MEHAR BABA COMPETITION-II

"Swarm Drone Based Foreign Object Detection on Aircraft operating surface"

DIRECTORATE OF OPERATIONS (AIR DEFENCE)
INDIAN AIR FORCE

MEHAR BABA COMPETITION-II VERSION 7

Table of Contents

1.0 Background

1.1 Mehar Baba Competition

Few names in Indian Air Force history evoke such awe and inspiration as that of Air Commodore Mehar Singh, DSO, MVC, affectionately known as Mehar Baba. Commissioned as Pilot Officer in 1936 at the Royal Air Force College, Granwell, UK, he was posted to the sole squadron in the Royal Indian Air Force, No.1 Squadron. Post-independence Mehar Baba was the first to land in Poonch and Srinagar in Kashmir, and later the first to land in Leh, then the highest altitude airstrip in the world. Mehar Baba was awarded the Maha Vir Chakra (MVC) and was its first IAF recipient. He passed away in 1952 when his Beechcraft Bonanza aircraft crashed in Delhi a few days short of his 37thbirthday.

In his honour, the IAF has started a competition Mehar Baba Competition to provide a platform to the academic and the Indian Industry to boost the indigenous development of Drones. The first edition of the competition was launched in Oct 2018 and culminated in Oct 21. The second edition of the competition has been launched on 06 Apr 2022. The theme of the competition this time is Swarm Drone Based Foreign Object Detection on Aircraft operating surface.

1.2 Aircraft Operating Surface and Foreign Object Damage

Aircraft operating surface like runways, taxi tracks, aprons etc form an important and integral part of aviation. The surface always needs to remain clear of any foreign objects Damage (FOD) as they are flight safety hazards and cause damage to the aircraft externally (on the airframe) internally (in the engine). The term FOD is used to describe both foreign objects themselves and any damage attributed to them. FOD includes all items on the operating surfaces, upto millimetric sizes, which are alien to the aircraft operating. For example, small rocks, pebbles, broken pavements, nut bolts, tools, dead bird, metal pieces, locking wire, papers etc. These may find place on the surfaces due falling out of aircraft & vehicle operating on them. Such FODs can cause damage to tyres, airframe, canopy/ wind shield or get ingested in the engine which may further lead to an accident. For example, the cause of crash of Air France Flight 4590 in July 2000 was attributed to titanium debris dropped by and continental DC-10C flight that had departed only four minutes earlier.

1.3 Swarm Drones

The IAF faces a huge challenge in keeping the operating surfaces clean and clear of FOD. Towards this a large number of air warriors walk along surfaces at arm's length to each other (FOD walk) and pick up FOD manually. This is undertaken regularly during the day, from dawn to dusk. However, visual spotting of these FOD at night is not possible; hence FOD walk is not undertaken after dusk. FOD walk requires a large number of manpower and which if relieved, can be productively utilized towards core duties. Hence, the IAF is seeking innovative solutions towards detection of FOD without physical employment of manpower.

One such way is the employment of drones or unmanned aerial vehicles (UAV) in a swarm Collaborative UAVs equipped with appropriate software (e.g. artificial intelligence, swarm intelligence etc) and sensors have the potential to scan the aircraft operating surfaces and detect FOD. If implemented, this will benefit technologically and operationally.

2.0 Important Dates

(a) Period of duration of competition	06 April 2022 to 15 October 2023
(b) Competition announcement date	06 April 2022
(c) Deadline for initial submission of application for phase 0	02 October 2022 2355 Hrs
(d) Phase 0- Short listing of participant	03-14 October 2022
(d) Announcement of Shortlisted application for Phase I	17 October 2022
(e) Phase I presentation date	07-11 November 2022
(f) Phase I result announcement	21 November 2022
(g) Phase II dates	To be announced (TBA) later
(h) Phase II result announcement	TBA
(j) Phase III presentation date	TBA
(k) Phase III result announcement	TBA
(l) Final awards ceremony	October 2023 (exact date TBA later)

Note: - Please keep checking the website for any change in dates, interim announcements of dates for updates and various events related to the competition.

3.0 Competition Description

3.1 Vision

To stimulate the development of indigenous industries of UAS and find an innovative solutions to detect FOD on aircraft operating surface that will benefit the entire aviation industry. Though few of the technology ingredients of such a system exist, the competition strives to build the final end to end solutions and infrastructural capabilities to address the IAF needs.

3.2 Structure & Specifications

The competition is spread over four mandatory phases with stage expansion and elimination rounds at each stage. The IAF also provide financial support for capability demonstration in phase II & III**.**

Phase 0 will comprise of initial submission of applications i.e registration, short listing of 30 applicants based on predefined assessment criteria. Phase-I will have presentation by 30 shortlisted participant and selection of 10 participants for progressing in Phase-II, which will be demonstration of limited capability with a swarm of UAVs and further short listing of five participants for Phase-III.

At the end of Phase III, the teams are expected to showcase a collaborative VTOL UAV solution of Swarm UAVs equipped with requisite sensors & secure communication packages that can scan the operating surfaces, detect FOD and provide its image and accurate location at a centralized monitoring station. The entire activity of scanning, detecting and reporting to be completed within 30 minutes of the launch. The launch and recovery of the drones could be manual or machine based on ground. The system needs to demonstrate the ability to gather, analyse and fuse data in a collaborative swarm environment through a single operator on a single portable a Ground Control Unit (GCC) with adequate redundancy.

The solution should have substantial Indian Content (Minimum 60% indigenous content), with higher indigenous content getting due weightage during this phase as per the predefined assessment criteria. The breakdown details of equipment and sub assembly needs to be provided. Top three winners will be

announced at the end of this phase and which will be the culmination of this competition.

Broad Parameters

The broad parameters for swarm Drones to be achieved and will be assessed are as follows:-

(a) Scan and detect sub-centimetric size foreign objects on aircraft operating surfaces which comprises of following:-

(i) Runway of minimum dimension 9000 feet by 150 feet.

(ii) Taxi Track of minimum dimension 9000 feet by 75 feet.

(iii) Minimum four link taxi tracks each of dimension 2000 feet by 75 feet.

(iv) Two aprons (parking space) with sun shelters. The dimensions of each apron is1000 feet by 200 feet.

(b) Payload: EO, IR, Millimetric wave (MMW) Radar, light Detection and Ranging (LIDAR) any other suitable measures or combination of them.

(c) Provide alerts, accurate location & discernable image of FOD to a monitoring station. Should have image correction ability and identify the type of FOD.

(d) Should have a central monitoring and control station with recording facility.

(e) Ability to operate with minimum manpower.

(f) Should be capable of Operating from the airfield with elevation of upto 6000 ft and above.

(g) Entire activity of scanning, detection and reporting of FOD on all operating surfaces mentioned at sub Para (a) above should be completed within 30 min.

(h) Capable of executing the activities by day and night, in reduced visibility (<500 m) and light wind conditions (upto 10 knots).

(j) Should not generate FOD during operation.

(k) Capable of returning home automatically in case of un-serviceability or loss of data link or any other unexpected eventuality.

The deadlines and time duration of the whole competition and individual phases is outlined in section 2.0 (Important dates).

Phase 0

The participant will be shortlisted based as per predefined assessment criteria's for this phase on their proposal/data submitted during the registration process. The committee of experts will shortlist upto 30 participants for further progressing in phase-I.

Phase I

The shortlisted participants shall present an expanded version of the technical and financial proposal provided earlier, and a white paper based on the mission goals of the subsequent two phases (Phase II & III).

The 30 selected participants from the phase 0 will be giving a face to face presentation in New Delhi. Sub-system presenters will be required to give a practical demo of their software and or hardware.

At the end of phase I, a maximum of 10 participants will be shortlisted to progress in phase II.

Phase II

The 10 shortlisted participants from phase I need to demonstrate actual collaborative behavior of swarm of UAVs and their capability to scan detect and report FOD to a centralized monitoring system. The UAVs will need to operate at the designated place at the time of the demonstration. But the minimum requirements for the demonstration are:-

(a) Scan the operating surface (9000 ft X 150 ft) in 30 min by day.

(b) Detection of FOD upto centimetric sizes

(c) Feedback mechanism to a central location.

(d) Height of operation not more than 100m

At the end of phase-II, a maximum of 05 finalists will be shortlisted to participate in phase III

Phase III

The shortlisted participants need to demonstrate complete collaborative behavior of a swarm of UAVs. The UAVs will need to execute and demonstrate all activities as per parameters given above under para 3.2 above. Three winners will be announced at the end of this phase.

3.3 Extra Specifications

The previous section underlines the basic specification requirements. Incorporation of these extra specifications shall be given extra credit by the committee of experts.

(a) Ability to continuously monitor the operating surfaces 24 X 7.

(b) Picking up of FOD by drone without affecting other operations.

(c) Incorporation of counter measures to counter standard anti-drone/ hacking technologies.

(d) Modular architecture with functionality to plug in third sensors, actuators and programming.

(e) Any other innovative feature the team can highlight as pertinent towards FOD detection and pickup.

4.0 Eligibility

Only Indian citizens and Indian registered entities made by only Indian citizens are allowed to participate in the corporation. Indian registered for-profit companies, entities, academic institutions and teams of Indian citizens are eligible to participate in the competition. This competition is not open to any air warrior from the sponsoring cell.

Groups of Indian citizens, e.g. college students, can participate only in phase-0 and phase 1 without a formal registered for-profit entity or startup.

Individuals with specific skill-sets or part of the desired solution are strongly encouraged to build a team, collaborative or join a team through the competition's ~~website~~ webpage Forum section. Further details are available in section 5.0.

But upon selection for participation in Phase-II and subsequent continued participation in the competition, the group shall need to form an established for-profit Indian company. No exceptions shall be allowed.

5.0 Incubation

The participating teams can avail guidance and mentorship throughout their duration of competition on various aspects of operating surfaces, FOD and Drones.

The IAF also encourages joint participation through team mergers or joint venturing etc, in case the jointly participating teams conclude that their combined skills and product functionalities will be enhances by such a joint participation to increase their chance of success in the competition upon forming such a venture or alliance.

Each team can participate in only one such collaboration. Any formation of cliques and other unethical behaviors shall disqualify the team indulging in such behavior. The decision of the organizers will be final and binding in this regard.

The eventual sole source order upon winning by such an alliance will be treated as a whole single entity.

6.0 Innovation

The participants are free to come up with any innovative or bold solution within the bounds of this competition Vision Document. Plagiarism of ideas, IP or solutions is prohibited; participants are encouraged to maintain references.

Primarily innovation is directed and encouraged towards artificial intelligence in swarm drones in terms of decision making, image correlation, provide alerts and suggest corrective measures.

7.0 Intellectual property

All Intellectual Property (IP) created during the competition shall be jointly owned by the developing team and the IAF. The developing team and the IAF will get into a binding contract of co-ownership at a later date.

8.0 Application & submission information

Interested participants are to submit their proposal via filling the requisite details in Google form available on webpage of the competition. The proposal should focus on meeting QR in the Google form.

Video

Video links for present state of the hardware and / or functionality are encouraged during Phase - I presentation.

Simulation

Simulation of utilized algorithms, physics and/ or sensors for single UAV and collaborative multi UAV (swarm) scenarios is encouraged. Participants are free to use any known standard / open source simulator to show various functionalities and capabilities in phase I.

Interested parties are encouraged to carefully read Section 12.0 (Terms and conditions for Participation) before the competition.

9.0 Application Review Information

9.1 Evaluation Criteria

Along with the operational goals, the collaborative UAV solutions will need to demonstrate the following technical abilities at the various stages of the competition. Technical evaluation of the participating UAS system will be done by committee of experts on the subject and shall be done on multiple levels including but not limited to following:-

(a) UAV Flight Characteristics

(i) Flight stabilization
(ii) Localization and navigation
(iii) Collision Avoidance

(iv) Power and energy management
(v) Launch and recovery
(vi) Return home (default and in failure)

(b) Communication

(i) Secure and viable solution
(ii) LOS/ADR/ Any other solution.
(iii) Distance projected and achieved
(iv) Backup data link
(v) Downlink, images, videos and recording
(vi) Autonomy/ Swarm mission programming
(vii) Ground control

(c) Collaborative Swarm Behavior

(i) Aggregation
(ii) Collective management
(iii) Task Allocation
(iv) Source Search
(v) Self Healing

(d) Payload

(i) Type of pay load:- EO or EO/IR , Millimetric wave (MMW) Radar, Light Detection and Ranging (LIDAR), any other
(ii) Benchmark achieved in Subsystem.
(iii) Total number of sensors
(iv) Type and Gen of sensors
(v) Any other suitable measures or combination of them
(vi) Viable solution projected in proposal

(e) Maintenance

(i) Ease of repair rectification
(ii) Cost effectiveness.
(iii) Concept of maintenance

(f) Scan and detect

(i) Method proposed/used for scan

(ii) Capability to differentiate between various type of FOD
(iii) Capability to identify type of FOD
(iv) Accuracy (image correlation capability)

(g) Extra credit features. As mentioned in section 3.3 (Extra Specifications)

9.2 Committee of Experts

Each stage shall be adjudged by a pre- selected committee of experts panel. The details of the committee shall remain confidential. Each committee may not have same members but shall comprise of members with similar cumulative skills, expertise and backgrounds. The committee shall have member from following backgrounds:-

(a) IAF serving officials with pertinent background,
(b) Serving officers with operational experience.
(c) Domain expert(s) from civil organisation

The committee might co-opt other domain experts on as a case to case and/ or need basis.

9.3 Swarm Intelligence

On the onset the drones needs to self assemble into a formation before initiating their sorties. The given area to be scanned is defined under section 3.2. Drone swarm dispersion for scan identity and report operations is not restricted to a specific sequence or algorithm.

The given drone swarm shall be intelligent enough to negotiate a collective movement through an artificial or natural landscape while avoiding collisions with them or within the swarm themselves.

The swarm needs to scan the entire operating surfaces to spot FOD on them and provide alerts with accurate locations and image of FOD. Multiple sensors and actuators may be incorporated to undertake collaborative operations.

The drones shall be intelligent enough to collaborate and distribute and allocate tasks amongst themselves (individual drones) in the swarm. Multi-sensor data fusion would invite more marks and any proprietary algorithms which

add value to the current professional discourse and practical applications would be judged with appropriate weightage.

9.4 Artificial Intelligence

Each drone in the swarm needs to be able to spot FOD, both stationery and moving. With image correction capability it should be able to identify type of FOD and provide alerts with suggested corrective actions. These identified applications do not limit artificial intelligence usage in other applications or functioning of the swarm.

10.0 Award Administration Information

Phase 0

Award amount : Zero Rupees
Development Funds : Zero Rupees

Phase I

Award amount : Zero Rupees
Development Funds : Zero Rupees

Phase II

Award amount : Zero Rupees/ Participation certificate

Development Funds :Upto Rs 30 Lakhs (Thirty lakhs only) per team (Development fund will be provided to the 10 shortlisted teams who meet a specific level of the scenario benchmarks as assessed by Committee of experts). The amount will be reimbursed based on the invoices submitted by the team and scrutinized by concerned IAF accounts dept.

Phase III

Award amount : Rupees 30 Lakhs (Thirty Lakhs only) to the winner, 20 Lakhs (Twenty lakhs) to runners up and 10 Lakhs (Ten lakhs) to the third position and participation certificate to all five finalists.

Development Funds	: Upto Rs 2 crores (Two crores) per team (Development funds will be provided to the 05 finalists who meet a specific level of the scenario benchmarks as assessed by Committee of experts. The amount will be reimbursed based on the invoices submitted by the team and scrutinized by concerned accounts dept).
Co-production Order	: Winners stand a chance to participate in capital procurement thereon to the volume of Rs 300 crores pan Indian Air Force and Indian Navy air bases.

11.0 Capital Procurement

The finalist (Phase III) of the competition may be given chance to participant in capital procurement of up to Rs 300 crores for IAF.

12.0 Terms and conditions for participation

1. Only Indian citizen/ entities/educational institutions/ registered organizations/ companies are allowed to participate.

2. All teams need to register by filling up the registration form given on the site with requisite documents. Incomplete form will not be accepted and would entail the team not being selected for participation.

3. A write up elaborating the proposed solution along with supporting documentation i.e. video/ presentation is a mandatory requirement for the selection process.

4. All participants shall abide by the timelines as given in the website. Non-adherence would entail disqualification of the team.

5. The teams would be solely responsible for the safety and security of the equipment.

6. The expenditure on travel including transportation of equipment boarding and lodging rests on the individual team. The IAF is not liable to pay for any

breakages/ damages/injury (to self/ other people) during the complete course of the participation.

7. The IAF reserves the right to select all, some, one or none of the proposals received in response to this solicitation for negotiation and to make awards without discussion with proposer.

8. Participants will be liable for any damage/ collateral damage/ injuries that would occur to any third party/ team members/ participants/ public at demonstration area during the competition while flying their respective drones.

9. The participants shall not publish any research paper without prior permission and vetting from the Air HQ, resulting from the proposed effort as the same is likely to disclose the performance characteristics of military systems or manufacturing technologies that are unique, critical to defence and have bearing on security of the state.

10. The decision of committee of experts detailed by the IAF for the assessment during the competition will be final and binding all participants. It will not be subjected to any dispute.

11. All suits or legal proceedings of any kind against the decision shall be instituted in the appropriate court(s) in Delhi or New Delhi notwithstanding the location of the competition, which may be subject matter of the dispute.

12. No suits or legal proceedings of any kind shall be instituted against the decision unless as notice in writing has been delivered to the IAF stipulating the nature of claims, cause of action, relief sought, name, registration number and address of the person, and a period of two months has expired thereafter.

13. The participants will strictly adhere to all security norms/ restrictions as instructed by the IAF from time to time.

14. IAF reserves the right to accept proposals in their entirety or to select only portions of proposals for award and subsequent co-production with IAF.

15. The IAF reserves the right to request further and/ or additional, documentation as it makes the award determination. Such additional information may include but is not limited to registration of operator and UIN with DGCA as they come into being.

16. The IAF reserves the right to move proposals from award consideration, should the teams fails to reach agreement on award terms, conditions, and or cost/ price within a reasonable time, or the proposer fails to provide requests additional information in the specified timelines provided by the IAF.

17. The viable swarm UAS solutions may be given a procurement contract, co-production agreement or other transaction, depending on the requirements.

18. For the publicity/ advertising of the given competition the IAF might use the provided documentation. The applicants can opt out of the above but shall need to state the same at the time of providing the information to the IAF.

19. The IAF reserves the right to cancel or postpone the event without any notification, if the Chief of Air Staff is satisfied that due to circumstance the proposed event cannot be held. Under such circumstances, the prospective participants are not entitles for any compensation or relief for the loss of any kind they may suffer.

20. The IAF holds the right to make any changes and amendments to these terms and conditions at any time without giving any prior knowledge whatsoever.

21. Details of resources employed, bills/invoices of equipments, sub assemblies and proprietary algorithms needs to be provided to the IAF towards calculating the indigenous content and financial outlay.

13.0 Competition Contacts

Address your queries to:

Group Captain OPS (RPA)
Air Headquarter (Vayu Bhawan)
Moti Lal Nehru Marg, New Delhi- 110011
Phone: 011-23010231 Ext: 5562
Email: apathy51@nic.in

Single Point of contact

Squadron Leader Manoj Kumar (Project Officer)

Contact Details: +91-9412727033
Email: apathy51@nic.in

Forum: **http://indianairforce.nic.in/meharbaba/forum**

The competition has a vibrant and very responsive Forum on its website. Posting a question or query there will most certainly elicit a response much faster than to the above email id.

14.0 Abbreviations

AMSL	: Above Mean Sea Level
BRD	: Base Repair Depot
DGCA	: Director General, Civil Aviation
DSO	: Distinguished Service Order
EO/IR	: Electro Optical/ Infra Red
GCC	: Ground Control Center
HADR	: Humanitarian Aid & Disaster Relief
IAF	: Indian Air Force
IP	: Intellectual property
M-Prize	: Mehar Baba Prize
MVC	: Maha Vir Chakra
RPA	: Remotely Piloted Aircraft
S/VTOL	: Short/Vertical Take Off & Landing
SME	: Subject Matter Expert
UAS	: Unmanned Autonomous System
UIN	: Unique Identification Number