4.11.1.1 List of equipment for blast furnace laboratory

Sl. No.	Name of the Equipment	Qty
1	XRF	1
2	Fusion bead furnace	2
3	High carbon C-S Analyser	2
4	CCS machine for iron ore pellet	2
5	Hydraulic briquetting press	2
6	Vibratory cup mill	3

4.11.1.2 List of equipment with broad technical specification for blast furnace laboratory equipment.

Sl. No.	Description of equipment	Qty
1	**X-ray fluorescence spectrometer** The instrument shall be used for sequential analysis of chemical constituents in the samples of hot metal, blast furnace slag, iron ore lump and sinter, limestone, dolomite, quartzite, manganese ore, etc. in an integrated steel plant. For analysis of blast furnace slag, reproducibility of the offered equipment shall be in line with stipulations of ASTM E-1031, (latest edition). For analysis of hot metal samples, typical precision of analysis of the offered equipment shall be in line with the stipulations of ASTM E-322, (latest edition). The x-ray fluorescence spectrometer shall be of wavelength dispersive type and shall consist of high voltage x-ray generator, spectrometer with mounted optics, counting and control electronics, computer, desk jet printer, colour graphic monitor, keyboard, water chiller, etc. as a composite unit. The high voltage generator shall supply stabilised power supply to x-ray tube. Main components of the high voltage x-ray generator shall be high voltage stabilised power supply system, filament power supply system, safety circuits, x-ray tube with cooling arrangement, etc. The selection of parameters shall be automatic	1

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Sl. No.	Description of equipment	Qty
	through computer. The system shall have tube on top arrangement. The x-ray tube shall be end window type with high purity Rhodium target and provided with requisite Nos. of filters for removal of interfering lines and for improvement in lower limit of detection. Tube life, to be guaranteed, shall be specified. The Spectrometer chamber shall be maintained at a high level of vacuum and shall house primary slit, goniometer mounted with crystals and detectors, multi position area limiting diaphragm exchanger, crystal changer with 8 or more position (which is sufficient to meet the requirement) with crystals fitted. The equipment shall have automatic sample changer and sample chamber under vacuum. The speed of rotation of the sample shall be sufficient to suppress the effect of non- homogenities in the specimen. It shall have facility for quick changeover of samples. The goniometer shall be fully automatic and microprocessor controlled. Selection of slit width, crystal, detector, collimator, primary beam filter (Ti), flow counter, window (of minimum thickness), etc. shall be optimum to provide maximum intensity and spectral resolution. The reproducibility, precision and accuracy of analysis for each element shall be finished in tabular form. The excitation conditions, the geometry and x-ray optics of the spectrometer shall provide for large signal to background ratio, stable and reproducible results and low detection limits with shortest measuring time. The equipment shall be provided with electronic devices like pulse height analyser, scaler with high counting capacity, timer, etc. The spectrometer shall have built-in computer with windows based software to control instrument parameters, evaluate and correct the analysis results, select pre-set analytical programme and print out analytical results.	

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Sl. No.	Description of equipment	Qty
	The water chiller (imported) shall provide closed circuit cooling to x-ray tube. The instrument shall be supplied pre-calibrated at the principals works for hot metal, blast furnace slag and steelmaking slag, iron ore lump, pellets and sinter, limestone, dolomite, quartzite, Pyroxenite, manganese ore. Copies of all metal discs/pressed pellets/beads along with instrument monitors and drift monitors used in calibration of the instrument for the calibration programs are to be supplied. If beads are used for calibration, the consumables such as fluxes, oxidizer and releasing agent (of the specification used to prepare the calibration samples) is to be supplied in sufficient quantity to prepare 500 beads shall be supplied along with the recipe and temperature cycle used for bead preparation. If Pressed pellets are used for calibration, sufficient binder (of the specification used to prepare the calibration samples) to press 1000 number of pellets are to be supplied. Also powder of 5 Nos. of international standards (CRMs) for all programs excepting Hot Metal for periodic calibration at site for each of the programs shall be supplied along with the equipment. Sample holder, masks, etc. will be included in the scope of supply. Supply of equipment will be complete in every respect including 2 Nos. of P-10 gas, filled in cylinder with regulators, voltage stabiliser of required capacity, mechanical tool set (1 No.) for regular maintenance, printer ribbon and paper rolls for commissioning and initial 3 months consumption etc. These items will be supplied from indigenous sources. **Major technical parameters** The equipment shall generally conform to the following technical parameters. X-ray generator X-ray tube : End-window type with high purity	

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Sl. No.	Description of equipment	Qty
	Rhodium target, output 4.0 kW (min.) X-ray tube cooling : Closed circuit, using deionised water HT generator : Full wave rectification, rating 4.0 kW(min.) 140 mA(min.), stability of tube current and tube voltage shall be (+) 0.001% for (+) 1% fluctuations in input voltage and current. Spectrometer chamber : X-ray beam : Vacuum path Evacuation system : Rotary vacuum pump with oil mist filter system Crystal : LIF (200), PET, GE, TIAP, etc., in line with the requirement of the analytical program. Detector : F-PC with gas density stabiliser for light elements and SC for heavy element Goniomter coverage : 0^{o} - 148^{o} (2 θ) (min.) Temperature : PID control to keep the temperature of chamber within (+) 0.05^{o} C for ambient temperature range of 18^{o}C to 28^{o}C. **Sample handling system :** Sample type : Solid & briquetted powder and Fused Beads Maximum sample dimension : 51 mm dia x 30 mm height Sample spin : 30 rpm (typical) **Counting and control electronics** Items to be controlled : All mechanical motions, controls, counting controlled electronics and data transfer Dead time correction : Better than 20 nano-seconds	

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Sl. No.	Description of equipment	Qty
	Integration time : 0.1 – 999 sec Memory back-up : Through stand-by battery **Computer system hardware** : Intel Core i5 12400 12th Gen or better / Pentium processor of latest version RAM : 8 GB DDR4 RAM or better HDD : 512 Processor GB minimum Keyboard & Optical Mouse Monitor : 21.5" LED Ethernet LAN 10/100/1000 OS : Microsoft windows 10 Professional 64 Bit or newer 1 x Display Port and 1 HDMI Port, 1 VGA Port - 7 x USB port / 1 Onboard Serial Port or more **Computer software** The software package shall be comprehensive and shall include all programmes which are necessary for control of equipment, analysis, on-line and off-line data processing, report making and data transmission, etc. In general, it includes. - Back ground correction & drift correction - Internal standard correction & matrix correction - Process parameter calculations - Standardisation & calibration - Regression analysis - Preparation of calibration curves - Repeat analysis - Reporting Transmission to external CPU Standard less analysis Peak search, peak identification, PHA adjustment, selection of output for chart, etc.	

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Sl. No.	Description of equipment	Qty
	- Dialogue functions - Equipment monitoring job The equipment shall be supplied along with the following items : - All mounted electrics and instrumentations along with computer hardware - Vacuum pump - Interface and software for data transmission - Supply of suitable standalone UPS to cater to the power requirement of the instrument with minimum 30 minutes back-up time. - Commissioning spares as recommended by the manufacturer Standard accessories - initial fill of oil and grease and consumables for three months of operation after commissioning - Any other item which is not mentioned in this specification but is required for smooth and proper functioning of the equipment for the intended purpose A typical analytical program for the equipment is indicated in Table-1. **Scope of supply for utilities** 1 set piping for P-10 gas supply to the X-Ray Fluorescence spectrometer, and 2 Nos. of P-10 gas, filled in cylinder with regulators	
2	**Fusion bead furnace** The equipment shall be used for preparation of glass beads of blast furnace slag, iron ore, sinter, limestone, raw dolomite, quartzite, manganese ore, etc. of uniform and homogeneous composition for chemical analysis by XRF Spectrometer. It shall be provided with electric resistance heating system, to prepare glass beads and it shall be possible to select melting conditions individually for each sample. The equipment shall be microprocessor controlled and fully automatic based. Fusion shall be done by using electric resistance heating system.	2

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Sl. No.	Description of equipment	Qty
	The equipment shall have the following features: 1. Furnace capacity: 6 samples 2. Auto loader capacity: 6 samples 3. Bead size: 32 mm 4. Weight loss/ gain range: 0-100% 5. Furnace powered by electric power only. 6. No usage of gas. Power requirement is 2.0 kW, 220 V 50-60 Hz 7. Temperature range: Ambient to 1150^{o}C or more 8. Temperature stability: ±2°C range 9. Samples per cycle: mínimum 24 samples /hr 10. Crucibles shall be moldable and cleaning shall be reduced to every 20 – 30 operations 11. Capable of integrating with automatic sample/ flux doser in future. 12. All heated parts made of Ceramic (carousels, pedestals, mould holder, etc.) 13. In-built optical sensors to avoid mechanical accidents in sample crucible movement in the equipment. 14. Equipment shall have provision to agitate melted sample and flux, to get homogeneous beads without any air bubbles. 15. Platinum crucible and/or mould for melting, mixing and bead making. 16. Equipment can be operated/ controlled through external PC or built in LCD touch screen interface. The equipment shall be supplied with the following accessories: ➢ Platinum crucibles and molds (approx 100 grams of platinum and gold alloy, 95% of Platinum and 5% of gold). Platinum Crucibles shall be moldable - 8 Nos. ➢ Balance: suitable external electronic weighing balance with sensitivity 0.1 mg shall be supplied as a part of equipment for sample/flux weighing. ➢ Voltage stabiliser/ un-interrupted power supply with sufficient power back-up of required capacity.	

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Sl. No.	Description of equipment	Qty
	➢ For determination of LOI (loss on ignition), a suitable muffle furnace shall be provided. - Any other item which is not mentioned in this specification but is required for smooth and proper functioning of the equipment for the intended purpose	
3	**Carbon Sulphur analyser** It shall be microprocessor controlled and shall be used for rapid, accurate and simultaneous determination of carbon and sulphur content in blast furnace hot metal samples. It shall basically consist of high power induction furnace, analyser and control console. Analytical results shall appear directly in weight percent of carbon and sulphur. The detection method shall be infra-red absorption for both carbon and sulphur. The analyser shall incorporate programmable automatic Dual Zone cleaning mechanism for both Metal Filter and combustion tube removal vacuum cleaner environment. **Broad parameters of equipment** Range (with 1g sample) **Carbon** : 0.6 ppm to 6.00% **Sulphur** : 0.6 ppm to 6.00% **Precision** **Carbon** : 0.3 ppm or 0.5% RSD, whichever is greater **Sulphur** : 0.3 ppm or 0.5% RSD, whichever is greater **Readability** : 0.001 ppm The equipment shall be supplied along with the following items: ➢ Interface and software for data transmission	2

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Sl. No.	Description of equipment	Qty
	➢ Commissioning spares, as recommended by the manufacturer ➢ Consumables / operating supplies required for 1000 analyses, as recommended by the manufacturer ➢ Two (2) Nos. of gas cylinder, one each for oxygen (purity 99.5% / OEM recommended) and instrument quality compressed air with piping, SS regulator and manifold and required No. of CO_2 gas (high purity) cylinder for gas dosing. ➢ Standard calibration samples of NIST traceable Certified Reference Material ➢ One No. sample cutting device for cutting of pin portion (1.0 g sample: pneumatic type pin cutter) from lollypop sample, with abrasive disc kit, recommended cutting wheel Silicon Carbide to reduce heat generation. ➢ Standard accessories and items as recommended by the manufacturer ➢ Voltage stabiliser/ un-interrupted power supply with sufficient power back-up of required capacity. ➢ List of spares for 2 years of operation and maintenance, as recommended by the manufacturer Any other item which is not mentioned in the specification but is required for smooth and proper functioning of the equipment for the intended purpose.	
4	**Cold Compressive Strength (CCS) machine for iron ore pellet** The equipment shall be automated, dual column type. The system shall be connected to a computer. **Load frame:** • Capacity shall be 10kN • Servo motor drive • Programmable positional alarm limits (PPAL) system • Emergency stop switch	2

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Sl. No.	Description of equipment	Qty
	Load measurement system: • High Precision Load cell 10kN, 2.5kN and 100N • Digital encoding for automatic load cell recognition, scaling and calibration. • It shall conform to ASTM E4, ISO 7500-1 and equivalent standards. • Range: 0.2% to 100% of capacity with guaranteed accuracy of ±0.5% of the applied Load or better. **Speed Control System:** • Test speed range (minimum): 0.001 mm/min to 1000 mm/min • Return speed range (minimum): 0.001 mm/min to 1000 mm/min. • Speed accuracy: +/- 0.05% of indicated speed • Speed resolution (minimum): 0.001 mm/min. **Extension/ Strain measurement system:** • Measurement direct from ball screw • Single measurement range • Fully auto scaling • Displacement resolution: 0.0001 mm or better • Automatic detection of specimen break • Crosshead shall return automatically to its initial position after specimen break. • Strain measurement shall confirm to ISO 9513 **Controller:** Data processing rate : 168 MHz approx Data acquisition rate : 1000Hz External PC connection : USB / Ethernet **Drive:** High Torque precision DC / AC servo motor with digital closed loop controller. Material testing software for machine control, data acquisition and	

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Sl. No.	Description of equipment	Qty
	analysis with license. Any other item which is not mentioned in this specification but is required for smooth and proper functioning of the equipment for the intended purpose.	
5	**Hydraulic briquetting press** The equipment shall be used for preparing pellets from powdered samples for X-ray spectrometric analysis. Pressure shall be applied to a die fixed to a cross-arm by means of an electro-hydraulic system. There shall be provision for adjusting the press force from 5 to 40 Tonnes. The machine shall be consisted of : ➢ Welded sectional steel frame ➢ Noise insulated shell ➢ Swing-out crosshead ➢ PLC ➢ Operator panel ➢ Integrated electric switch cabinet ➢ Hydraulic pump The sample material to be compacted is added manually to the die and the pivoting upper cross-head is closed. After pre-selecting the compacting parameters at the operator terminal (e.g. press force, pressure holding time, pressure relief time) and actuating the start button, the compacting process shall start automatically. All the sequences of functions shall be controlled by means of a programmable logic controller (PLC). When the crosshead is open, the ejection process is started and the compact is removed. The position of the crosshead is pulled by means of limit switches. The press cylinder is powered by an integral hydraulic power pack. The lower stand is completely surrounded and noise-insulated.	2

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Sl. No.	Description of equipment	Qty
	Pressure shall be applied to a die fixed to a cross-arm by means of an electro-hydraulic system. There shall be provision for adjusting the press force from 0 to 40 tonnes. A timer shall be provided for applying the pre-set pressure for pre-set period of time. Thus, a time limit relay shall automatically switch-off the power supply to the hydraulic pump after the lapse of the pre-set time. The timer shall also indicate the counting of time from start to end. It shall be provided with dust proof covering and tactile keys / knobs for easy setting of time. In case, there is a drop in pressure during holding time then the pump motor has to restart to bring the pressure back to set value.1.5 Kilowatt/2.0 HP (minimum) motor capacity. The hydraulic oil used for the pressing energy shall be easily available and shall be of correct grade to support pressing of the concerned material for the set time in order to generate a good sample surface for XRF analysis. The pressing pressure shall not be affected by the temperature of the oil. The top lid of the press tool shall be of chrome steel for pressing powder samples in Aluminum cups to get a sample of dia 40 mm and shall be capable of being fixed tightly onto the sample with the help of a screw mechanism. It shall be provided with facility for removal/ fitting of the press tools having different diameters. The machine shall be supplied with the following items: ✓ Standard press tool : 40 mm diameter, chrome steel for aluminium cup ✓ 3000 pieces aluminium cups (Dia. 40 mm, H=7.5 mm, painted) - Any other item which is not mentioned in this specification but is required for smooth and proper functioning of the equipment for the intended purpose	

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Sl. No.	Description of equipment	Qty
6	**Vibratory cup mill** The equipment shall be used for pulverising materials like blast furnace slag, iron ore lump, pellet, sinter, limestone, raw dolomite, quartzite, manganese ore, etc., for getting uniform composition for X-ray spectrometric analysis. The machine shall be consisted of : ➢ Welded sectional steel frame ➢ Noise insulated shell ➢ Clamping device ➢ PLC ➢ Operator panel ➢ Integrated electric switch cabinet It shall consist of a bowl, a ring and a hammer. The sample shall be kept in the space between the bowl, ring and hammer. The top of the bowl shall be closed and it shall be clamped on a vibratory platform which shall impart kinetic energy to the ring and hammer. The grinding vessel shall be of 100 cc volume. Material of construction of grinding vessel shall be tungsten carbide lined. The mill and the drive mechanism shall be housed in a suitable metallic enclosure in order to minimize noise. The sample grinding area shall be covered by a lid which can be lifted and closed easily for operating safely. One electronic / electromechanical timer shall be provided for automatically stopping the mill after a preset period of operation. The actual time countdown shall also be displayed. The timer shall have dust proof covering and tactile keys / knobs for easy setting of time. The transmission of rotational force required shall be through springs of adequate strength with 1.1 kilowatt/1.5 HP (minimum) motor capacity. It shall have auto tripping on motor over load / single phasing (of 3∅) for safety of motor. It shall have enough electrical capacity to work continuously. It shall have enough speed for pulverizing the sample of max. hardness 9 Mhos to the required size in the set time. It shall have enough speed for pulverizing the sample to the required size in the set	3

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Sl. No.	Description of equipment	Qty
	time. It shall also be provided with a start and a stop button. It shall be provided with safety switches to prevent start of the operation if lid is open. The input size shall be less than 5 mm and the output size of the sample shall be less than 100 microns. The supply shall include extra one 100 cc tungsten carbide lined grinding vessel.	

4.11.2 Successful bidder to provide following inputs for process laboratory:

1. A comprehensive list of tests required for the blast furnace complex and also for process controls.
2. List of the testing equipment necessary to conduct the aforementioned tests, including their requisite technological specifications for procurement by purchaser.
3. Any preferred makes available with the bidder, preferable from Indian Sources.
4. Utility requirement indicating quantity, quality, level & location at the T.O.P.
5. Electrical load, power requirement.
6. Civil foundation load data / foot print / bolt plan/cut out drawings.
7. Requirement of tools & tackles for erection.

Typical analytical program for sequential X-ray fluorescence spectrometer for blast furnace laboratory

Table-1

Element	Hot metal	Blast furnace slag	Iron ore	Lime stone	Dolomite		Mn-ore	Quartzite	Sinter	Iron ore pellet	Pyroxenite
C	0.20-4.70	-	-	-	-		-	-	-		
Si	0.10-2.00	-	-	-	-		-	-	-		
Mn	0.10-1.50	-	-	-	-		-	-	-		
S	0.01-0.10	-	0.01-0.10	0.01-0.10	-		0.01-1.00	0.05	-		
CaO	-	25.00-40.00		40.00-90.00	25.00-40.00			0.01-2.00	5.0 – 10.0	0.10-5.00	0.10-8.00
MgO	-	5.00-12.00		0.10-5.00	10.00-30.00			0.01-2.00	1.0-3.0	20.00-45.00	0.10-3.00
SiO_2	-	15.00-40.00	1.00-7.00	0.10-10.00	1.00-10.00		3.00-10.00	90.00-99.00	1.5-5.0	20.00-50.00	1.50-7.00
Al_2O_3	-	14.00-28.00	1.00-5.00	1.00-5.00	1.00-5.00		2.00-10.00	0.10-2.00	1.5 – 4.0	0.05-5.00	1.50-4.00
Fe	-	-	58.00-70.00	-	-		5.00-20.00	1.00-3.00	50- 65	0.05-5.00	58.00-68.00
FeO	-	0.01-2.00	-	-	-		-	-	6-15		
P_2O_5	-	-	0.01-2.00	0.01-2.00	0.01-2.00		0.05-2.00	0.01-2.00	-	0.01-2.00	0.01-2.00
MnO	-	0.01-2.00	-	-	-		25.00-50.00	-	-	0.01-4.00	0.01-4.00
Na_2O	-	0.01-2.00	0.01-2.00	0.01-2.00	0.01-2.00		-	-	-	0.01-4.00	0.01-2.00
K_2O	-	0.01-2.00	0.01-2.00	0.01-2.00	0.01-2.00		-	-	-	0.01-2.00	0.01-2.00

** End of Clauses**