ANNEXURE 1

TECHNICAL SPECIFICATIONS OF THE "BET SURFACE AREA ANALYZER"

1. PURPOSE:

The equipment is used to analyze the specific surface area of the materials (minimum surface area of 0.01 m2/g to 'No known upper limit') in various physical shapes and forms, either in powdery form/s or consolidated structure of the specimens both in 'single point or multi-point' modes. The equipment provides the data for i) evaluating absorption/desorption isotherms of the materials at variable pressure levels, ii) total pore volume of the material, iii) average pore size (in the range of 0.35 nanometer to 300 nanometer, iv) BJH pore size distribution of the material etc, calculated from the absorption-desorption isotherms with high level of accuracy and reliability in the measured data and analysis. :

The equipment should be fully automated with built-in micro-processors & control systems for the entire operation and analysis for the purpose.

Besides the main equipment, other essential attachments of the equipment would consist:

i) External provision for sample preparation system with four (04) number of ports under heating, gas flow or vacuum conditions having a programmable heating arrangements upto a temperature of 400^{o}C with a temperature accuracy of $\pm$ 5^{o}C
ii) Analysis system along with appropriate high sensitivity pressure transducers
iii) Gas inlet systems for various gases (adsorbets, e.g., Nitrogen & Helium or other gases, if any, depending on the system)
iv) Suitable software and other interfacing & integration for carrying out the measurement and analysis with high levels of reliability and accuracy.

Other essential parts of the equipment which are required for carrying out measurement should also consist:

i) Sample tubes (total thirty numbers; ten numbers each in three different types of holders with suitable capacity) for sample preparation, measurement and analysis
ii) Standard samples in different ranges of BET specific surface area
iii) Gas cylinders with gas controlling system for two different adsorbet gases, Nitrogen & Helium (total two numbers; one cylinder for each gas) with appropriate gas regulators, suitable gauges, cylinder connectors, isolation valves along with its safety features/accessories & attachments for the operation, control, degassing & related purposes
iv) Cryocan for storage of liquid nitrogen etc (One number) with suitable safety trolley along with its recommended safety thermals (two pairs)

and safety goggles (two numbers) for safe handling the liquid nitrogen etc

2. DEGASSING SYSTEM:

The following are the technical requirements for the degassing system:

i) Number of ports: 04 (FOUR) – Suitable arrangements to prepare samples under heating, gas flow or vacuum conditions in all the ports

ii) Degassing Temperature:

- Suitable arrangements to prepare the samples at any set temperature and independent holding time (ramp) from ambient to 400^{o}C (programmable)
- Temperature deviation/stability should be within ± 5^{o}C of set temperature
- Suitable arrangement for heating/cooling the samples

iii) Vacuum system: The vacuum system should be capable of degassing the samples upto a vacuum level of 1 x 10^{-3} Torr.

3. ANALYSIS SYSTEM:

i) Number of measurement ports: 03 (THREE) for analysis

ii) Vacuum system capability: 1 x 10^{-3} Torr; (appropriate filter gaskets to be provided to avoid contamination from fine powered samples). Vacuum system for degassing and analysis should be independent.

iii) Ability to measure a minimum of 100 numbers of absorption and 100 numbers of desorption isotherm points

5. SAMPLE TUBES/HOLDERS:

- Variable IDs (inner diameter) of the sample tubes/holders to be supplied so that samples with various geometries with irregular dimension/s could be accommodated for the measurements & analysis [Ten (10) numbers in each, comprising three (03) different types of holders with suitable capacity for analyzing for solid and powder samples to be provided]

- Samples holder for fine powders should have the provision to seal it from vacuum

- Standard samples in different BET surface area ranges to be provided

6. ANALYSIS REPORTS:

- Able to generate both 'Single- and Multi- point BET specific surface area'
- Able to generate all the measured 'Adsorption and Desorption Isotherms'
- Langmuir surface area with slope, intercept, constant and correlation co-efficient
- Mesopore volume and Mesopore area distribution by BJH, HK and other models
- T-plot for micropore area & volume
- Density functional theory to generate various parameters, e.g.,:
    - Micropore and mesopore distributions
    - Porevolume distribution of Poresize
    - Surface energy distribution of poresize
    - Surface area distribution of poresize

      and a summary report

7. ACCESSORIES TO BE PROVIDED:

- Complete system along with its safety features & accessories for regulating different gases (Nitrogen & Helium or other gas/es depending on the equipment configuration) to the main equipment with suitable & recommended gas regulators and gauges, gas cylinders (total two numbers, one cylinder for each gas) with cylinder connectors, isolation valves, suitable gas line connectors & appropriate fittings for different gases required for the measurements in the desired pore size ranges are to be supplied along with the equipment

- A computer with latest configuration (core2duo) with 19-inch TFT monitor along with a colour laser printer with necessary software for interfacing various modes etc to be provided those required for programming, operation, recording data & analysis, obtaining results with graphs etc. from the main equipment are to be supplied along with the equipment

- The equipment is also to be provided with suitable power back-up system (UPS) system in which the equipment should restart after power resumes without any loss of data

- Electronic weighing balance capable of measuring weight with an accuracy upto 0.1 mg level (10^{-4} g) having maximum weighing capacity of ~ 200 gm (one number) to be supplied

- Other recommended spares and consumables that should be required for a period of two years for the equipment to be supplied

8. LIST OF EQUIPMENT SUPPLIED IN INDIA AND USERS' CERTIFICATE:

Also, the Vendor should also provide a list of equipment supplied in India so far, along with its Users' certificate.