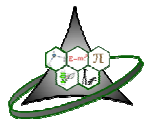


RULES AND GUIDELINES

FOR

DBFC-5

2010



1. INTRODUCTION

STEM Careers Programme is a joint venture of the Higher Education Commission and Pakistan Institute of Engineering and Applied Sciences for grooming talented students for careers in Science, Technology, and Engineering & Mathematics (STEM).

National Engineering Competition (NEC) is one of the projects launched by STEM Careers Programme along with National Science Talent Competition. The main idea behind the NEC is to encourage undergraduate engineering students in public as well as in private sector institutions to come up with innovative solutions to problems of national interest. STEM Careers Programme has launched **National Design, Build & Fly Competition (DBFC)** in collaboration with GIK Institute. The **fifth National Design, Build & Fly Competition (DBFC-IV)** will be held in April 2010 at GIK Institute, Topi Swabi.

The Competition will provide a real world aircraft design experience to engineering students by giving them the opportunity to validate their analytical studies.

2. JUDGING

Students must design, document, fabricate, and demonstrate the aircraft they determine as best capable of achieving the highest score on the specified mission profile(s). Flight scores will be based on the demonstrated mission performance obtained during the Competition. The overall team score is a combination of the Design Report, Debriefing of the Design and Manufacturing of the Aircraft and Flight scores. The team with the highest overall team score will be declared the winner. Grading of complete event will be as follows:

- a. Design report: 40 %
- b. De briefing and viva voce: 30 %
- c. Flying : 30 %

Each team will submit a written Design Report. A maximum of 100 points will be awarded for the design report submitted by the team. Scores for the written reports will be announced at the beginning of the fly-off. All submitted reports are the property of STEM Careers Programme and may be published or reproduced at their discretion.

3. COMPETITION SITE

Host for the competition will be Ghulam Ishaq Khan Institute of Engineering Sciences and Technology, Topi, Swabi, Pakistan.

4. TEAM REQUIREMENTS

All team members (except for a pre-approved pilot) must be full time undergraduate students at HEC accredited Universities or Engineering Colleges of Pakistan. At least 1/3 of the team members must consist of Freshman, Sophomores or Juniors. There should not be more than 5 members in each team.

There must be a maximum of two (2) teams one for each category: electrical and engine driven, entered from any one educational institution. For institutions with multiple campuses in different cities/parts of the country, each campus will be considered as a separate entity.

Members of the one team participating in one category are not allowed to be the members of the team participating in the second category. In addition, if two teams in both categories are participating from one university/institute/college then both of their designs must not be similar or the same.

5. SPONSORSHIP

Teams may solicit and accept sponsorship in the form of funds or materials and components from commercial organizations. All design analysis and fabrication of the Competition entry is the sole responsibility of the student team members.

6. SCHEDULE

• Design Reports

- Design reports must **ARRIVE** to the Coordinator office address by 5 pm local time on **1st March 2010**. Reports will be judged “as received”, no corrections/additions/page changes will be made by the organizers so check your reports carefully before sending them.
- Teams must submit **5** hard copies of the report (printing details are outlined in the report section at the bottom of this document) **AND** one electronic copy in PDF. ***Only the hard copies will be used for judging.***

Note: The ***Entry Name*** may not be changed once the form is submitted, but must be retained and used on all reports and correspondence during the competition year.

- Be sure to include the Phone and FAX number for your team advisor and at least one student contact so we may reach you in case of any last minute problems or changes. All teams are required to provide two point-of-contact e-mail addresses with their Competition application, one of which must be the teams advisor. ***It is the teams responsibility to make sure the e-mail contact addresses they supply remain active during the entire period from entry to the close of the competition, as e-mail will be the primary means to provide information and updates.***

Note: All schedule deadlines are strictly enforced mentioned by organizers. Late entries will NOT be accepted. Late report submissions will NOT be judged. Teams who do not submit the required written reports will NOT be allowed to fly. It is the team’s responsibility to assure that all deadlines are known, understood and met.

- **Competition Date**

- The Competition is scheduled for **9 to 11th April 2010**. The teams will arrive on 9th April 2010 by 10 AM and will be tested for their designed models on the same day. Final awards will be given at the end of competition. Teams arriving after the specified time will not be allowed to participate in the briefing session.
- Please note that tech inspections will be available on **9th April 2010**.
- All teams are required to be prepared and get ready for the DEBRIEFING session on 9th April 2010.
- Any team which will miss DEBRIEFING session will miss marks for this activity. DEBRIEFING session is very important activity which will provide the physical and theoretical judgment of the design to fly.
- The order in which team will be judged for DEBRIEFING and FLYING will be announced after lucky draw before start of the each event.
- Flying competition will commence on completion of the briefing session, timing of flying event will be strictly adhered. Flying phase of competition will terminate at 1300 hours on 11th April 2010.

7. AIRCRAFT REQUIREMENTS

7.1. GENERAL REQUIREMENTS

- The aircraft may be of any configuration except rotary wing or lighter-than-air.
- No structure/components may be dropped from the aircraft during flight.
- All aircraft must be propeller driven and electric powered/engine powered with an unmodified over-the-counter model electric motor. May use multiple motors and/or propellers. May be direct drive or with gear or belt reduction.
- No form of externally assisted take-off is allowed. All energy for take-off must come from the on-board propulsion battery pack(s)/engine.
- Motors may be any commercial brush or brush less electric motor.
- For safety, each aircraft will use a commercially produced propeller. Teams may modify the propeller diameter by clipping the tip, and may paint the blades to balance the propeller. No other modifications to the propeller are allowed. Commercial ducted fan units are allowed.
- Motors and batteries will be limited to a maximum of 40 Amp current drawn by means of a 40 Amp fuse (per motor or pack) in the line from the positive battery terminal to the motor controller. (Standard ATO or blade style plastic fuses may be used, for further information please visit www.Mcmaster.com)
- ***Must use over the counter NiCad or NiMH batteries. For safety, battery packs*** must have shrink-wrap or other protection over all electrical contact points. The individual cells must be commercially available, and the manufacturers label must be readable (i.e. clear shrink wrap preferred). All battery disconnects must be "fully insulated" style connectors.
- ***Maximum battery pack weight is 3 lb. Battery pack must power propulsion and*** payload systems only. Radio Rx and servos MUST be on a separate battery pack. Batteries may not be changed or charged between sorties during a flight period.
- The aircraft TOGW (take-off gross weight with payload) must be less than 50 lb.

- **Teams must submit proof that the aircraft has been flown prior to the Competition date (in flight photo) to the technical inspection team.**

7.2. SAFETY REQUIREMENTS:

All vehicles will undergo a safety inspection by a designated Competition safety inspector prior to being allowed to make any competition or non-competition (i.e. practice) flight. All decisions of the safety inspector are final. Safety inspections will include the following as a minimum.

- Physical inspection of vehicle to insure structural integrity.
 1. Verify all components adequately secured to vehicle. Verify all fasteners tight and have either safety wire, locktite (fluid) or nylock nuts.
 2. Verify propeller structural and attachment integrity.
 3. Visual inspection of all electronic wiring to assure adequate wire gauges and connectors in use.
 4. Radio range check, motor off and motor on.
 5. Verify all controls move in the proper sense.
 6. Check general integrity of the payload system.
- Structural verification. All aircraft will be lifted with one lift point at each wing tip to verify adequate wing strength (this is "roughly" equivalent to a 2.5g load case) and to check for vehicle cg location. Both upright and inverted wing lift tests will be performed. Teams must mark the expected empty and loaded cg locations on the exterior of the aircraft fuselage. Special provisions will be made at the time of the Competition for aircraft whose cg does not fall within the wing tip chord. This test will be made with the aircraft filled to its maximum payload capacity.
- Radio fail-safe check. All aircraft radios must have a fail-safe mode that is automatically selected during loss of transmit signal. The fail-safe will be demonstrated on the ground by switching off the transmit radio. During fail safe the aircraft receiver must select:
 - Throttle closed
 - Full up elevator
 - Full right rudder
 - Full right (or left) aileron
 - Full Flaps down (if so equipped)

The radio Fail Safe provisions will be strictly enforced.

- All aircraft must have a mechanical motor arming system separate from the onboard radio Rx switch. This MUST be the Competition specified "blade" style fuse. This device must be located so it is accessible by a crewmember standing ahead of the propeller(s) for pusher aircraft, and standing behind the propeller(s) for tractor aircraft (i.e. the crew member must not reach across the propeller plane to access the fuse). The "Safety Arming Device" will be in "Safe" mode for all payload changes. The aircraft Rx should always be powered on and the throttle verified to be "closed" before activating the motor arming switch. Fuses MUST be accessible from outside the aircraft and act as the "safeing" device.

Note: The aircraft must be “safe” (arming fuse removed) any time the aircraft is being manually moved, or while loading/unloading payload during the mission. The arming fuse must be removed anytime the aircraft is in the hangar area.

8. MISSION TASK MATRIX

8.1. GENERAL SPECIFICATIONS

- Aircraft must fit in a 2-ft wide by 1-ft high by 4-ft long (interior dimensions) box.
- Boxes must be made using wood, plastic or composite materials. Boxes must have mechanically fastened top/hatch (latches or screws are allowed, Velcro and tape are not allowed) and be able to be rotated upside down, end for end and dropped without damage to or shifting of their contents. Cardboard boxes are not sufficient.
- The Entry Name and University Name must be clearly visible on the upper surfaces of the upper-most wing. Font used should be large enough to allow easy identification in photographs of the aircraft.
- Take-off distance is 100 ft wheels off the runway. For each take-off of a multi-sortie mission the aircraft will be returned to the start line for each new take-off.
- On landing the aircraft must land on the runway to obtain a score for that flight.
- For any landing other than on the runway will lead to marks deduction.

8.2. PAYLOAD SPECIFICATIONS

- The aircraft **MUST** be configured to support both wing tip **EXTERNAL** payload carriage and fuselage **INTERNAL** payload carriage.
- To ascertain maximum take off weight of an aircraft, payload will be provided by the DBFC organizing committee. However teams will also bring their own payloads as mentioned below.
- The identically same payload must be used for both the **INTERNAL** and **EXTERNAL** payload missions.
- Each payload will be 12” long and 3” in diameter (PVC Tube) with closed ends.
- Each payload will weigh 3 lbs.
- Total weight of external payloads will be 6 lbs. Similarly total weight of internal payloads will be 6 lbs.
- **EXTERNAL** payload must be carried on a hard-point located within 3 inches of the wing tip of the largest span wing. One payload hard-point will be located at each wing tip. The aircraft will **NOT** be required to fly with only one wing tip payload package loaded. External payload must be capable of remote (RC) release, but will use only manual reloading. Payload release must use a dedicated servo; it can not be integrated with any flight control servo.
- **INTERNAL** payload must be carried fully inside the fuselage. Payload must be symmetric to the fuselage centerline. (i.e. They can be side-by-side and symmetric to the fuselage centerline, or they may be one above the other and on the fuselage centerline). For dual-fuselage configurations one sensor package will be in each fuselage, on that fuselage’s plane of symmetry.
- All payloads must be adequately secured using mechanical means. Tape and Velcro are not acceptable forms of restraint.

8.3. MISSION SPECIFICATIONS

In the event that, due to time or facility limitations, it is not possible to allow all teams to have the maximum number of flight attempts as mentioned below, the Competition committee reserves the right to ration and/or schedule flights. The exact determination of how to ration flights will be made on the Competition day based on the number of entries, weather, and field conditions.

- The maximum number of attempts is 2.
- Missions must be completed in order as: Mission 1; Mission 2; Mission 3.
- During each mission Aircraft will take-off and must fly at least 2 laps. One lap means that the aircraft must complete a 360 degree turn.
- **There is no score for partial missions.**

8.3.1. MISSION-1: WITHOUT PAYLOADS

- Aircraft will begin the mission without payloads

8.3.2. MISSION-2: WITH EXTERNAL PAYLOADS

- Aircraft will begin the mission with **2 EXTERNAL** payloads.

8.3.3. MISSION-3: WITH INTERNAL PAYLOADS

- Aircraft will begin the mission with INTERNAL payload.

8.4. GENERAL MISSION SPECIFICATIONS AND NOTES

- Aircraft are to remain assembled while waiting in the queue. Teams will install the propulsion batteries when the aircraft is 3rd in the queue.
- Aircraft batteries may be charged while the aircraft is in the queue IF AND ONLY IF the batteries are removed from the aircraft.
- The aircraft propulsion system(s) must be disarmed or "safed" during any time when crew members are preparing the aircraft.
- Maximum flight support crew is: pilot, observer, and 3 ground crew.
- Observer and all ground crew must be students. Only the pilot may be a non-student.
- Aircraft must land on the paved portion of the runway. Aircraft may "run-off" the runway during roll-out (however for this marks will be deducted).
- After landing, aircraft may taxi back to the starting line. Alternatively, aircraft may be carried back to the starting line; however, the team may not leave the pit area to retrieve the aircraft until the aircraft has come to a complete stop, and they are signaled it is "Ok" to retrieve the aircraft by the flight line judge.

Aircraft experiencing significant damage during landing will be considered to have completed their flight where they come to rest and may not be "carried" to the starting line to "complete" a lap. Determination of "significant -vs- non-critical" damage will be made by the flight line judges. Aircraft with "significant" damage will not receive a score for that flight. Aircraft with "non-critical" damage may continue to the disassembly task with no penalty.

- Flight altitude must be sufficient for safe terrain clearance and low enough to maintain good visual contact with the aircraft. Decisions on safe flight altitude will be at the discretion of the flight line judges and all rulings will be final.

- The Competition judges may stop any plane at any time if they feel that it is performing, or is about to perform, any action that is dangerous or hazardous to people or equipment.
- In all matters of interpreting the rules before and during the Competition and in any issues not covered by these rules, the decisions of the Competition Judging Committee will be final.

9. FLIGHT LINE ORDER

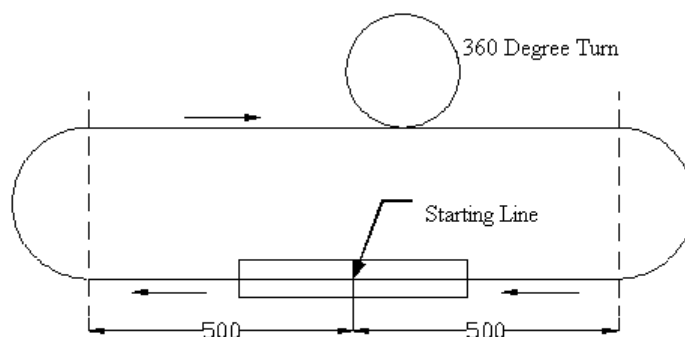
- A flight order list will be generated and posted at the beginning of flying. Teams will always rotate in this order. The flight order will be repeated continuously and will be carried over at whatever spot in the rotation it leaves off.
- Each team's position in the flight order will be determined from their written report score, highest report score goes first.
- There will be four staging box positions near the flight line. While in the staging box teams can make any final preparations and checkout required prior to flight.
- If you are not in place in a staging box when your rotation number comes up you will miss your opportunity for that rotation.

Note: We will not call teams to the staging box, it is the team's responsibility to monitor the progress of the Competition and decide when they need to get ready to enter an open spot in the staging box. A Competition official will be available to help teams in entering the staging box area.

- Electing to enter one of the staging box positions on your turn in the rotation order will constitute using a flight attempt.
- If you choose to leave the staging box for any reason you will forfeit that flight attempt.
- If you go to the flight line and are not able to begin your takeoff when instructed you will forfeit that flight attempt.

10. FLIGHT COURSE

- The orientation (direction) of the flight course will be adjusted based on the prevailing winds as determined by the Flight Line Judge. The flight course will be positioned to maintain the greatest possible safety to personnel and facilities. The nominal flight course is shown in the Figure below.



Course Layout
Shown to Scale

11. PROTEST PROCEDURE

- Submitting a protest is a serious matter and will be treated as such. Teams may submit a protest to the Competition Administration at any time during the competition. Protests may not be submitted after the conclusion of the competition. Protests must be submitted in writing and signed by the team advisor, designees are not allowed for protest submissions. If the team advisor is not present, he may FAX a signed protest to the team for them to present.
- Protests and penalties (up to disqualification from the Competition for deliberate attempts to misinform officials, violate the Competition rules, or safety infractions) will be decided by the Competition Administration. The decision of the Competition Administration is final.

12. Design Report:

Each team will submit a judged design report as outlined below and in the **SCHEDULE** section of this document.

- Reports must have the University and Team name (as listed on the ORIGINAL entry form, not team “nicknames”) on the cover page. Reports missing this identification information will not be scored.
- Reports must be bound; unbound reports will not be scored. Simple spiral bindings are sufficient and preferred. Paper clips, 3-ring binders, or clamps are NOT allowed. Stapled reports are discouraged and will be penalized 10 points.
- Report paper may be no larger than 8 ½ inches wide by 11 inches long with the exception of the drawing package. A4 paper may be used ONLY if it is cut to a maximum length of 11 inches. The drawing package may be on 11 inch long x maximum of 17 inch wide pages. A 10 point penalty will be given for the use of oversize paper.
- Absolute maximum page count for the report is 60 pages, inclusive of all pages of any type including any form of front and back cover.
- For reports printed as double sided, blank back-sides of pages WILL be included in the page count with the specific exceptions of:
 - 1) the back side of the very first page or cover;
 - 2) the back side of the very last page or cover;
 - 3) the back side of 11 inch x 17 inch size drawing pages.
- Reports exceeding the maximum page count will be given a 10 point penalty for each additional page.
- Reports will be scored on a 100 point basis following the guidelines outlined below;
 - All information used for scoring must be in the outlined sections. Content that is out of sequence, including the drawing package, will be treated as missing and scored accordingly.
 - All reports should be at least one and one half line spacing, 10-pt Arial font. Tables and figures will also be at least 10-pt Arial font. Margins should be at least 1 inch on all sides.
 - All figures and tables should be clear and readable for the judges.
 - The reports will be judged on format and readability.
 - **ALL** items listed must be present, easy to locate and identify, well documented and in the correct section for full scoring.

Report scoring is based on the reports AS SUBMITTED. Final proofing of the report printed copies (ALL) prior to submission is STRONGLY encouraged.

Repetition of copying of pervious design report will render the team disqualified for the competition and team will be informed accordingly so that they should not travel to venue.

12.1. COMPONENTS OF DESIGN REPORT AND OTHER MARKS DISTRIBUTION:

- a. Executive Summary: (10 points):**
- Provide a summary description of your selected design and why it is the best solution to the specified mission requirements.
 - Describe your key mission requirements and design features keyed to those requirements.
 - Document the performance/capabilities of your system solution.
- b. Management Summary (5 points):**
- Describe the organization of the design team.
 - Provide a chart of design personnel and assignment areas.
 - Provide a milestone chart showing planned and actual timing of the design / fabrication / testing processes.
- c. Conceptual Design (15 points):**
- Describe mission requirements (problem statement).
 - Translate mission requirements into design requirements.
 - Review solution concepts/configurations considered.
 - Describe concept weighting, selection process and results.
- d. Preliminary Design (15 points):**
- Describe design/analysis methodology
 - Document design/sizing trades
 - Describe/document mission model (capabilities and uncertainties)
 - Provide estimates of the aircraft lift, drag and stability characteristics.
 - Provide estimates of the aircraft mission performance.
 - One set of manual calculation be included in this portion.
 - Highlight the computer based designing methods and software used while designing the model.
- e. Detail Design (20 points total. 10 points for discussion items, 10 points for drawing package):**
- Document dimensional parameters of final design.
 - Document structural characteristics/capabilities of final design.
 - Document systems and sub-systems design/component selection/integration/architecture.
 - Document Weight and Balance for final design. Must include a Weight & Balance table for the empty aircraft and with each of the possible payloads
 - Document **flight** performance parameters for final design.
 - Document Rated Aircraft Cost
 - Document **mission** performance for final design.
 - Teams will provide in the design report, the data sheet concerning engine and propeller used in the aircraft, provided by OEM (Original Equipment Manufacturer).

Drawing Package

- 3-View drawing with dimensions.
- Structural arrangement drawing.
- Systems layout/location drawing.
- Payload(s) accommodation drawing(s).

f. Manufacturing Plan and processes (10 points):

- Document the process selected for manufacture of major components and assemblies of the final design.
- Detail the manufacturing processes investigated and the selection process/results.
- Include a manufacturing milestone chart showing scheduled and actual event timings.

g. Testing Plan (5 points):

- Detail testing objectives, schedules, and check-lists.

h. Innovative ideas (20):

Any innovative ideas with design/analysis justification will be given additional marks as deemed appropriate by the judging team.

12.2. DESIGN REPORT ELECTRONIC COPY

- Each team must provide an electronic copy of their final design report in addition to the hard copies used for the report judging as outlined below.
- Electronic copy must be RECEIVED by the same deadline as documented for the written reports. Both the Word and PDF files are requested to be submitted on CD.
- Electronic report files must be named: **“2010DBF [university] [team name].PDF”** and **“2010DBF [university] [team name].doc”**
- Electronic report must be a single file with all figures/drawings included in the proper report sequence in PDF format. (Free PDF file conversion programs are available on the Internet, such as www.pdf995.com.)
- Electronic reports should have all figures compressed to print resolution to minimize file size.

13. Questions / Comments:

Questions regarding the Competition, schedules, or rules interpretation may be sent to the Competition Coordinator by e-mail mentioning team name and personal name.

Written reports (only) should be sent at the following postal address:

Dr. Muhammad Abid
Coordinator Design, Build and Fly Competition (DBFC)
Faculty of Mechanical Engineering,
GIK Institute, Topi – 23460, NWFP. Pakistan
Email: abid@giki.edu.pk, dbfc@giki.edu.pk
Ph: 0092-938-271858~61, Ext: 2293 (Off), 2294 (Res),
Fax: 0092-938-271889
Mob: 0300-5394185