

Director General CRPF
Block No. 1 CGO Complex, New Delhi-110003

(Govt. of India/Ministry of Home Affairs)
(Phone / Fax- 011-24360155)
(E-Mail- digprov@crpf.gov.in)

No. U.II-98 (Spec)/2024-25-Prov (PEARL)-14 Dated, the December, 2024

To

The DsG: AR, BSF, CISF, ITBP, NSG, SSB and BPR&D.

Subject: QRs/Specifications of “ Passive Exoskeleton for Augmentation and Rapid Logistics (PEARL)”.

I am directed to refer on the subject mentioned and to say that the QRs/Specification in respect of “**Passive Exoskeleton for Augmentation and Rapid Logistics (PEARL)**” recommended by CAPFs Sub-Group as per Appendix-A has been approved by the competent authority.

2. Henceforth, all the CAPFs may procure the above item by them strictly as per the laid down QRs/Specification.

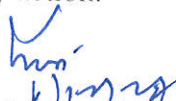
3. This has the approval of the DG on 26/11/2024 (empowered by MHA vide ID Note No. IV-24011/24/2019-Prov-I/CF:3465740/442 dated 23/07/2024.)

Encl: As above


(Shahnawaz Khan)
DIG (Prov) Dte

No. U.II-98 (Spec)/2024-25-Prov (PEARL)-14 Dated, the 6th December, 2024
Copy forwarded to:

01. SO(IT), North Block with request upload the approved QRs/Specification of **Passive Exoskeleton for Augmentation and Rapid Logistics (PEARL)**” on MHA Website (e-mail ID : soit@nic.in.
2. Sh. Paritosh Singhal, ACEO(GeM), Government of India, Ministry of Commerce & Industry, Government e-Marketplace, Jeevan Tara Building, 5- Parliament Street, New Delhi-110001 with request to upload the approved QRs/Specification of **Passive Exoskeleton for Augmentation and Rapid Logistics (PEARL)**” on GeM Portal
3. DIG (IT), Dte Genl., CRPF with request to upload this approved QRs/Specification of **Passive Exoskeleton for Augmentation and Rapid Logistics (PEARL)**” on CRPF Portal and SELO Module.
4. All Zones/ Sector/GCs/Units for information and necessary action.


(Shahnawaz Khan)
DIG (Prov) Dte

N.O.O.

Prov-05/06/08/09 for information please.

BOARD PROCEEDINGS

- Proceedings of : Sub-Group of CAPFs
- Constituted vide : GOI/MHA ID Note No. IV-24011/24/2019-Prov-I/CF:3465740/442 dated 23/07/2024,.
- Assembled at : Directorate CRPF, Block No. 01, CGO, Complex Lodhi Road, New Delhi
- Assembled on : 26/11/2024 (at 1130 hrs)
- Purpose : Framing of QRs/Specification of “ **Passive Exoskeleton for Augmentation and Rapid Logistics (PEARL)**” for augmenting the capability of the soldier/individual to carry more weight and enhance the endurance without experiencing the actual pay load.

Composition of Board

1. Sh. Sandeep Khirwar, IPS, ADG (HQr) CRPF
2. Sh. Sonal V Misra, IPS, IG(Prov) HQr, CRPF
3. Sh. Shahnawaz Khan, DIG (Prov), CRPF
4. Sh. Sanjeev Kumar Singh, 2-I/C, CRPF
5. Sh. Neeraj Kumar Patel, DC , CISF
6. Sh. Nitin Rana, DC/CTS, BSF.
7. Sh. Kamlesh Kumar Sharma, AC, ITBP
8. Insp/Armr Prabhat Kumar Manna, SSB
9. Sh. Madan Pal Tyagi, N/Sub., AR

Expert Members

- i. Dr. K. Mohanavelu, Scientist-G, Associate Director, DEBEL
- ii. Shri Avinash C.Verma, Addl. Director, DEBEL

2. In pursuance of GOI/MHA ID Note No. IV-24011/24/2019-Prov-I/CF:3465740/442 dated 23/07/2024, the sub group of CAPFs under the chairmanship of ADG (HQr), CRPF assembled at Directorate General, CRPF to frame the QRs/Specification of “ **Passive Exoskeleton for Augmentation and Rapid Logistics (PEARL)**” for augmenting the capability of the soldier/individual to carry more weight and enhance the endurance without experiencing the actual pay load.

8. In view of above, CAPFs Subgroup members and expert members unanimously agreed to freeze the QRs/Specifications of “ **Passive Exoskeleton for Augmentation and Rapid Logistics (PEARL)**” and submitted for approval of DG, CRPF.

Member : NB. Sub. Madan Pal Tyagi, AR	Member : Insp/Armr Prabhat Kumar Manna, SSB
Member : Kamlesh Kumar Verma, A/C , ITBP	Member : Neeraj Kumar Patel, D/C , CISF
Member : Nitin Kumar, D/C , BSF	Member : Sanjeev Kumar Singh, 2-I/C, CRPF
Member : Shahnawaz Khan, DIG, (Prov), CRPF	
Member : Sonal V Misra, IPS, IG(Prov) HQr, CRPF	
Chairman : Sandeep Khirwar, IPS, ADG HQr, CRPF	

Passive Exoskeleton for Augmentation and Rapid Logistics (PEARL)

PEARL exoskeleton systems shall augment the capability of the soldier/individual to carry more weight and enhance endurance without experiencing the actual payload. These structures shall be coupled with the human and move synchronously with the User. The primary objective for developing the passive exoskeleton system, PEARL, is to transfer the loads carried by an individual, as a backpack, directly to the ground. The system aims to reduce the compressive loads experienced in the spine and lumbosacral joints while walking on even & uneven terrains at higher walking speeds or longer distances. This will, in turn, reduce the risk of musculoskeletal injury by selectively supporting specific body positions to enhance the payload-carrying capacity and improve endurance without being exerted too much. This simple system will significantly enhance human performance by reducing muscle activity by effectively utilising springs, dampers, and cushioning devices to alleviate the detrimental Impacts. DEBEL has conducted extensive trials and experiments and optimized the performance using EMG.

PEARL Exoskeleton has been tried out extensively in different theatres, weather conditions, terrain, and altitudes by ITBP and CRPF. The product's usability has been assessed & found to be useful for logistic purposes. In thick vegetation and for quick reflexes, the usefulness of the product is limited.

Functional Qualitative requirements

1. Operating Conditions: Passive exoskeleton shall be used by soldiers to carry heavy backpack loads in the following environmental conditions:

- (a) Temperature: -25 to +50 degree Celsius
- (b) Moderate Rain / Snow/ Plain terrain/ Hot regions/ Moderate Elevation Zones
- (c) Relative humidity: 50% to 95%
- (d) Operating during logistics, patrolling during walking and standing on even and uneven surfaces up to altitudes of 20,000 ft AMSL.

2: Donning and Doffing: Easy to Don and Doff. & is comfortable during usage. The system has modularity, adjustability and interchangeability for soldier height between 160-190 cm encompassing (the 5th -95th) percentile of the population. *(However, the DEBEL team/ Approved ToT partners will be training a set of officers/men for donning/doffing and adjusting the system to be used for different appendages, as desired by the buyer)*

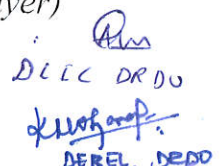

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3: Material Requirement:

The materials shall be lightweight and desirable to have the following properties.

- 1) The structural strength and integrity of the materials used should be able to augment the backpack load for at least 2000 hours.
- 2) Fabrics & garniture materials used for Human exoskeleton interfaces should be waterproof/ water repellent and flame retardant.
- 3) The colour of the above shall be as per Users' requirements.
- 4) The requirement of the materials used with performance parameters shall form part of the specification.

Note: In the wake of the complexity of the metallurgy, DEBEL will ensure the quality of the product through DMI (During manufacturing inspection) and PDI (pre-dispatch inspection) through ToT holders.

4: Performance: Conformal to the parameters listed in Table 1.

Table-1

i.	Biomechanical Activity	Standing, Moderate, & Brisk walking on even and uneven surfaces.
ii.	Weight of PEARL	≤ 5kg
iii.	Payload Capacity	a) 15kg of backpack load b) 30kg with minor modification in the system
iv.	Walking Speed	up to 5 kmph (Approx.) depending upon terrain
v.	Walking Terrains	Walking is possible on even and uneven terrains
vi.	Compatibility with Combat Gear, Rucksack, shoes with exoskeleton	Designed, tested and evaluated for <ul style="list-style-type: none">• Any type of backpack (shoulder rucksack) load of 15kg (Optional weight of 30kg) along with combat gear and weapons• Any type of shoes in service use during walking.


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vii.	Anthropomorphic Variability	The anthropomorphically modular design has adjustability from the 5 th to 95 th percentile (160cm – 190 cm) of variation in height.
viii.	Range of motion	Unobtrusive to humans during natural walking
ix.	Acceptances Test Criteria	a. The system should have greater than 60 % of spinal offloading up to 15000 ft, with a 50% offloading of backpack payload to ground, thereby reducing the risk of muscular, joint and lower back spinal injuries. b. Donning time of <30s and Doffing time < 15 seconds with training. <i>(As tried at DEBEL Lab, Bangalore, it is possible only through training and consistent practice. DEBEL/Approved ToT holders will impart familiarization training to the set of officers and men of the buyer force)</i>
x.	Qualification Standards	Conformal to JSS55555 standard as applicable

5 Ergonomics:

The passive exoskeleton, along with all accessories, shall be lightweight and should be compact. It should not foul with any of the combat gear or accessories and should not hinder the movement of the individual while providing assistance.

6. Shelf Life.

The system should have a minimum shelf life of seven years.

7. Warranty: The system should have a minimum service life of two years, after which it should be able to be refurbished and reused. *DEBEL/Approved ToT holders/production agencies will provide spares and maintenance for the next two years at a reasonable rate. The rate of spares and maintenance may also be mentioned at the time of purchase.*

8. Workmanship: The workmanship & finish should be of the highest quality, and uniformity needs to be ensured in each lot. The inspection teams and Internal Quality Assurance (IQA) shall critically examine the same during various production and Pre-Dispatch Inspections (PDI) stages.

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QUALITATIVE REQUIREMENTS FOR STORES/ EQUIPMENT TO BE DEVELOPED BY DEFENCE BIOENGINEERING AND ELECTROMEDICAL LABORATORY (DEBEL), DRDO, CV RAMAN NAGAR, BANGALORE-560093

Passive Exoskeleton for Augmentation and Rapid Logistics (PEARL)

1.	(a) Sponsoring authority	ITBP, Ministry of Home Affairs
	(b) Their Reference	DLIC 8 th Council Meeting
2.	(a) Full Nomenclature	Passive Exoskeleton for Augmentation and Rapid Logistics (PEARL)
	(b) Section reference No. or part No. of existing item (s)	NA
3.	Publication number of equivalent (if any)	NA
4.	Security classification (Give the security classification e.g., restricted/ secret during development)	Restricted Niche Technology for Human augmentation
5.	Priority (State urgency, if any, and reasons thereof)	Urgent
6.	State nature of development as indicated below	
	(a) New design	Yes
	(b) Based on existing model	No
	(c) Modification of the existing type	No
7.	Related items likely to influence the Design of items under consideration	NA
	(a) Already in existence	NA
	(b) Contemplated	NA
8.	Drawbacks, if any of the existing	The present system is developed for the augmentation of a 15kg backpack payload, extendable up to 30 kg.
9.	Number of prototypes required for user trials	03 No's for ITBP, CRPF, SSB (Each)
10.	Indicate the Unit/Location where the Users' trials will be conducted	Leh, Tawang, Chhattisgarh, Rajasthan with High altitude, Semi-mountainous terrain involving logistics and long endurance marches and other adjoining Op Areas.

PART II: OPERATIONAL CHARACTERISTICS

11.	Primary Role	Offloading major portion of backpack payload to the ground during standing and walking on even and uneven surfaces.
12.	Alternate Role	NIL
13.	Functional requirement	
	(a) Performance requirement of the item	As mentioned above.
	IMPORTANT NOTE: Full details of the item's performance should be given in the opposite space. If the space is not adequate, information may be given in a separate appendix (this information is vital to the success of the development project)	

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	(b)Operational conditions (Give details of climate and other service conditions in which the item must operate).	Operational between -25 to +50 degrees Celsius with backpack load walking under even and uneven terrain
	(c)Limitations of weight, dimensions and any other special limitations, such as the nature of the power supply,etc.	≤ 5 kg without accessories
14.	Any other essential characteristics	<ul style="list-style-type: none"> (i) It should be conformal and adjustable from the 5th to 95th percentile (160-190 cm) height of anthropometry (ii) All Human Machine interfaces should be water-resistant (iii) Modular and interchangeable between soldiers (iv) Easy to repair and maintain.

PART III: PHYSICAL CHARACTERISTICS

15.	Mode of transport required for movement of store/equipment	The same shall form part of the specification
16.	Special requirement of packaging, any special limitations on size of package, etc.	The same shall form part of the specification

PART IV: PROVISIONS AND RELATED DATA

17.	Estimated quantity required and date by which it is required	
	(a)Initial requirement (Quantity)	50,000
	(b)Recurring requirement (Give details of annual requirement and reserves)	This will depend on the requirements of the user force
	(c)Indicate the number of years the item is likely to remain in use	Till upgraded with a better version

Note: This data is required by the development authority to properly phasing design, development, testing and acceptance.

PART V: IDENTIFICATION, PRESERVATION AND SERVICING

18.	Preservation requirements	
	(a)For field use	A comprehensive User cum maintenance manual in print and digital format shall be provided with each PEARL..
	(b)For storage	A comprehensive usage and maintenance manual in print and digital format shall be provided with each item. The manual shall specify the storage conditions and maintenance activities to be undertaken at the storage depot, OEM level, Unit level, preventive maintenance and Service maintenance to ensure the desired usage life within the specified shelf life.


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19.	Identification Mark (State any special markings to be stenciled, painted, etc.)	Two labels, as per the governing specification, are to be provided. The label shall be embroidered / water resistant and shall have the nomenclature, part no, date of manufacture, vendor details, life and specification indicated on it.
20.	Servicing features	Servicing and maintenance manual to be provided. As per para 18 above.

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Anish Dayal Singh, IPS
Director General, CRPF