OFFICIAL RULES

The 1st US-Asian Demonstration and Assessment of Micro Air and Unmanned Ground Vehicle Technology will be held in conjunction with the 1st US-Asian Micro Air and Unmanned Ground Vehicle Technology Workshop (collectively referred to as *MAV'08*) 10 – 15 March 2008 in Agra India near one of the Seven Wonders of the Modern World, the Taj Mahal.

Micro Air Vehicle (MAV) systems are ideally suited for deployment in intelligence, surveillance and reconnaissance missions, and the intelligence, surveillance, and reconnaissance (ISR) community is perceived as the primary benefactor of these developments. The objective of the MAV Demonstration and Assessment ("Demonstration") is to provide potential end-users of MAV systems with a clear picture of the present state-of-the-art of the technology while spawning ideas for the design of specific systems. The Demonstration will be complementary to the MAV'08 Technology Workshop which will identify where improvements in enabling technologies are urgently needed and which approaches appear to be most promising in reaching those technology goals. As much as $600,000 may be available in the form of Research Grants to those entries meeting and exceeding minimum performance standards across several categories. Prospective demonstrators are encouraged to form interdisciplinary and international teams to maximize expertise and the likelihood of success in meeting the prescribed missions set forth in these official rules.

The official World Wide Web pages for the MAV'08 Demonstration are your source for all information concerning rules, interpretations, and information updates regarding the Demonstration. The official rules and application form should be obtained from the official web site and will *not* be mailed to potential demonstrators. If you have received these rules as a hard copy from some other source, be advised that the official source of information can be found at

www.nal.res.in/MAV08

NOTICE

Demonstrators of prototype systems that are deemed to be meritorious will, subject to the availability of funds, be requested to submit proposals against the U.S. Army Research Office's Broad Agency Announcement and the award of research grants will follow.

GENERAL RULES GOVERNING ENTRIES

1. Micro Air Vehicles will have no dimension greater than 30 cm when operational (the vehicle with rotating rotors, propellers, extended wings, moving parts, etc. must fit within a 30 cm sphere).

2. Vehicles may be teleoperated or fully autonomous. They must compete based on their ability to sense the semi-structured environment of the Demonstration Arena, which may extend beyond line of sight (LOS). At most, 3 crew members are allowed in the launch site to operate their vehicle(s).

3. Computational power need not be carried by the vehicle(s). Computers may be set up outside the Demonstration Arena boundary, and data may be transmitted to/from the vehicles. Links can be by radio, infrared, acoustic, or other means so long as no tethers are employed.

4. The scoring formulas and arena have been carefully designed to normalize advantages inherent to a given class of vehicles (rotary wing, fixed wing, flapping wing, hybrid, etc.) such that all may compete fairly to perform the same tasks. Prospective teams must decide how best to allocate resources to maximize their potential score in light of the constraints imposed by the arena, the task, and the scoring algorithm.

5. The complete task will be performed in an arena with fixed boundaries of one (1) kilometer square. Vehicles crossing these boundaries, or which seem to be going away from a logical path, must be brought back under safety pilot control or terminated on command of the Judges. Way points may be dictated beforehand to avoid populated areas.

6. Each vehicle must be equipped with a termination mechanism that can render the vehicle ballistic upon command of the Judges. This termination mechanism must be demonstrated to the Judges prior to the first flight. Both autonomous and manually-assisted landings must occur within the boundaries of the Demonstration Arena.

7. Any form of propulsion is acceptable if the design is deemed safe in preliminary review by the Judges.

8. So that your application can be anticipated, and so that you can be notified were it not to arrive by the deadline, an *Intention to Compete* should be received before 14 September 2007 and preferably as soon as possible. The Intention to Compete should be transmitted by E-MAIL to the Organizer by clicking here. The E-MAIL of intention is not a prerequisite for application submission.

9. A completed application form must be submitted on or before 14 October 2007 via www.nal.res.in/MAV08/Registration. Entries received after the deadline may be rejected unless prior intention to compete has been expressed. All communications must be in English. A brief concept outline describing the vehicles must be submitted for safety review (the application form provides space for this). The Demonstration Organizers will either confirm that the design concept is acceptable, or will suggest safety improvements that must be made in order to participate. The official application form is available electronically from www.nal.res.in/MAV08/Registration.

10. The completed application form and a check or money order for Rs.12000 (~USD300) must be received on or before 30 November 2007. This application fee will be returned upon arrival at the MAV'08 Demonstration. (The fee has been instituted to discourage teams from applying that are not serious demonstrators.)

11. A research paper describing your entry is required as a submission to the associated workshop. Such a paper will be due in accordance with the dates and formats set forth in the MAV'08 Workshop documentation.

The Demonstration will be conducted under daylight conditions in winds gusting up to 37 kph (20 knots) and precipitation of as much as 1 mm hour. The Demonstration will be conducted during the most favorable weather occurring on the week of the MAV'08 event. Should weather preclude flight trials, the Demonstration will be cancelled; however, the workshop will still be conducted. Note that the risk of cancellation has been minimized by including a "rain day". Only the demonstrators who successfully pass through the "performance judging" (see below) will be *eligible* for the award of research grants. If weather precludes some demonstrators from flying their machines, there is no obligation to consider award of Research Grants beyond those that have actually been judged on their performance.

MISSION DEFINITION

THE SITUATION

Mavedonia is the smallest country in terms of population, and the smallest country that is a member of the World Bank. The Mavedonian Peoples Party has traditionally exercised exclusive control over the government; however, opposition parties legalized after the 2006 national elections has opened the door to the *Mavedonian Advocates for Violence* (M.A.V.) which has ties to the Mavedonian mafia. The M.A.V. group has adopted the stated mafia objective of eliminating World Bank influence where it interferes with mafia business objectives.

In March 2008, the only Mavedonian bank was overtaken by the M.A.V. group which is holding the banking staff hostage until certain concessions are granted by the World Bank and the Mavedonian government.

In response, the Mavedonia National Defense Forces have been marshaled to rout the M.A.V. group from the banking complex without loss of innocent life.

A PRIORI KNOWLEDGE

The Mavedonia National Defense Forces know that the hostages have been locked in a single room on the ground floor of the bank building, but exactly which room is unknown. Intelligence indicates that there are at least five armed M.A.V. members in control of the banking staff, but during a 40-minute window, all but two guards (who will be circling the building in a heavily armored vehicle with a 50 cal machine gun) will be participating in a staged video broadcast from the bank headquarters building elsewhere in the banking complex. The M.A.V. group has warned that the approach to the bank has been booby trapped with anti-personnel mines. Further, it is suspected that additional members of the M.A.V. group are en route to reinforce those already holding the bank hostages and could arrive at any moment.

MISSION PLAN

The Mavedonia National Defense Forces plan to make their hostage rescue during the distraction of the video broadcast. The Mavedonia National Defense Force intends to send in explosive ordnance disposal (EOD) robots in advance of an assault on the building. The Mavedonia National Defense Force plans to use one or more micro air vehicles to perform the following functions in connection with the planned raid:

1. Based on micro air vehicle reconnaissance, plan a path and correct timing for an assault from the 1 km banking complex perimeter to the designated building when the circling guard vehicle view is occluded by obstacles or buildings. The designated building is NLOS to the perimeter due to other buildings within the complex blocking the view.

2. Identify which room the hostages are in based on micro air vehicle reconnaissance.

3. Plan a path from the insertion point to the hostage room based on micro air vehicle reconnaissance.

4. Sweep the path to the bank building (using EOD ground robots) based on information gathered by micro air vehicles about the location of any mines encountered.

5. A successful mission will be declared if two Mavedonia National Defense Force commandos can reach the hostage room safely and undetected in under 40 minutes.

USEFUL BEHAVIORS

1. Micro air vehicles surveying the building exterior should not lose sight of the patrolling guard vehicle (which may stop, change direction, speed up, or slow down). Using multiple high flyers or multiple perching micro air vehicles may ensure that all blind spots are continuously interrogated.

2. Due to the difficulty in transmitting information from in and around buildings, micro air vehicles may work as relay teams to get the information back to the perimeter monitoring stations being used by the Mavedonia National Defense Force.

3. Micro air vehicles may communicate directly with ground-based EOD robot(s) or may relay information to EOD robot operators who direct those vehicles.

4. Micro air vehicles may share information about obstacles detected so a corporate data base can be created in real time to prevent different micro air vehicles from being surprised by unanticipated obstacles.

A LOGICAL MISSION SUCCESSION (Example)

1. Commandos choose an infiltration point (IP). Micro air vehicles are deployed to gain situational awareness and to map obstacles, threats, and aid in path planning for commando ingress based on discovery of hostage location from motion and acoustic cues delivered by hostages themselves.

2. UGVs deploy to locate and inactivate the mines that are between the IP and the building along selected ingress path.

3. Commandos deploy while micro air vehicles provide real-time updates about the position of hostiles in the area. Commandos may be ordered to hide, advance, or return based on surveillance monitored at the IP (commandos will not have direct link to/from robotic vehicles).

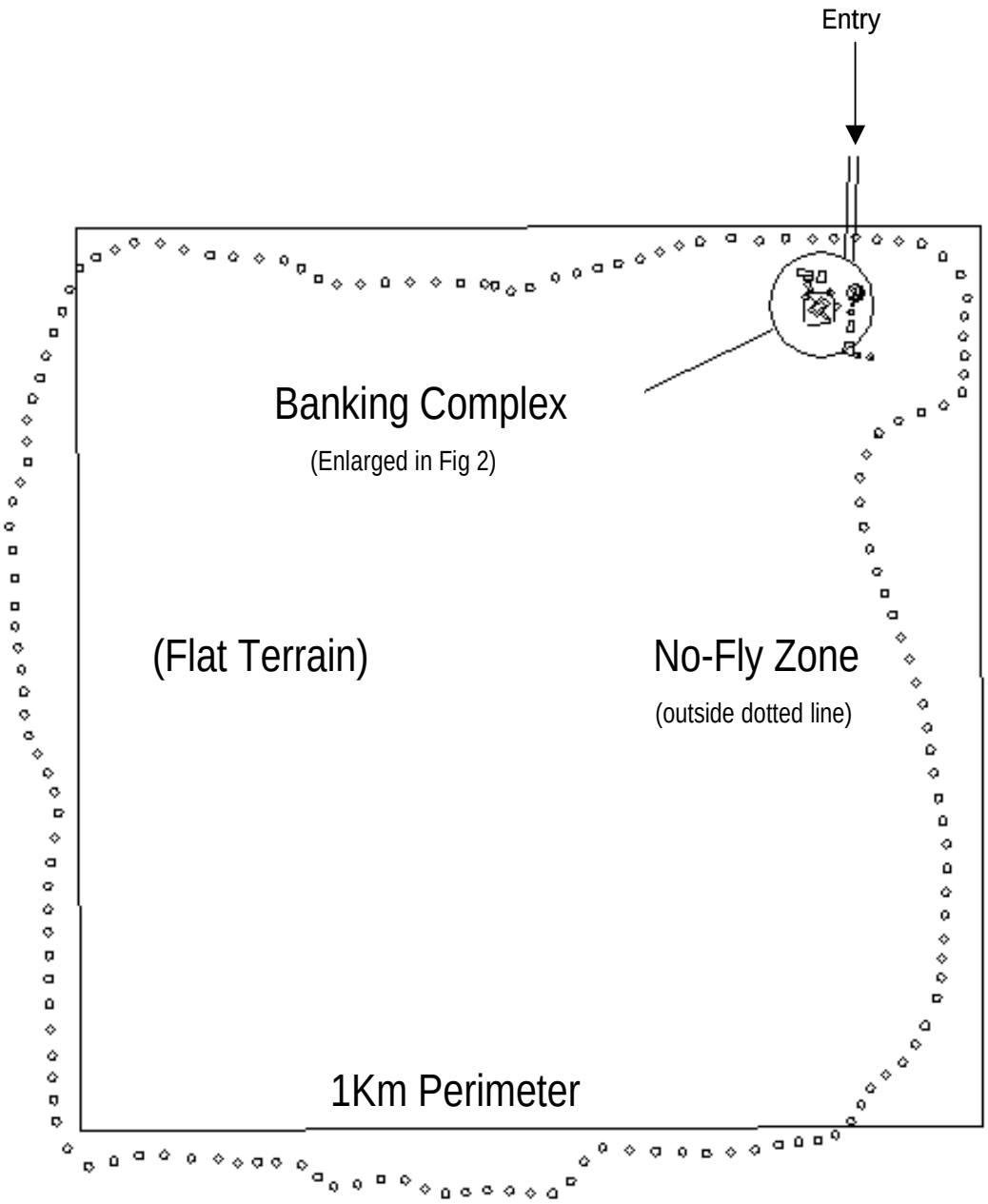

Fig. 1. Sketch of Test Range Site

NO-FLY ZONE BOUNDARY MAY NOT BE VIOLATED. NOTE THAT THIS IMAGE ALSO DICTATES ACCEPTABLE DEPLOYMENT AREAS ALONG THE 1 KM PERIMETER. THE BANK AND ITS IMMEDIATE SURROUNDING STRUCTURES ARE SHOWN IN FIG 2 AND FIG 3.

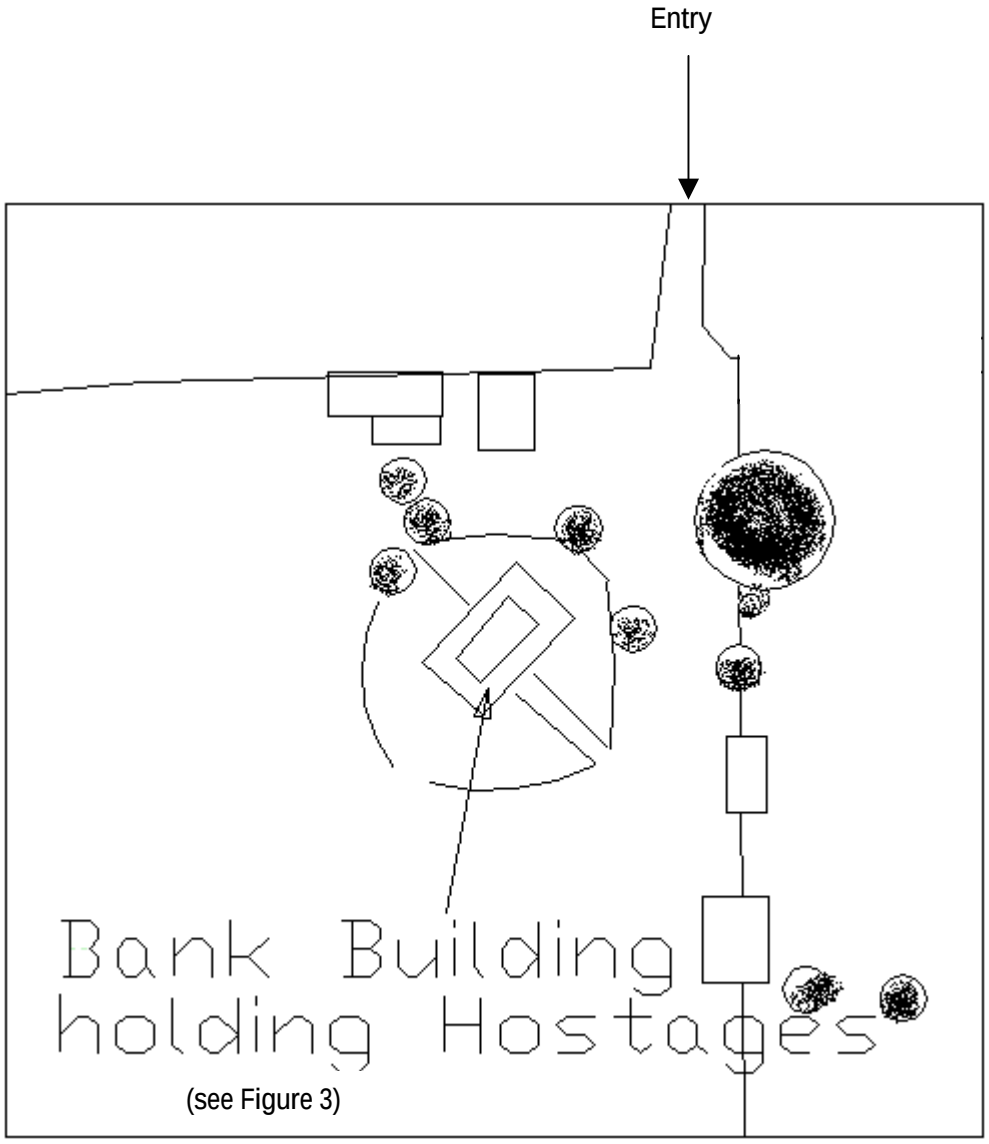

Fig 2. Aerial View of the Bank Building

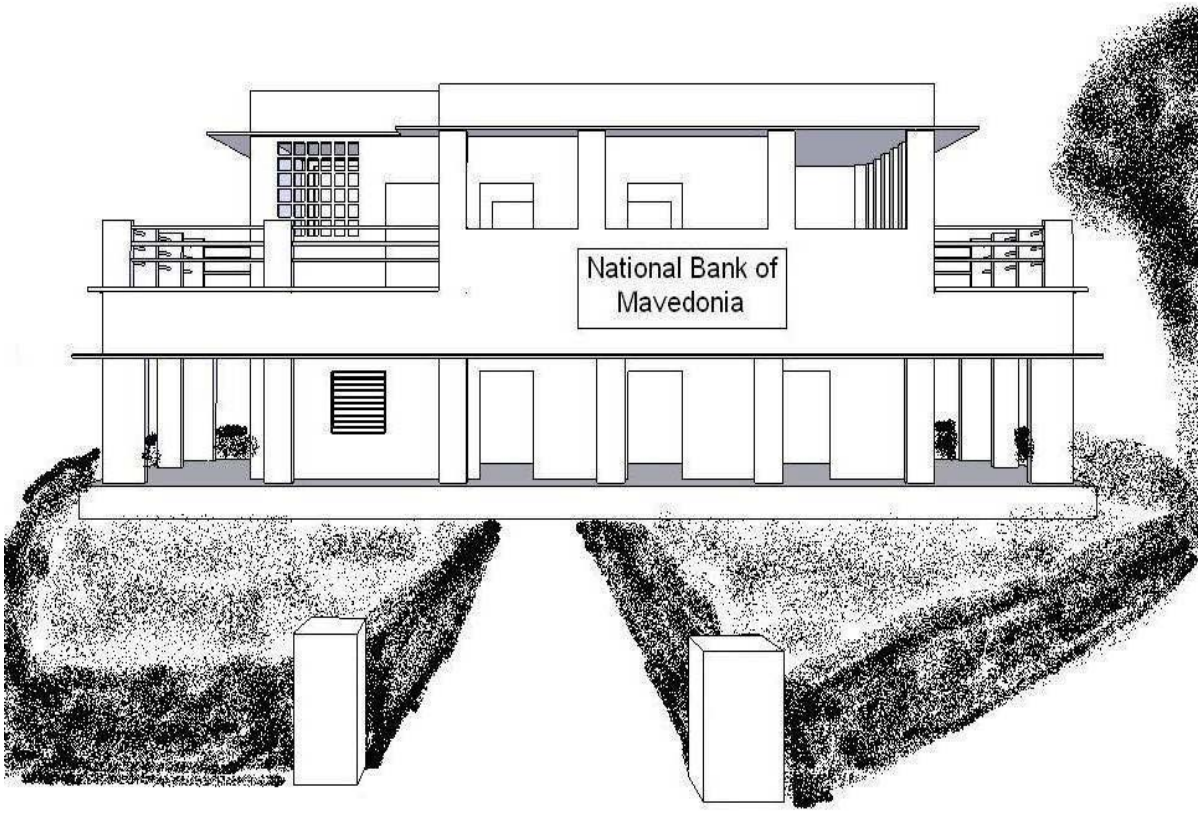

Fig 3. Bank Building

Assets: Each team will have at its disposal a military radio officer and two radio-enabled commandos. Teams will supply micro air vehicles, EOD ground robots or simulator (see below), telemetry, and ground control stations. 220 VAC, ~50 Hz power will be available. Necessary GPS coordinates for the bank building and any no-fly zones will be provided on site. See the FAQ for more pictures of the bank building. No dimensions will be provided to the teams for the building or its surroundings. You may make estimations from the photographs in the FAQ.

UGVs: EOD robot vehicles may be purpose-built by the teams, purchased and adapted to the mission, or simulated by a manned ground vehicle directed by a ground control station or micro air vehicle interface so that the operational behavior is similar to an unmanned ground vehicle.

Mines: The FAQ found at the MAV'08 Demonstration web site describes the architecture of the mines, how they are actuated and how they can be disarmed. The mines will be able to simulate detonation by various means. Commandos or EOD robots which set off a mine while in proximity are considered killed in action and must leave the arena.

JUDGING

An international panel of Judges will verify compliance with all rules. Mission success will be determined in the Performance Judging, and design characteristics will be assessed during a Static Judging period. Starting time slots will be allocated based on rank order in the Static Judging. The criteria and maximum points achievable per feature/behavior are:

Performance Judging (maximum 500 points)	**(0 to Max)**
Total mission completion bonus (a)	or 300
Percentage of mission completed (b)	
Time to complete mission (c)	
Degree of covertness (audio, visual, RF/IR) (d)	

Static Judging: Innovation, Elegance, and Safety of Design (maximum 500 points)

Team is multidisciplinary with substantiated contributors from multiple organizations (e)
Multi system coordination (f)
Primary air vehicle propulsion mechanism (g)
Isolation/shielding of air vehicle propulsors (h)
Containment of fuel and exhaust by-products (i)
Attitude/heading adjustment schemes (j)
Navigation techniques (k)
Obstacle avoidance schemes (l)
Target identification techniques (m)
Degree of autonomy (per FAQ definitions) (n)
Component integration (p)
Craftsmanship (q)
Durability and crash-worthiness (r)
Power saving techniques (s)
(e.g., re-use of energy, flight strategies, lift/drag (L/D) maximization)

NOTE: 10% of the total score (up to 100 points (t)) is discretionary by Judges so they can recognize features of merit not anticipated by the scoring formula. All decisions of the Judges are final and cannot be appealed.

SCORING FORMULAS

Static Judging Score = ((#$_{orgs}$ e) + f + g + h + i + j + k + l + m + [(autonomy level ÷ 10) n] + p + q + r + s)

Performance Judging Score = (a + (%complete b) + [(40 - actual time) ÷ 40) c] + d)

Total Composite Score = [(Static Judging Score + Performance Judging Score) t] + (Static Judging Score + Performance Judging Score)

SPECIAL AWARD OPPORTUNITIES

In addition to the main opportunity to become eligible for a Research Grant, three special opportunity categories will be awarded for the following:

Best rotorcraft and flapping wing micro air vehicle (two awards)
A "rotorcraft/flapping MAV" should be capable of vertical landing and sustained stable hover for at least 2 minutes. Special recognition will be made for outdoor hovering-flight MAVs that are able to land onto the bank building rooftop.

Best autonomous micro air vehicle
An "autonomous MAV" is one capable of executing a fully autonomous mission, including automatic takeoff, landing, stability, control, and navigation. Switching from a manual mode to a fully autonomous mode must be declared to the Judges beforehand in order to receive full credit for autonomous behavior.

Best exotic micro air vehicle
An "exotic MAV" might be either a MAV concept based on an original configuration (non rotorcraft/ fixed wing concept) or a MAV which includes a new technology (power source / avionics, etc).

Best UGV performance
If a team chooses to implement a UGV (rather than simulate it), the agility, ease of control, levels of autonomy, if any, and overall performance may warrant this special award.

SCHEDULE

Notification of intention to compete	14 September 2007
Application / Fee Deadline	14 October 2007 / 30 Nov 2007
Recommended last date to have performed the mission at home	1 February 2008
Teams can arrive on site	8 March 2008
Journal quality paper (no paper, no fly)	10 March 2008
Static Judging (2 days)	10 - 11 March 2008
Performance Judging (3 days)	12 - 14 March 2008
Award Ceremony (and Rain-day for Performance Judging if needed)	15 March 2008

LINK DIRECTORY

Official Web Site: www.nal.res.in/MAV08

Express Intention to Compete by clicking here

Demo and Workshop on line Applications: www.nal.res.in/MAV08/Registration

Application Fee Mailing Instructions: www.nal.res.in/MAV08/Registration

MAV'07 Discussion Forum: www.nal.res.in/MAV08/Discussion (Questions about Demonstration Rules, Workshop Details, and On-site Arrangements can be submitted to the appropriate discussion thread and the appropriate committee member will respond.)

Frequently Asked Questions: www.nal.res.in/MAV08/FAQ