rd, 2008 provided citizenship (for team leader only) and age requirements are met.
7. Team members must be 18 years of age on the date of registration for the prize competition.

Additional Requirements/Restrictions/Allowances.

1. State and local government organizations, such as public universities may enter or support entries into the competition.
2. U.S.- or Foreign-owned Companies and Corporations may enter and support entries into the competition. Team leader citizenship requirements shall apply.
3. No team leader, team member, or individual participant can be:

- a Federal Employee of the U. S. Government
 - a Member of the U.S. Uniformed or Armed Services which includes reserve components of the U.S. Department of Defense. (Members of the National Guard are eligible to compete in the Wearable Power Prize Competition.)
 - an Employee of a Federally Funded Research and Development Center (FFRDC), which includes, but is not limited to U.S. National Laboratories.
4. The use of Government funding or Government-owned equipment is allowable subject to the approval of the Government contracting officer in writing. Submission of this information must be provided by 03 June 2008.

2.3 Sponsorship

Individuals/Teams competing in the WPP competition are permitted to receive sponsorship from corporations, manufacturers, civilian sporting and outdoor goods manufacturers, or other sources. Sponsorships are not regulated or managed by the Competition Officials.

3.0 COMPETITION DESCRIPTION

3.1 Competition Objectives

Overall, the WPP is seeking a wearable power system that:

- Provides 20 Watts of power on average for 96 hours
- Minimum energy to weight ratio of 480 W-hr/kg
- Attaches to a MODular Lightweight Load-Carrying Equipment (MOLLE) vest garment
- Operates autonomously

The complete power system must weigh 4 kg or less and provide a minimum of 1920W-hr. The power system must operate continuously for 92 hours, power-off (standby) for a period of time up to 48 hours, and operate continuously for an additional 4 hours. During the 92 hour and 4 hour periods of operation, the system must operate: (1) continuously (i.e., 24 hrs a day); (2) at partial power; (3) for a number of periods of high power of up to 200W for 5 min; (4) in a non-air breathing mode in an oxygen (O₂) deficient chamber for 15 minutes or less; (5) be attitude or vertical orientation and motion independent; (6) provide output voltages of 14 VDC (+2/-4) and 28 VDC (+4/-8). The system must attach to a MODular Lightweight Load-Carrying Equipment (MOLLE) vest and operate during the field test while worn. A MOLLE vest will be provide for each competing system at the start of the competition.

3.2 Description

3.2.1 Overall Competition Description

The final competitive demonstration will start on 22 September and end on 04 October 2008 at the Marine Corps Air Ground Combat Center (MCAGCC), located in Twentynine Palms, California. Competitors are responsible for all expenses and equipment unless specifically stated in these rules as provided by the Competition Officials. Competitors must make all logistics, transportation, housing, and other arrangements for themselves and bear their costs.

Only the systems that meet the weight requirements and successfully complete the safety evaluation, the 92-hour bench test, and the final 4-hour Field Test are eligible for the cash prizes. Those systems that do not complete the 96-hour test sequence are not eligible for cash prizes.

1st Place - The lightest weight system weighing 4 kg or less at the weigh-in and meeting the total energy requirement as demonstrated in the competitive demonstration (bench plus field tests) is the winner. 2nd and 3rd place prizes are determined in the same manner.

In the case of systems with identical weights, a secondary “wearability” criterion is the maximum thickness of the system as it protrudes from the body when attached to a MOLLE vest. The thinnest system wins the tie-breaker and the thickness will be measured from the torso to the maximum point of the system extending from the torso. The distance the system protrudes from the body when mounted to a vest is the only metric related to how “wearable” the system is. The lower the protrusion, from the vest, the better.

3.2.2 System Safety Evaluation

Prior to the system weight determination and start of bench tests, each system will undergo a system safety evaluation. This will be the first time Competition Officials will physically view and have access to each system. A team of government personnel will review each system to ensure the system is safe and will not pose any hazards that may cause undue harm to personnel, or damage to other systems or the environment. During this evaluation, the Safety Evaluation Team (SET) will also check to ensure the actual system and fuels/batteries used are representative of that described in the System Description submitted on 03 June, 2008.

At the start of the safety evaluation, systems should not be attached to a vest. A Tyco Electronics 211398-X connector shall be present on each system at the time of the system safety evaluation. The SET will provide the mate connector to enable the systems to “power on”. Each system will be required to “power on.” During this period a small load will be placed on the system to verify both 14 VDC and 28 VDC operations. The load will be 5 Watts or less for up to 5 minutes. Teams will retain possession of their

systems and will have the opportunity to refill/recharge the systems prior the system weigh-in.

3.2.3 System Weigh-In

The entire system, ready for use, including all consumables and MOLLE vest attachments will be weighed to the nearest 0.1 gram. Any additional equipment required to start the power system will be included in the system weight. The MOLLE vest weight is not included as part of the system weight. Systems weighing over 4kg will not be eligible for a cash prize however systems weighing over 4 kg may be allowed to continue in the bench and field tests at the discretion of the Competition Officials.

Batteries or other energy storage systems should be fully charged and ready to begin testing prior to the weigh in. Systems can use multiple fuel storage canisters but all necessary canisters contribute toward the 4kg limit. After system weigh in, the power system will be attached to a MOLLE vest provided by the Competition Officials. Permanent modification of the MOLLE vest for the purpose of attaching systems is not allowed. Only the MOLLE vests provided by the Competition Officials will be used during the competition.

3.2.4 Vest Thickness Measurement

Each system may undergo a vest thickness measurement. In the event no individual/team has an identical system weight, this measurement may be eliminated. The vest thickness will be measured from the torso to the maximum point of the system extending from the torso. Measurement will be taken before the start of the Bench Test with the system mounted on the MOLLE vest and the vest on the bench test mannequin.

3.2.5 Bench Test

Competitors are to provide a single power output connector, Tyco Electronics – 211398-X, on their power system for this competition. The power system will be mounted on a vest and placed on a bench test mannequin. Only those accessories/attachments that were previously weighed may be used for mounting the system on to the vest. Competitors will be given up to 30 minutes to attach their system to the MOLLE vest and up to an additional 30 minutes to start or power-up their system once it is in place at the bench test station.

The system will be connected through the single power outlet to standard electronic loads executing a load profile which will be identical for all systems. This load profile will dissipate 1840 W-hr over a 92 hour period. The load profile will include periods that are less than 20W and periods with peak loads that range up to 200W for 5 min. maximum duration. The maximum possible load encountered is 200W for 5 minutes. Some of the loads may be in the form of step loads and others may have a profile that matches specific equipment for rise time and inrush current. Forty-Eight (48) hours of the 92 hour Bench Test load profile can be found at the Wearable Power Prize web site http://www.dod.mil/ddre/prize/doc/Load_Profile_Bench_Test.pdf. The entire load profile for the 92 hour Bench Test and 4 hour Field Test will not be released. At the end of the Bench Test period, systems will be required to power off (stand by) for a period of up to

48 hours. The competitors' systems will remain in the bench test area until the beginning of the Field Test.

3.2.5 Field Test

All systems that have successfully completed the Bench Test will compete in the Field Test. The final portion of the competitive demonstration is a 4 hour test where each power system, worn by a team member, will complete power draining tasks at various field stations. This segment of the competition is designed to deplete the remaining 80 W-hrs of energy through both a continuous average power load and short peak-power loads. The systems enter the Field Test without refueling and using only the equipment weighed prior to the Bench Test. In the Field Test, each system will remain attached to the MOLLE vest and worn through a course consisting of stations where they will connect with modified military or commercial equipment such as radios, GPS receivers and computers. Civilian electronics equipment with roughly equivalent power consumption as military items may be used as surrogates.

The object of the non-physically challenging course is to have the competing power systems operate while in motion and in different spatial orientations. There will be periods where the participant is stationary while the power system operates a piece of equipment, but the power systems will be expected to operate continuously while the competitor travels from station to station. The Field Test will subject the wearers of the power systems to periods of walking, lying prone and outdoor environmental conditions. An oxygen-deficient test will take place as part of the Field Test. The competitors' system is expected to operate in the oxygen deficient chamber for up to 15 minutes.

3.2.7 Testing Schedule:

A notional day-to-day description and schedule for the competition was provided to the competitors during the Competitors Forum on 07 August 2008. This schedule is subject to change and may be modified.

3.3 System Requirements – Dual Voltage

Systems are required to supply an average of 20 Watts for 96 hours. During the bench and field tests, the systems will be connected to test equipment and it will be verified that the systems supply 14 VDC or 28 VDC, depending on the load profile. When required to supply 14 VDC, systems must remain within the 10 – 16 VDC voltage range. When required to supply 28 VDC, systems must remain within the 20 – 32 VDC voltage range. If a system drifts outside of these voltage ranges for any period of time, that system will no longer be eligible for a cash prize and may be removed from the competition. During the Bench and Field Tests if a system fails to meet voltage requirements, the Team leader will be contacted and advised that their systems' performance has not met competition requirements.

Each system must have two output voltages always on. Instructions for the required connector wiring can be found at: www.dod.mil/ddre/prize/doc/Power_Connector_Wire_TerminationGuide.pdf and shows two pins required per voltage, a common ground pin, and one pin that will not be used by the WPP test unit. The test equipment must be able to draw power from either voltage without operator interaction with the power system under test (i.e. an operator will not be able to engage a mechanical switch in order to switch between the two voltages). The systems ability to meet the voltage requirements will be tested during the Safety Evaluation.

3.4 Competition Schedule

The competition was announced 05 July 2007 and will be held 22 September through 4 October 2008 at the Marine Corps Air Ground Combat Center, Twentynine Palms, California. The Competition Schedule is as follows:

5 July 2007	Competition Announcement
21 September 2007	Public Information Forum (Held in the Washington, D.C. area.)
29 October 2007	Registration for Prize Competition Opens
30 November 2007	Registration for Prize Competition Closes
25 January 2008	Required data and format for Fuel Usage Plan Released
25 January 2008	Required data and format for System Description Released
29 February 2008	Competitor's Forum (Held in the Washington, D.C. area.)
7 March 2008	Submission of Fuel Plan
3 June 2008	Submission of the following documents required by each registered individual/team: <ul style="list-style-type: none"> ▪ Intent to Compete-from each registered team member and team leader ▪ System Description White Paper ▪ Statement of Use of Government funding/Government owned equipment with approval from applicable Government Contracting Officer. ▪ Individual/Team Visitor Request for Marine Corps Air Ground Combat Center
7 August 2008	Final Competitor's Forum (Held in the Washington, D.C. area)
22 September to 4 October 2008	Wearable Power Prize Competition, MCAGCC, Twentynine Palms, CA

4.0 PRIZE CRITERIA

4.1 *Winning Criteria*

The lightest weight system weighing 4 kg or less at the weigh-in and meeting the total energy requirement as demonstrated in the competitive demonstration (bench plus field tests) is the winner. Second and third place prizes are awarded to systems that meet the power and weight requirements but weigh more than the first place winner. In the case of systems with identical weights (defined as within 0.1 gram), a secondary “wearability” criterion is used. Wearability is measured by the maximum thickness of the system as it protrudes from the body when attached to a garment. The thinnest system wins the tie-breaker.

4.2 *Judging and Competition Rule Changes*

Competition Officials will monitor all parts of the competition and will accompany competitors during the field test. The Competition Adjudication Team (CAT) made up of senior DoD personnel will adjudicate and resolve any discrepancies throughout the competition and will validate winning systems that will receive any of the three cash prizes. In the event there is no team eligible for a cash prize, the CAT will validate the three best performing systems. The criterion used for the best performing system will be longest duration system. All decisions of the CAT are final.

Revision of these rules is subject to change and all competitors are encouraged to check for rules changes. All revisions will be posted to the Wearable Power Prize website at www.dod.mil/ddre/prize. The email address for recommended rule changes or clarifications is wearablepower@osd.mil.

4.3 *Prize Eligibility*

Prize Eligible refers to a situation where a team’s system is operating within competition requirements or has completed the bench and field tests and meets program requirements. The team is expected to stay for the entire competition and fully participate in the October 4th activities.

4.4 *Non-Prize Eligibility*

Non-Prize Eligible refers to a situation that occurs before or during testing where a decision is made by the Competition Officials that the entered system does not or is no longer meeting the system and/or competition requirements. Some examples of this include, but are not limited to a system falls outside specified voltage ranges during the bench or field tests, a system stops operating during the bench or field tests, the system presented does not pass the System Safety Evaluation, a system does not supply the required voltages when checked at the Safety Evaluation, a system does not stay mounted on the vest, and a system that does not power on. The team is encouraged to stay at the MCAGCC and participate/observe in the WPP activities e.g., MCAGCC tour, Kid’s Day, Competition, Social, Technology Exhibits, and WPP Field Tests.

5.0 SAFETY

DoD laboratory personnel will conduct a safety evaluation of each system prior to the start of the competition to verify that the system is safe to proceed into both bench testing and field-testing. Competitors will be given the opportunity to meet the safety criteria if the initial evaluation determines that the system is unsafe to begin the test. See Section 3.2.2 *System Safety Evaluation* for additional details.

No radioisotope or nuclear power sources are permitted. Human-powered harvesting systems are not eligible for this competition.

Competitors will be required to submit a System Description complete with a sketch(es) or photograph(s) of the prototype by 4:00 PM EDT, 3 June 2008. The System Description must meet the requirements contained in the document found at: www.dod.mil/ddre/prize/doc/wear_pwr/Instructions_System_Description.pdf.

6.0 FUELS

A wide range of fuel(s) and battery chemistry(ies) are allowed for use in this competition. The fuel or chemistry used by the power system during the competition must appear on the Acceptable Fuels/Chemistry list. Competitors are required to submit a Fuel Plan by 4PM EDT 7 March 2008. The Fuel Plan Instructions and Guidelines can be found at: www.dod.mil/ddre/prize/doc/wear_pwr/Instructions_FuelPlan_FINAL.pdf. In the event a competitor's required fuel or battery chemistry does not appear on the Acceptable Fuels/Chemistry list, a request to have the fuel and/or chemistry added to the acceptable fuels list can be made by submitting an email request to wearablepower@osd.mil.

No radioisotope or nuclear power sources are permitted. Human-powered harvesting systems are not eligible for this competition.

7.0 INTELLECTUAL PROPERTY

The government claims no rights to the intellectual property of competitor's systems. Any proprietary information disclosed to the government will be protected in accordance with government regulations.

Future development of the candidate systems will be under separate contracts and subject to government rights clauses agreed to under those contracts.

Systems will be visible to competitors and media during the bench test and field test. Competitors concerned about proprietary information should ensure no proprietary information can be ascertained from a casual viewing of the system.

8.0 TEAM DISQUALIFICATION

Registered individuals/teams shall be terminated for the following:

- At the request of the registered Individual or Team Leader participating in the Wearable Power Prize competition.
- Individual, Team Leader, Team Members not meeting eligibility requirements. At the time of prize award, if it is determined that an individual/team has not met the eligibility requirements, the individual/team shall be terminated without regard to competition performance in meeting prize objectives. No cash award will be given.
- Failure to Submit WPP documents by the required due dates. These documents include: Fuel Plan, Notice of Intent to Compete, System Description, Statement of Use of Government funding/Government owned equipment with approval from applicable Government Contracting Officer, and Individual/Team Visitor Request for MCAGCC.
- Use of fuels/chemistries not shown on the Acceptable Fuels/Chemistry List or use of fuels/chemistries without express permission given by the Competition Officials.
- Substitutions or changes to a system that were not previously documented in the Fuel Plan or System Description White Paper and approved by Competition Officials.
- Fraudulent acts, statements, or misrepresentations involving any Wearable Power Prize documentation or systems used for the competition.
- Behavior or dress not consistent with guidance given by Competition Officials or violation of Base regulations while at the U. S. Marine Corps Air Ground Combat Center.
- Violation of any federal, state, or local law or regulation determined to be inconsistent with the WPP program.

9.0 CANCELLATION

The DoD reserves the right to cancel this prize program at any time leading up to and during the competition.

Appendix A-1:Acronyms

CAT	Competition Adjudication Team
D.C.	District of Columbia
DoD	Department of Defense
EDT	Eastern Daylight saving Time
EST	Eastern Standard Time
FFRDC	Federally Funded Research and Development Center
GPS	Global Positioning System
Hr	Hour
Kg	Kilogram
MCAGCC	Marine Corps Air Ground Combat Center
MOLLE	Modular Lightweight Load-Carrying Equipment
SET	Safety Evaluation Team
O ₂	Oxygen
USD	United States Dollar
VDC	Volts Direct Current
W	Watt
WPP	Wearable Power Prize