



BRICS
2022 CHINA

2022 BRICS Skills Competition

(BRICS Future Skills Challenge)



TECHNICAL DESCRIPTION

Additive Manufacturing (Offline)

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I. Project Brief

(I) Projects Description

The Offline Additive Manufacturing of 2022 BRICS Skills Competition requires, on the one hand, to complete inverse modeling based on a given product so as to get the point cloud data of an object shape using a handheld 3D scanner, as well as the defect repair and 3D digital inspection using the two-point cloud data. On the other hand, the competitors are required to design a product according to a given scenario, print all the parts making up the product through the metal printer, FDM printer, and light-curing 3D printer, and finally physically assemble all the printed items. The competitors will complete seven module competition tasks including reverse modeling; defect repair; 3D digital inspection; scheme design; product internal motion mechanism design; product appearance design; product 3D printing and post-processing.

The offline competition of this competition is for individuals.

(II) Purpose of the competition

The competition focuses on key areas such as high-end manufacturing, digital economy, new industries, new business models, and new technologies, in a bid to enhance the abilities of teachers and students from vocational institutions in the five countries in innovation, coordination, organization, and cooperation, to enrich the content of exchanges and cooperation among vocational institutions and enterprises in those countries, and to promote the training of international high-quality skilled personnel in the BRICS countries.

(III) Participating objects

Students and teachers in vocational institutions (including polytechnics) aged 16-35 years old.

(IV) Related documentation

1. Remote technical description of the project;
2. Sample Questions of Offline Additive Manufacturing competition of 2022 BRICS Skills Competition;
3. Offline remote layout;
4. Checklist of Offline Infrastructure;
5. Schedule for Offline Finals;
6. Training programs and schedules for offline training camps;
7. Organization Plan for Offline Remote Competition.

II. Competencies Required for the competitors

1. Able to capture 3D data from products using 3D scanning devices, and after data processing, reconstruct the models with the valid data from polygonal models to create editable CAD models;
2. Recover missing data for redesigned object elements from the available data on polygonal models, and restore the product to the design state.
3. Use 3D digital inspection software to align polygon model and CAD model coordinate system, and perform data analysis and measurement (such as 3D, 2D, geometric tolerance, etc.)
4. Able to judge if the mechanism has defined relative motion, determine the overall scheme based on the functional requirements of the product, and use computer drawing software to produce engineering drawings of parts and 2D assembly drawings;
5. Able to make the structural design of the mechanism according to the principle of the mechanism, draw a digital model of the parts using 3D modeling software, and design integrated structures following the combination of several parts according to the characteristics of the 3D printing manufacturing process;
6. Design the shape of a product with relevant knowledge of ergonomics and aesthetics, draw correctly the assembly diagram of a product and be able to create an animation

simulation;

7. Able to reasonably slice 3D models, make the products by using printing equipment correctly, remove printed items from the platform correctly and make post-process for such prints, and employ correct assembly methods for assemblies and verification;

8. Able to perform their duties in a team, communicate and consult with clients and team members, and manage members of their own team as well as time.

III. Competition Items

(I) Competition Modules

Module A: Reverse modeling

Module B: Defect repair

Module C: 3D digital inspection

Module D: Scheme design

Module E: Internal motion mechanism design of the product

Module F: Product appearance design

Module G: Product 3D printing and post-processing

(II) Description of the Module

Module A reverse modeling: the competitors will collect 3D data of the specified product using the given 3D scanning equipment and auxiliary supplies and do the 3D digital modeling after data processing. The produced CAD model should eliminate the original object defects caused by the process of production, operation, failure, maintenance (nicks, burrs, welding, brazing, chips, etc.), and restore the original geometrical shape, which is the key test point;

Module B defect fixing: competitors will recover missing data for elements of the redesigned object from the available data for the polygonal model by using point cloud data for a given product. The produced CAD model should eliminate the original object defects caused by the process of production, operation, failure, and maintenance (nicks, burrs,

welding, brazing, chips, etc.), and restore the original geometrical shape, which is the key test point;

Module C 3D digital inspection: by using the point cloud data of a given product, the competitors will compare them with the given CAD digital models and detect their size errors according to the requirements of the drawings, and then issue a 3D digital inspection report, which is the key test point;

Module D scheme design: according to the given scenario or task requirements, the competitors will design a product program to solve the problems. They will also draw the 2D engineering drawings (2D part drawings and 2D assembly drawings) of all external and internal parts (except for external part drawings given) and all parts digital model of the assembly product by using the drawing software designated by the competition organizing committee, which is the key test point;

Module E product internal kinematics design: based on the requirement of the task statement and the professional knowledge of mechanical principles and mechanical design, combining with the characteristics of the 3D printing manufacturing process for the product transmission mechanism design and with the combination of characteristics of the 3D printing manufacturing process, the competitors shall have at least one integrated structure (parts integrated manufacturing) design, which is the key test point;

Module F product appearance design: competitors should consider the requirements of ergonomics, aesthetics, and convenience of use during the product appearance design. competitors will also draw a 3D digital model of the product appearance and a 3D assembly drawing of the product, and create a simulated motion simulation animation of the product, which are the key test point;

Module G product 3D printing and post-processing: competitors may choose the 3D printers themselves from the required metal printing equipment, FDM printers, or light-curing printers. competitors shall print all parts making up the product, post-process the

prints, and finally assemble the processed prints to enable the product to achieve its functional requirements, which is the key test point.

(III) Proposition Design

Sample questions are open to the public and final competition questions are confidential.

(IV) Proposition Program

The chief expert will organize a group of experts to prepare sample questions for this competition according to the technical documents. The final questions will be proposed by the chief expert and presented in the same way as the sample questions.

IV. Scoring Criteria

(I) Scoring Method

1. Judgment Score (Subjective)

Scoring method for judgment: the referees will score independently, and the score difference among the referees must be less than or equal to 1 point.

Referees' judgment is given on four grades from 0 to 3. Such a judgment is used to make a subjective judgment on the quality of the evaluation object, and three experts are required to participate in the judgment. Each expert makes his/her own judgment, and the difference between expert ratings should be less than 1 point in each case. If it's more than 1 point, the judgment is invalid; and the referees should negotiate appropriately. The weight table is shown in Table 1.

Table 1 Table of judgment score weight

Score weight	Requirement Description
0 point	Below the occupation standard in all respects, including
1 point	Up to the occupation standard

2 points	Up to the occupation standard, and above it in some
3 points	Up to the excellent level expected by the vocation, perfect

2. Measurement points (objective)

Scoring method for measurement: all referees negotiate together and finally give only one score after agreeing on the actual score of the competitors on this item. See Table 2 for a sample measurement score.

Table 2 Examples of objective score

Type	Examples	Maximum score	Scores for correct answers	Scores for wrong answers
Full score or zero	If the integrity of a certain printed scored 1 point, the competitors will score either the full point score or zero point	1	1	0
Deducted from the full point	There are 10 key dimensions in a certain printed item, with a maximum score of 2 points; and 0.2 points will be deducted if one dimension fails to meet the requirements, and the competitor fails to meet the requirements in four dimensions.	2	1.2	0.8
Add from zero	There are 5 key dimensions of reverse modeling, with a maximum score of 5 points; one point will be scored for meeting the requirements of one dimension, and the competitor meet the requirements in 2 dimensions	5	2	3

3. Application of subjective versus objective assessment

The application table of judgment (subjective) and measurement scores (objective) contains general information, and it is used to formulate the scoring plan and competition items. The specific score allocation is shown in Table 3.

Table 3 Table of judgment and measurement score allocation for each module

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Module	Competition Task	Judgment Score	Measurement Score	Total Floor Area
A	Reverse modeling	2	13	15
B	Defect repair	3	12	15
C	3D digital inspection	0	10	10
D	Scheme design	4	11	15
E	Internal motion mechanism design of product	2	8	10
F	Product appearance design	2	8	10
G	Product 3D printing and post-processing	3	22	25
Total		16	84	100

(II) Scoring Procedures

1. After completing module tasks A, B, and C within the time limit on Day C1, competitors should save their finished works to a USB flash disk given on site and submit it to the referees on site, and the referees for grading will then score the three modules.

2. After completing module tasks D, E, F and G tasks on Day C2 within the allotted time, competitors should save their finished electronic work to a USB flash disk given on site; the printed work will then be put into an absorbent box and submitted to the referees on site, and the referees for grading will then score the four modules.

(III) Score Calculation

1. Spot check and review

To maintain the accuracy of the results, the Supervisory Team will re-check the results of all teams (competitors) ranking top 30% in the overall scores of the competition; the remaining results will be sampled for review, covering a minimum of 15%.

The supervisory team is required to inform the chief expert in writing of any errors

found in the re-inspection timely, and the chief expert will correct and sign the results.

If the error rate of re-check and spot check exceeds 5%, it is considered a non-rare event, and the panel of referees is required to re-check all the results.

2. Scoring statistics

After the referees of each group have signed and confirmed the scores of the competitors, the scorers will input the scores according to the scoring sheet. After each day's scoring, the chief expert will "lock" the scores. The sum of the results of modules A, B, C, D, E, F, and G will be used as the overall score of the competitors, where the best score will rank first, rest following the same method. The final results and ranking of the competitors are confirmed by the signature of the chief expert.

3. Tied in the results

(1) For competitors with the same total score, they will be ranked in the order of scores for Module A, Module B, Module C, Module D, Module E, Module F, and Module G. The higher the module score, the higher ranking.

(2) When the competitors still cannot be sorted based on the above two rules, the competitor with the shorter cumulative competition time will rank higher.

(IV) Referee Make-up and Grouping

1. Panel of referees

An instructor from each team will be appointed as a referee who will form the panel.

2. Recommendations from referees

The referees are divided into the site referees and scoring referees. The referees will be spot referees during the competition and scoring referees after the competition. The grouping and division of the referees will be made by the chief expert. There will be 10 panels in total, with one panel consisting of four referees. Each panel shall officiate four teams and each referee shall not officiate his or her own team. There will be 8 referee panels with each panel consisting of five scoring referees. Modules A, B, C, D, E and F will be each officiated by

one panel of referees, and Module G will be officiated by two panels of referees.

3. Judging discipline and requirements

(1) All referees are required to officiate fairly without falsification. Anyone who is found to be falsified will be disqualified from officiating.

(2) All spot referees should enter the competition platform in advance and check whether the network works properly to ensure smooth officiating.

(3) Each scoring referee should be fair and meticulous in scoring against the scoring criteria. If there are any objections to the scoring, communicate with the chief expert timely to ensure smooth scoring and that the results of the competitors be submitted on time.

V. Required Facilities and Equipment

(I) Standards for competition technology platform

The technical platform of the competition is composed of typical and common hardware and software equipment in the society, comprising primarily computers, operating systems, word processing software, design software, 3D scanners, FDM3D printers, light-curing 3D printers, metal 3D printers, and post-processing tools; among them, there are 40 sets of computers, operating systems, word processing software, design software, FDM3D printers, light-curing 3D printers, and post-processing tools, one set for each competitor; 20 sets of 3D scanners, which will be used by competitors in two batches; 10 sets of metal 3D printers, together with 10 sets of wire cutting machines, which will be used by competitors in four batches.

(II) Environmental requirements

1. An indoor space of not less than 1,200 m² with a flat and unobstructed floor is required;

2. Good ventilation and no direct light; temperatures between 10 and 30°C and humidity between 45 and 75%.

(III) List of equipment

1. Technology Platform

(1) Computer: Minimum configuration: Windows 10-64, i7 dual-core processor / 32G DDR memory / 500G SSD + 2T HDD mechanical hard drive / Graphics card: NVIDIA Quadro P1000 with 4GB GDDR5 independent graphics card / Gigabit Ethernet port.

(2) Operating system: MS-Windows 10.

(3) Word processing software: MS-Office 2010.

(4) Design and inspection software: UG NX 1899, Geomagic Design X 2022, Control X 2022, Wrap2021, 3D One Plus 2021, and SolidWorks 2021 sp5.

(5) 3D scanner: model ZCSCANK30;

(6) FDM 3D printer: model CT-400D;

(7) Light-curing 3D printer: model CT-005PRO;

(8) Metal 3D printer: model HBD-180G

(9) 1 set of powder spraying, polishing, and repair tools

2. Hardware specifications

(1) Parameters and accessories of the 3D scanner (Model: ZCSCANK30)

Technical indicators	Scan Mode	Standard scanning mode and hyperfine scanning mode
	Dimensions	325*133*84 (mm)
	Weight	1.19 kg
	Laser Aggregation Form	7 crossed red laser rays and 1 separately working red laser ray, a total of 15 red laser rays; 5 parallel blue laser rays
	Fine scan by framing	Supported
	Scanning of deep holes and dead ends	Supported
	Small parts splicing	The scanning of small thin-walled parts could be achieved by splicing together three marker points that are not located together by applying a separate point on each of the three sides

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	Scanning speed		Standard scanning mode: 650,000 measurements/sec.; Hyperfine scanning mode: 320,000 measurements/sec
	Laser category		Class II (safe for eye exposure)
	Minimum resolution		Standard scanning mode: 0.05 mm; Hyperfine scanning mode: 0.01 mm;
	Accuracy		Max. 0.02mm
	Volume Accuracy (use scanner alone)		0.015mm+0.035mm/m;
	Depth of field		450mm
	Reference distance		300mm
	Photo gram metry	Scanning area	2500 mm × 3000 mm
Depth of field		2500 mm	
General requirement s	<p>Supported systems: Win7, Win8, Win10 systems Output data formats: STL (triangular mesh), ASC (point cloud), and PLY (wireframe format) Languages supported: Chinese, English, German, Russian and Korean</p>		

Attachment Table

No.	Name	Specification
1	Quick calibration board	400mm
2	Reflective marking point	6mm
3	Reflective marking point	3mm
4	Vernier caliper (provide by yourself)	0-200mm

(2) Major parameters of FDM 3D printer (Model: CT-400D)

Technical indicators	Forming principle	FDM
	Box type	Closed, floor type

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	DIMENSION S	800*720*1222mm
	Print Size	Single nozzle (single color/bi-color): 400*400*450 mm Dual nozzle and dual model: 165*400*450mm
	Number of nozzles	2
	Nozzle diameter	0.4mm (standard)
	Nozzle temperature	300°C
	Nozzle structure	Proximal extrusion
	Screen	7-inch color touch screen
	Printing mode	Method 1: single nozzle independent printing (single color); Method II: simultaneous printing with dual nozzles, one for model printing and one for support printing (bi-colors are available); Method 3: independent printing with dual nozzles, and it can print two models at the same time (single color).
	Precision	±0.1mm
	Layer Height	0.1-0.4mm
	Filament	1.75 mm diameter filaments: PLA, ABS, ASA, PETG, PVA, HIPS, PA, PC, etc.
	Hotbed	110 degrees
	Z-axis motion form	Double wire rod and double optical axis for smooth motion
	XY axis type	Linear guide rail
	Power Loss Recovery	Supported
	Filament Detection	Supported
	Operating noise	The whole device is less than 60db, and with silent motherboard
	Slicing software	Creality slicer
	Filaments warehouse	Yes

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	Tool kit	Yes
	Wifi	Supported
	Leveling method	Auto Leveling
	Air filtration	HEPA Filters
	Rated Power	750W
	Automatic shutdown	Supported
	Cloud platform	Android/IOS/mobile apps support model data sharing and storage in the cloud model library. After uploading the model, a 3D slicer within the APP may be used to slice the uploaded model file, and a G-code file will be generated on the phone. Users can register and log in to their personal accounts. The platform supports not only video, picture, and model uploads but also such functions as likes, comments, sharing, and downloads, etc.
General requirements	Supported systems: WIN10 and above systems; MAC systems Supported file types: GCODE (STL file slice)	

(3) Major parameters of light-curing 3D printer (Model: CT-005PRO)

Technical indicators	Forming principle	LCD stereo lithography
	Print Size	192x120x235mm
	Operating screen	5" true-color touchscreen
	Print screen	8.9" 4K black-and-white screen, with pixel of 3,840*2,400 and lifetime of 2,000 hours
	Layer Height	0.01-0.2mm
	Quick print	1-4s/layer
	Filament	Photosensitive resin
	Use of 3D nano-release technology	Significantly reduce draft resistance for faster and more successful printing
	Wavelength/light source	405nm / Integral light source, 95% light uniformity, outperforming the parallel light sources.
	Printing Method	U-disk offline printing / WIFI printing supported

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	Slicing software	Crealty Box 8x anti-aliasing; no lamination is allowed
	Z-axis structural design	Ultra-stable double linear guide + ball screw to provide higher positioning accuracy
	Air filtration	Fitted with an air filtration system
	Cloud platform	Support sharing and storing of model data in a cloud-based model library. After uploading the model, a 3D slicer within the APP may be used to slice the uploaded model file, and a G-code file will be generated on the phone. Support 3D photo-generated model function. Users can register and log in to their personal accounts. The platform supports not only video, picture, and model uploads but also such functions as likes, comments, sharing, and downloads, etc.
	Overall dimensions	432mm×292mm×595mm
General requirements	Supported systems: WIN 7, WIN 8 and WIN 10 systems etc. Supported file types: STL and SLC	

(4) Major parameters of metal 3D printer (Model: HBD-180G)

Forming size	Φ160X120 mm
Laser power	200 W
Layer Height	10-40 μm
Print line width	40-80 um
Line scan speed	≤10,000 mm/s
Line forming speed	600-3,000 mm/s
Oxygen concentration	≤ 100 ppm
Forming atmosphere	Overall sealing, automatic monitoring of oxygen content, with cyclic purification and dust removal rate ≥ 99%;
Precision	0.05-0.1mm
Powder spreading method	Single-way powder spreading

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Printable material	Stainless steel, cobalt-chromium alloy, die steel, titanium alloy, high temperature alloy, hastelloy and some precious metals
Supported system	WIN7, WIN10
Supported languages	Chinese and English

Attachment Table

No.	Name	Specification
1	Vacuum cleaner	Standard
2	Sieving machine	Standard
3	Drying oven	Standard
4	Mineral powder	316L Stainless Steel
5	Scraper	Standard
6	Base board	Standard
7	Filter element	Standard
8	Standard fitting package	Standard

Major parameters of the DK7720 medium wire cutting machine that separates the printed part from the printing platform during the competition

Name	Technical Specifications
Host operating system	windows XP
Wire cutting programming and control software	autocut
Workbench size mm	420×270
Workbench stroke mm	200×250

VI. Instructions for the Competition

(I) Instructions to teams

1. Participation teams should use the name of their unit but not that of any other organization or group.

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2. All participation teams will be determined after registration and passing the qualification check.

3. Competitors should fill in their personal information according to the requirements, otherwise they will be disqualified from the competition.

4. Competitors will participate in the competition with uniformly printed entry cards and valid ID documents and will compete at the time, in the order, and at the place specified by the competition.

5. Competitors are required to learn and understand the relevant documents of the competition, abide by the discipline consciously, obey the command, listen to the arrangement and participate in a civilized manner.

6. Competitors must strictly abide by the safety procedures and civilized production rules, take care of the equipment and instruments at the venue, and refrain from artificially damaging the instruments and equipment.

7. Competitors are required not to bring any electronic devices, communication equipment, or other materials into the venue.

8. No operation may be started before the start signal is received during the competition. Each team decides its own division of labour, work procedures, and time schedule, and finishes the competition items at the designated stations; cheating is strictly prohibited.

9. At the competition comes to an end, all competitors should stand up and finish the operation. Put the equipment and tools back in place, arrange the materials neatly on the operating platform and leave the competition area only after the staff has counted them. You may not take any materials with you when leaving.

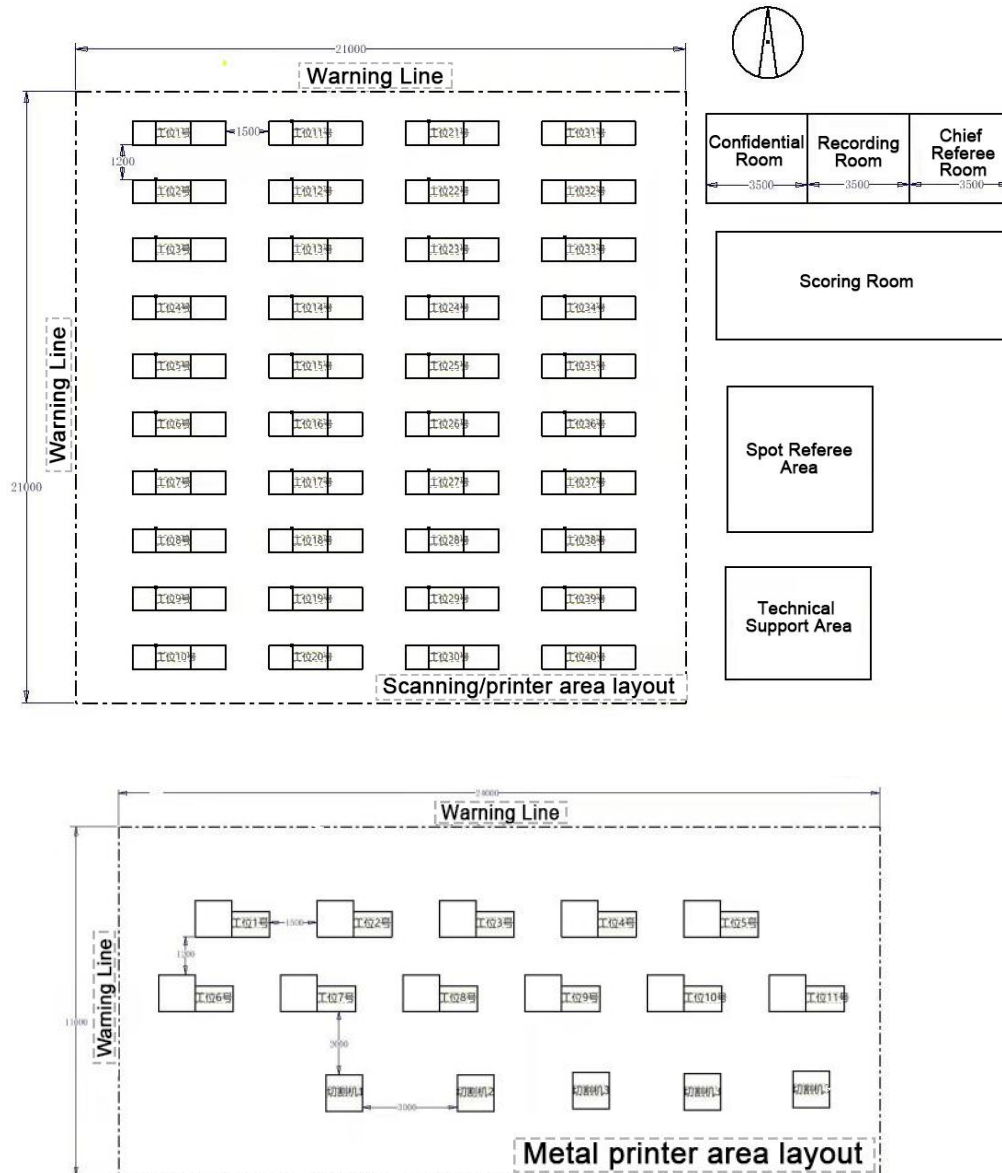
10. The teams shall submit their results according to the requirements of the competition and the competition questions. It is forbidden to leave any marks on the results irrelevant to the competition.

11. Submit the results of the in pursuance to the procedures and sign off with the

referees.

VII. Venue Layout Requirements

The total area of the additive manufacturing competition venue is 1200 square meters, and the overall layout is shown in Figure 1.





VIII. HSE

(I) Environment required

1. There shall be adequate light, good lighting, and ventilation in the venue; the ambient temperature and humidity shall be in compliance with the requirements of the equipment, as well as the normal competition requirements of the competitors;

2. The venue shall have stable water, electricity, gas supplies, and power supply emergency equipment, and the medical, guarding, and equipment maintenance personnel shall be on standby in case of emergencies;

3. The venue shall be neat and tidy, with segregation and non-interference between the stations.

4. An isolation zone is set up in the competition venue, no one is allowed to enter the venue except for referees, competitors, and staff.

(II) Safety Requirements

1. Before the competition, the equipment management personnel will conduct safe operation training for the competitors. The competitors should conduct operations in strict accordance with the safety instructions of the equipment;

2. If a competitor is found to have operated the equipment in violation of the rules, the

referee will promptly inform the chief expert and suspend the competition;

3. The competitor shall promptly notify the examination staff and the chief expert for safe handling if he/she finds an operation safety problem of equipment.

(III) Environmental protection

Competitors should strictly abide by environmental protection laws, and all waste should be effectively sorted and disposed of, and any unused materials should be recycled; competitors and all participants are prohibited from bringing any toxic or harmful substances into the venue.

(IV) Epidemic prevention and control

Competitors shall strictly implement the COVID-19 prevention and control policies of their countries to avoid any physical uncomfortableness during the competition, which may affect the normal operation of the competition. The competition venue is supervised throughout the whole process, with isolation areas and green channels for emergencies. In case of emergencies, it is necessary to ensure that a seamless connection with the hospital be immediately available. Pay attention to the changes in the epidemic situation, strengthen epidemic publicity, timely launch emergency plans, implement prevention and control measures, and make great efforts to prevent and control the spread of the pandemic.

Other matters not covered concerning epidemic prevention and control will be notified separately.