

NTPC Limited

(A Government of India Enterprise)



**EPC PACKAGE FOR SETTING UP 700 TPD (2 X 350 TPD)
WASTE TO ENERGY PROJECT AT KAWAS, SURAT**

TECHNICAL SPECIFICATION

FOR

EPC PACKAGE

PART – B (MECHANICAL)

(BOOK 1 OF 5)

SECTION - VI

BID DOC. NO.: CS-2600-001-9

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BID DOC. NO.: CS-2600-001-9

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PART – B

MECHANICAL

PART – B (MECHANICAL) (BOOK 1 OF 5)

A – 01	OPERATING CAPABILITY OF THE PLANT
A – 02	EQUIPMENT SIZING CRITERIA
A – 03	STEAM GENERATOR AND AUXILIARIES
A – 04	NOT USED
A – 05	LAYOUT REQUIREMENTS
A – 06	STEAM TURBINE & AUXILIARIES SYSTEM
A – 07	POWER CYCLE PIPING
A – 08	LOW PRESSURE PIPING
A – 09	NOT USED
A – 10	SURFACE PREPARATION & PAINTING
A – 11	THERMAL INSULATION
A – 12	WATER SYSTEM
A – 13	NOT USED
A – 14	COMPRESSED AIR SYSTEM
A – 15	AIR CONDITIONING
A – 16	FIRE PROTECTION AND DETECTION SYSTEM
A – 17 TO 20	NOT USED
A – 21	ASH HANDLING PLANT AND CRANE
A – 22	NOT USED
A – 23	NOT USED
A – 24	LP DOSING AND OXYGENATED TREATMENT SYSTEM
A – 25	SERVICE ELEVATORS CRANE, HOIST & MONORAIL
A – 26	PRE-COMMISSIONING & COMMISSIONING ACTIVITIES
A – 27	VENTILLATION SYSTEM

SUB-SECTION – A-01

OPERATING CAPABILITY OF THE PLANT

TECHNICAL REQUIREMENTS			
OPERATING CAPABILITY OF PLANT			
1.01.00	The operating capability of various systems, equipment and associated auxiliaries in the scope of the Bidder is specified elsewhere in the Technical Specification.		
1.02.00	The plant and its unit (s) shall be designed to operate with all the specified margins for continuous operation without any limitations under any of the conditions indicated in the Technical Specification. The major operating capabilities for the unit(s)/plant shall be as follows: (a.) Operate continuously with the rated RDF disposal quantity with rated parameter with the range of waste fuel. (b.) The unit shall be capable of start-up / shut-down and achieving rated steam parameters without external steam supply for turbine gland sealing, de-aerator pegging etc. (c.) In case of sudden reduction in demand (load throw off, grid failure), the unit should get safely unloaded and stabilized for continuous operation at a minimum load (i.e. house load) so as to keep the unit alive and cater the unit's own auxiliary power requirement with bypass open to full capacity. (d.) Bypass operation under rated steam conditions with bypass valve open to full capacity and turbine on house load. (e.) The equipment and auxiliaries shall be suitable for continuous operation in the frequency range of 47.5 Hz to 51.5 Hz. (f.) The plant should be able to supply upto 60% of the rated steam flow at 8 ata at the input of the vapour absorption chiller (Absorption chiller not in bidder's scope) for use in district heating/ cooling or other uses. In such case the electric output of the plant may reduce accordingly.		
1.03.00	All the systems/equipment/auxiliaries under Bidder's scope shall be designed to cater to the above operating conditions envisaged for the unit(s)/plant by the Owner. Unless specified otherwise in the Technical Specification the design should cater to the above operating conditions with adequate margin as per standard practice prevailing in the RDF fired Waste to Energy plants.		
1.04.00	The plant shall be designed to operate as a base load station catering the captive power requirement.		
1.05.00	The plant shall be designed to operate for all the envisaged quality of RDF for the following		
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-01 OPERATING CAPABILITY OF PLANT
			PAGE 1 OF 2

	TECHNICAL REQUIREMENTS																															
	<table><tr><td>POINT</td><td>ENERGY CONTENT [kCal/kg]</td><td>LOAD POINT [%]</td><td>THROUGH PUT [%]</td></tr><tr><td>Loading Point – Design point</td><td>2100</td><td>100</td><td>100</td></tr><tr><td>Load Point 1</td><td>1600</td><td>~ 78</td><td>100</td></tr><tr><td>Load Point 2</td><td>1600</td><td>60</td><td>~ 81</td></tr><tr><td>Load Point 3</td><td>2100</td><td>60</td><td>60</td></tr><tr><td>Load Point 4</td><td>3150</td><td>~ 90</td><td>60</td></tr><tr><td>Load Point 5</td><td>3150</td><td>100</td><td>~ 68</td></tr></table>				POINT	ENERGY CONTENT [kCal/kg]	LOAD POINT [%]	THROUGH PUT [%]	Loading Point – Design point	2100	100	100	Load Point 1	1600	~ 78	100	Load Point 2	1600	60	~ 81	Load Point 3	2100	60	60	Load Point 4	3150	~ 90	60	Load Point 5	3150	100	~ 68
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Note: Energy content - Lower calorific value as NCV (dry basis)																																
1. In addition, the vendor needs to provide a margin of 10 % for both Waste throughput and thermal load beyond 100 % as overload area, as shown.																																
2. Bidder should clearly define the operation area requiring supplemental fuel in this diagram.																																

SUB-SECTION-A-02

EQUIPMENT SIZING CRITERIA

CLAUSE NO.	TECHNICAL REQUIREMENTS													
1.00.00	STEAM GENERATOR AND AUXILIARIES The design/specifications/sizing of various plants/systems/equipment offered for Steam Generator(s) & Auxiliaries shall comply with the requirements detailed hereinafter:													
1.01.00	Steam Generator(s) Type and Other Features													
1.01.01	Type The Steam Generator shall be of single pass or multi pass type using either spiral wall (inclined) or vertical plain / rifled type water wall tubing.													
1.02.00	FUEL <table border="0"> <tr> <td>i)</td><td>Primary fuel</td><td>Refuse Derived Fuel</td></tr> <tr> <td>ii)</td><td>Normal Start up/ Black Start /low load/stabilizing fuel</td><td>natural gas</td></tr> <tr> <td>iii)</td><td>Backup fuel</td><td>LDO</td></tr> </table> The capacity of additional / secondary burners shall be designed to maintain 950 Degree C for 2 seconds criteria.	i)	Primary fuel	Refuse Derived Fuel	ii)	Normal Start up/ Black Start /low load/stabilizing fuel	natural gas	iii)	Backup fuel	LDO				
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1.03.00	Boiler Operation <table border="0"> <tr> <td>i)</td><td>Startup</td><td>: The steam generator shall also be capable of start-up with turbine pass system in service</td></tr> <tr> <td>ii)</td><td>Load Throw Off</td><td>: In case of sudden load throw-off, in worst case from full load, the Steam Generator shall be capable of automatically bringing down the steam generating capacity to match with Turbine bypass capacity</td></tr> <tr> <td>iii)</td><td>Frequency Variation</td><td>: The equipments and auxiliaries shall be suitable for continuous operation in the frequency range of 47.5 Hz to 51.5 Hz</td></tr> <tr> <td>iv)</td><td colspan="2">In line with the plant operating capability requirement indicated in sub-section A-01, the steam generator shall be designed for variable pressure operation. Thermal design of steam generator and the selection of material of pressure parts shall be suitable for variable pressure operation modes.</td></tr> </table>	i)	Startup	: The steam generator shall also be capable of start-up with turbine pass system in service	ii)	Load Throw Off	: In case of sudden load throw-off, in worst case from full load, the Steam Generator shall be capable of automatically bringing down the steam generating capacity to match with Turbine bypass capacity	iii)	Frequency Variation	: The equipments and auxiliaries shall be suitable for continuous operation in the frequency range of 47.5 Hz to 51.5 Hz	iv)	In line with the plant operating capability requirement indicated in sub-section A-01, the steam generator shall be designed for variable pressure operation. Thermal design of steam generator and the selection of material of pressure parts shall be suitable for variable pressure operation modes.		
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1.04.00	Component sizing/Design Criteria													
1.04.01	Furnace/evaporator/waterwalls shall comply with following requirements at 100% BMCR and for the range of specified waste fuel, under most stringent combination of conditions <table border="0"> <tr> <td>i)</td><td>Furnace residence time</td><td>2.0 sec. (Minimum) Shall be designed to maintain 950 Degree C for 2 seconds criteria.</td></tr> </table>	i)	Furnace residence time	2.0 sec. (Minimum) Shall be designed to maintain 950 Degree C for 2 seconds criteria.										
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KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-02 EQUIPMENT SIZING CRITERIA PAGE 1 OF 7												

CLAUSE NO.	TECHNICAL REQUIREMENTS			
1.04.02	ii)	Furnace exit gas temperature	Shall be designed to avoid slagging / fouling – as per vendor proven practice.	
	iii)	Pressure withstanding capability	As per vendors proven design (Maximum conceivable head of fans).	
	DESIGN OF PRESSURE PARTS			
	(a)	The design of all pressure parts (tubes, headers, separators, vessels etc.) shall be as per Indian Boiler Regulations (IBR) or other international codes with the approval of the Employer. It is however, the responsibility of the Contractor to get various calculations and other technical documentations approved by the statutory authorities in the state and country of location of the plant.		
	(b)	Design pressure of the Steam Generator pressure parts shall be atleast 1.05 times the maximum operating pressure, or as required by IBR/other international codes, whichever is higher.		
	(c)	The thickness of the pressure parts (steam and water tubes/headers, Drum, pressure vessels etc.) shall be calculated using IBR formulae/factor of safety etc. (and not as per codes/formulae acceptable to IBR). Minimum tube thickness at the bends in no case shall be less than the minimum tube thickness for the straight tubes. For this purpose appropriate thinning allowance shall be considered by the Contractor while calculating the thickness of the bends. Additional erosion allowance on the calculated tube thickness shall be provided at specified locations as specified by the Employer in this specification.		
	(e)	Materials for Steam Generator Components		
	The material used for Steam Generator components i.e. boiler pressure parts including boiler tubing, headers, drum, piping, vessels, valves & fittings etc. and other components shall be equal to or better than the following unless specified otherwise:			
		Design Metal Temperature	Material	
	(i)	Upto & including 400 degree Celsius	Carbon steel to ASME SA-106 Gr. B/C or SA 210 Gr. C or approved equivalent.	
(ii)	Upto & including 550 degree Celsius	Alloy steel to ASME SA-335: P-11/P-12/P-22 ASME SA213:T-11/T-22/T23/ or approved equivalent.		
(iii)	Upto & including 605 degree Celsius	Alloy steel ASME SA-335/213:P-91/T-91, T-92, or approved equivalent.		
(iv)	Upto & above 605 degree Celsius	Austenitic stainless steel, Super 304H, TP347H or approved equivalent.		
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-02 EQUIPMENT SIZING CRITERIA	PAGE 2 OF 7

CLAUSE NO.	TECHNICAL REQUIREMENTS		एनडीपीसी NTPC											
1.04.03	Alloy 625 type filler and cladding material to service temperatures below 450 °C. (such as cladding of membrane walls, evaporators and preheaters). Alloy 686 type filler and cladding material to service temperatures above 450 °C. DRUM (i) Design Code IBR (ii) Design Pressure 1.05 times the max. operation pressure or highest set pressure of the spring loaded safety valve for full discharge, whichever is higher													
1.04.04	SUPER HEATERS Superheater(s) shall be designed, suitably sectionalized and positioned to comply with the following, for the specified load(s), Waste fuel(s) and for normal, upset, most adverse and other operating conditions (refer as specified at clause no 1.00.00 of Sub Section-A-03 also) <table><tr><th>Parameter</th><th>Requirement</th></tr><tr><td>(1) Rated Steam Temperature The control system for SG shall be able to maintain SH outlet temperatures within ± 5°C of above values over complete control range of Steam Generators with the range of specified waste fuel.</td><td></td></tr><tr><td>(2) Maximum average flue gas velocity in section/tube banks</td><td>As per vendors standard proven practice</td></tr><tr><td>(3) Maximum allowable tube metal skin temperature</td><td>40 degree Celsius below oxidation limit for the tube metal.</td></tr><tr><td>(4) Means of Temperature Control Super heaters</td><td>Spray Water attemperation</td></tr></table>				Parameter	Requirement	(1) Rated Steam Temperature The control system for SG shall be able to maintain SH outlet temperatures within ± 5°C of above values over complete control range of Steam Generators with the range of specified waste fuel.		(2) Maximum average flue gas velocity in section/tube banks	As per vendors standard proven practice	(3) Maximum allowable tube metal skin temperature	40 degree Celsius below oxidation limit for the tube metal.	(4) Means of Temperature Control Super heaters	Spray Water attemperation
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1.04.05	ECONOMISERS Economizer design shall conform to the following criteria/requirements under all condition of operation and for the complete range of specified fuels. <table><tr><th>CRITERIA</th><th>REQUIREMENT</th></tr><tr><td>(i) Economizer Type</td><td>Non-steaming type with parallel cross flow or counter flow arrangement.</td></tr><tr><td>(ii) Approach Temperature control range</td><td>within 17°C (minimum)</td></tr><tr><td>(iii) Maximum average flue gas velocity</td><td>As per vendors proven practice</td></tr></table>				CRITERIA	REQUIREMENT	(i) Economizer Type	Non-steaming type with parallel cross flow or counter flow arrangement.	(ii) Approach Temperature control range	within 17°C (minimum)	(iii) Maximum average flue gas velocity	As per vendors proven practice		
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KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-02 EQUIPMENT SIZING CRITERIA	PAGE 3 OF 7										

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनडीपीसी NTPC
	through the Economizer tube banks			
	(iv)	Economizer tube thickness	i) Provide erosion allowance of 1mm (minimum) in addition to thickness calculated as per IBR formulae. ii) Minimum tube thickness at the bends in no case shall be less than the minimum tube thickness for the straight tubes calculated in the manner described at (i) above. For this purpose appropriate thinning allowance shall be considered by the contractor while calculating the thickness of the bends.	
	(v)	Maximum allowable tube metal skin temperature	Oxidation limit for the tube metal.	
1.04.07	Steam Coil Air Preheater (SCAPH)			
1.04.07.01	SCAPH shall be designed / sized to increase the air heaters inlet air temperature based on following criteria:			
	Sl. No.	DESCRIPTION	Primary SCAPH (if provided)	Secondary SCAPH (if provided)
	(i)	Design ambient air temp.	6°C	6°C
	(ii)	Number of SCAPHs	As per vendors proven practice (considering high moisture, low energy content Indian RDF)	
	(iii)	Type of fuel	Worst waste fuel	Best waste fuel
1.04.07.02	Design SCAPH and connected air ducts to handle flows corresponding to full load with margin without any undue noise/vibration.			
1.05.01	PRIMARY AIR FANS			
1.05.01.01	Fan Design			
	(a)	Type of Fan	:	Centrifugal with VFD drive
	(b)	No. of fans	:	one
	(c)	Type of fan blade	:	Designed to withstand different load on the blade.
	(d)	Fan suction	:	Each one from waste pit and from atmosphere (in case of fire in waste pit)
1.05.01.02	Fan Sizing Criteria			
	(a)	Fan shall be rated to meet requirement of 100 % of full load with the following conditions all occurring together.		
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9		SUB SECTION-A-02 EQUIPMENT SIZING CRITERIA PAGE 4 OF 7

CLAUSE NO.	TECHNICAL REQUIREMENTS		एनडीपीसी NTPC																																					
	(1)Worst waste fuel firing with maximum moisture content. (2)Power supply frequency - 47.5 Hz. (3)Ambient air temp. - 50 degree Celsius & RH 60%. (b)In any case the margins on flow & pressure shall not be less than 25% and 30% respectively over the calculated values at full load condition.																																							
1.05.01	DRAFT PLANT																																							
1.05.01.01	The forced draft (F.D.)(if applicable) and induced draft (I.D.) fans shall be capable of maintaining balance draft conditions in the furnace over the entire load range while firing the specified range of fuels.																																							
1.05.01.02	Fan Sizing Criteria FD & ID fans shall be sized such that they satisfy the criteria stipulated below. <table><tr><th>S.N.</th><th>Description</th><th>FD Fans</th><th>ID Fans</th></tr><tr><td>1</td><td>Type of fans</td><td colspan="2">Centrifugal Fan with VFD</td></tr><tr><td>2</td><td>No. of fans per unit</td><td>One</td><td>One</td></tr><tr><td>3</td><td>Fan sizing criteria with all the following conditions occurring together :</td><td colspan="2">Fan to be sized for 100 % load calculated taking into account following factors occurring together:</td></tr><tr><td>(i)</td><td>Type of Waste fuel firing</td><td>Design / Best / Worst Quality of RDF, whichever gives maximum FD fan air requirement</td><td>Design / Best / Worst Quality of RDF, whichever gives maximum flue gas flow.</td></tr><tr><td>(ii)</td><td>Power supply frequency</td><td>47.5 Hz</td><td>47.5 Hz</td></tr><tr><td>(iii)</td><td>Excess air</td><td>20% over the Stoichiometric air</td><td>20% over the Stoichiometric air</td></tr><tr><td>(iv)</td><td>Fan inlet air/flue gas temperature</td><td>50°C with 60% relative humidity</td><td>Gas temperature corresponding to 50°C ambient temperature and 60% relative humidity</td></tr><tr><td>(viii)</td><td>Pressure required at chimney inlet</td><td>Not applicable</td><td>+ 10 mm WC (or) as per the vendors proven practice – to ensure dispersion of gas through chimney</td></tr></table>				S.N.	Description	FD Fans	ID Fans	1	Type of fans	Centrifugal Fan with VFD		2	No. of fans per unit	One	One	3	Fan sizing criteria with all the following conditions occurring together :	Fan to be sized for 100 % load calculated taking into account following factors occurring together:		(i)	Type of Waste fuel firing	Design / Best / Worst Quality of RDF, whichever gives maximum FD fan air requirement	Design / Best / Worst Quality of RDF, whichever gives maximum flue gas flow.	(ii)	Power supply frequency	47.5 Hz	47.5 Hz	(iii)	Excess air	20% over the Stoichiometric air	20% over the Stoichiometric air	(iv)	Fan inlet air/flue gas temperature	50°C with 60% relative humidity	Gas temperature corresponding to 50°C ambient temperature and 60% relative humidity	(viii)	Pressure required at chimney inlet	Not applicable	+ 10 mm WC (or) as per the vendors proven practice – to ensure dispersion of gas through chimney
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CLAUSE NO.	TECHNICAL REQUIREMENTS				एनडीपीसी NTPC
1.05.01.03	S.N.	Description	FD Fans	ID Fans	
		The fan shall also fulfill following sizing criteria in addition to above	Fan to be sized flow calculated taking into following conditions		
	(i)	Margin over 100% Full load flow	20%	20%	
	(ii)	Margin over 100% Full load pressure requirement	44%	44%	
	Note to 1.05.01.02 & 1.05.01.03: ID/FD fan shall have a minimum stall margin of 10% over the Design duty points.				
1.05.02	Duct Work				
1.05.02.01	Sizing Criteria: Allowable velocities in the duct work. The design shall ensure appropriate velocity so as to avoid erosion of ducts.				
1.05.03	Fuel oil firing system :				
1.05.03.01	The Fuel oil preparation and firing system shall be sized based on following criteria.				
	Description	Requirement Oil firing			
	(i)	Purpose of fuel oil firing	Initial start up, flame stabilization at start up/low load		
	(ii)	Type of fuel	LDO AS PER IS 15770-2008		
	(iii)	Oil firing system capacity	To be designed as per the vendors proven practice.		
1.05.04	THERMAL INSULATION, LAGGING, CLADDING & REFRACTORIES Thermal Insulation shall be designed based on criteria mentioned in separate chapter on Thermal insulation.				
1.05.05	BLOW DOWN SYSTEM				
1.05.05.01	The atmospheric flash tank shall be sized to receive following: i) Maximum possible start up drain flow under all possible normal, abnormal, upset, accidental conditions. ii) All drains from Steam Generator such as drains from water wall headers, attemperators headers, SCAPH drains, soot blowers drains, superheater etc.				
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9		SUB SECTION-A-02 EQUIPMENT SIZING CRITERIA	PAGE 6 OF 7

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC				
2.00.00	iii) Alternate drains from main steam lines as required. iv) Any other drains from High Pressure piping. For sizing, combination of all the above occurring simultaneously to be considered. Atmospheric tank shall be located at suitable level in the Steam Generator area.							
	Grate The grate shall be designed to operate for all the envisaged quality of RDF for the following Loading Point 1 Loading Point 2 Loading Point 3 Loading Point 4 Loading Point 5 Loading Point – Design point Vendor shall provide the firing diagram, showing the capability of the grate to fire different quality of RDF with additional 10 % margin for both waste throughput and thermal load, as over load area.							
2.01.01	In addition the vendor shall clearly mark the area where secondary firing is required to maintain minimum 950 Degree C and minimum 2 sec residence time. Further, the grate shall be designed to ensure complete combustion of RDF fuel and achieve the following performance <table><tr><td>Temperature in Secondary Combustion chamber conditions</td><td>min. 950°C / min 2 sec residence time</td></tr><tr><td>Slag & Bottom ash quality</td><td>TOC ≤ 3% or LOI ≤ 5%</td></tr></table> Waste cannot be allowed to be fired when furnace temperature is less than 950 Degree C. Whenever the furnace temperature falls below the 950 Degree C, the secondary fuel needs to be put into service so as to maintain the required temperature of 950 Degree C.				Temperature in Secondary Combustion chamber conditions	min. 950°C / min 2 sec residence time	Slag & Bottom ash quality	TOC ≤ 3% or LOI ≤ 5%
Temperature in Secondary Combustion chamber conditions	min. 950°C / min 2 sec residence time							
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SUB-SECTION–A-03

STEAM GENERATOR AND AUXILIARIES

CLAUSE NO.	 TECHNICAL REQUIREMENTS			
1.00.00	STEAM GENERATOR AND AUXILIARIES			
	EQUIPMENTS AND SYSTEMS SPECIFICATIONS			
	Specified hereafter are the minimum acceptable functional requirements of the Employer, and all components, equipments and systems for the Steam Generator(s) shall be designed to cater to these requirements. Compliance to various stipulations of the Technical Specifications, functional requirements of Employer and utilization of various parameters and their values in the specification by the Contractor shall in no way relieve the Contractor of his responsibilities to meet all guarantee requirements or of providing completely safe and reliable operating equipment/systems. The specified requirements shall be complied for the most stringent conditions resulting either from the range of fuel (design/worst/best) specified or from the range of operating conditions specified or from both occurring simultaneously, unless specifically mentioned otherwise by the Employer.			
	FUELS			
1.01.00	Refused Derived Fuel (RDF)			
1.01.01	(a) The primary fuel for the main Steam Generator(s) shall be waste fuel (RDF). The quality parameters are given in Annexure -2, Sub-Section-I-B of Part A of the project. (b) The Steam Generator shall be designed to give the maximum efficiency when firing the waste fuel having the characteristics for Design waste fuel is given in Annexure -2 of Sub-Section-I-B of Part-A of the project. (c) The Steam Generator and its auxiliaries shall also be capable of obtaining the boiler maximum load when firing the waste fuel having the characteristics for worst waste fuel as given in Annexure -2, Sub-Section-I-B of Part-A of the project. The Steam Generator and its auxiliaries shall be designed for efficient and trouble free operation when firing the design, worst and best waste fuel of the project and any of the waste fuel characteristics in between these for complete load range. The Steam Generator and its auxiliaries shall also be capable of giving full load rating as specified at clause no 1.02.00 of Sub-section- A-02, and other operating capabilities matching the requirements of plant operating capabilities specified in this Sub-Section, without any trouble and limitations, when firing the waste fuel having the specified range of characteristics. (d) The Bidders are advised to collect waste fuel samples for independent analysis of combustion, slagging/ fouling characteristics etc., to satisfy themselves so as to meet all specified requirements.			
1.01.02	Fuel Oil	(a) Fuel oil Firing System (1) The fuel oil, having characteristics as given at Annexure -2 of Part-A, Sub-section-I-B shall be used for start-up, waste fuel flame stabilization and low load operation of the main Steam Generator.		
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		BID DOC. NO.: CS-2600- 001-9	TECHNICAL SPECIFICATIONS SECTION – VI, PART-B	SUB SECTION-A-03 STEAM GENERATOR & AUXILIARIES
				PAGE 1 OF 33

CLAUSE NO.	 TECHNICAL REQUIREMENTS			
1.02.00	(2) The design and construction of the Steam Generator shall be suitable for firing the fuel oil mentioned above for continuous operation of the Steam Generator. Codes & Standards (1) All equipment, systems and work covered under this specification shall comply with all latest statutes, regulations and safety codes, as applicable in the locality where the equipment will be installed. This shall however be subject to change in Laws & Regulations as specified in Section-IV GCC. (2) The design of Steam Generator shall meet or exceed all the requirements of latest editions of Indian Boiler Regulations (IBR). This is subject to provision in Section-IV, GCC. (3) Any other standard acceptable to IBR can also be considered, provided that the requirements of that standard are equivalent or more stringent than the IBR requirements. (4) Wherever the specification stipulates requirements in addition to those specified in IBR, the same shall also be complied with, by the Contractor. (5) In all above cases specific approval of concerned Chief Inspector of Boilers shall be obtained by the Contractor before manufacture of the equipment. (6) In cases where IBR does not govern, other International Standards, established to be equivalent or superior to the Codes and Standards specified are also acceptable. However, in the event of any conflict between the requirements of the equivalent codes and standards, and the requirements of the Indian Standards/ Regulations, the latter shall govern, unless, specified otherwise in the specification.			
1.03.00	Statutory Approval It shall be responsibility of the Contractor to obtain the necessary approvals of Inspection Authority/Chief Inspector of Boilers Registration Authority etc. on behalf of the Employer, as may be required for designing and design calculations, manufacturing and erection procedure, testing etc. as called for under the IBR. All such documentation submitted to statutory authorities shall also be submitted to the Employer for his review. The design of Steam Generator shall be such that it does not call for any oil support for flame stabilization.			
1.04.00	Loading/Unloading Pattern and Adaptability for Sudden Load Changes/Load Throw off (i) To match the desired plant operating capabilities, the Steam Generator shall also be designed for expected numbers of Steam Generator start-ups during 25 years of design life. (ii) Under the above conditions, no portion of the Steam Generator and the associated systems shall be stressed beyond acceptable safe stress and fatigue levels and the design of Steam Generator and its pressure parts shall take care of above without affecting the life of equipment and pressure parts adversely. (iii) Steam Generator shall also be capable of satisfactory, stable and safe operation in case of rapid load changes in downward direction due to external disturbances or			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE	BID DOC. NO.: CS-2600- 001-9	TECHNICAL SPECIFICATIONS SECTION – VI, PART-B	SUB SECTION-A-03 STEAM GENERATOR & AUXILIARIES	PAGE 2 OF 33

CLAUSE NO.	 TECHNICAL REQUIREMENTS			
	equipment malfunction. Under such conditions the system shall stabilize itself through proven concepts and controls and within the recommendations of National Fire Protection Association, USA, NFPA-85. (iv) In case of sudden load throw-off, in worst case from Full load, the Steam Generator shall be capable of automatically bringing down the steam generating capacity to match with turbine bypass capacity. Contractor to indicate minimum load of Steam Generator to which it can be brought down under such condition, during short turbine outages or export load rejection. The boiler design shall ensure balanced draft condition, avoid overheating of boiler tubes and such other conditions that jeopardize the safety and life of boiler. (v) In line with automatic run back capability of the unit load on loss of critical auxiliary equipments, the Steam Generator equipment and systems shall also ensure smooth and stable runback operation. 1.05.00 Capital Overhaul of Steam Generator The design and materials for various equipments/auxiliaries etc. shall be selected by the Contractor keeping in view of the time between capital overhaul (as per the vendors proven practice), such that no major repairs/replacements, requiring shutdown of the unit, are needed in between the capital overhauls. 1.06.00 Maintenance 1.06.01 The Contractor shall provide adequate handling facilities & approach as for carrying out on-line and off-line maintenance of the Steam Generator and its auxiliaries. In order to carry out on-line maintenance, it shall be possible to readily disassemble, repair and reassemble the equipment supplied in the shortest period. 1.06.02 A minimum of two accesses and clean out doors shall be provided to permit access to the furnace, superheater the area between tube bank, economizer and any other area requiring maintenance. 1.06.03 Material handling equipment consisting of monorails, cranes, motorized hoists and motorized trolleys and any other lifting device, as may be required, alongwith all supporting structure etc. shall be provided for maintenance of all auxiliaries like ID, FD & PA fans, air preheaters, Steam Coil Air Preheaters etc. 1.06.04 A vertical & straight garbage chute of minimum 500 mm diameter and made from minimum 10 mm thick mild steel pipe shall be provided for each Steam Generator, from pent house level to ground level for disposal of debris & scrap generated during erection, operation and maintenance. The chute shall be provided with branch connections with doors and suitable access to the doors at all platform levels. Garbage collection trolleys shall also be provided at the ground level. 1.07.00 Noise level The equivalent weighted average of sound level measured at a distance of 1.5 m above floor level in each elevation and one meter horizontally from the base of any equipments furnished and installed under these specifications, expressed in decibel to a reference of 0.0002 microbar, shall not exceed 85 dB(A) except for i) Safety valves and associated vent pipes for which it shall not exceed 105 dBA-115 dBA.			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE	BID DOC. NO.: CS-2600- 001-9	TECHNICAL SPECIFICATIONS SECTION – VI, PART-B	SUB SECTION-A-03 STEAM GENERATOR & AUXILIARIES	PAGE 3 OF 33

CLAUSE NO.	एनडीपीसी NTPC TECHNICAL REQUIREMENTS			
	ii) Regulating drain valves in which case it shall be limited to 90 dBA-115 dBA. 2.00.00 STEAM GENERATOR ENCLOSURE 2.01.01 Steam Generator enclosure shall form air/gas tight envelope from secondary air and primary air inlet points to chimney inlet. 2.01.02 The enclosure integral with boiler shall be formed by water/steam cooled tubes on all the four sides, roof and bottom. The furnace water walls shall be formed using either spiral (helical) wound tubes or vertical plain/rifled tubes. The roof of boilers could be formed by gas tight metal sheeting of appropriate material. 2.01.03 Any penetration(s) into the Steam Generator enclosure shall be sealed for gas tight integrity. 2.02.00 The Steam Generator enclosure shall be provided with: - Observation ports for each oil burner and at various platform levels on all the walls. Cooling of the observation ports shall be as per bidder's proven standard practice - Openings with hinged doors (air/gas tight) in all areas needing access for internal observation/maintenance. Provide minimum two openings for each area. - Approach platform for each observation port/opening along with ladders from nearest platform level. 2.03.00 Dissimilar Metal Welds (DMW) between martensitic and austenitic steels, martensitic and ferrite steel shall be avoided inside the boiler enclosure for the pressure parts, which are exposed to hot flue gases. However, if such DMW are unavoidable, same can be permitted at shop provided manufacturer has previous experience of such DMW and appropriate heat treatment is done after welding. 2.04.00 In the Steam Generator enclosure, minimum 1.5 m (or as per the vendors proven practice) cavity height shall be provided in between the horizontal banks/sections of economizer, superheater for maintenance purpose. 3.00.00 FURNACE/EVAPORATORS AND WATER WALLS 3.01.00 Furnace/evaporator/waterwalls shall comply with following requirements at full load for the range of specified waste fuel, under most stringent combination of conditions 3.02.01 Water/steam walls shall be of membrane wall construction (or as per the vendors proven practice) and shall be made of seamless tubes. Furnace / evaporator shall be formed using spiral wound / inclined tubing or vertical plain / rifled tubing as per the proven practice of the manufacturer for boilers of similar capacity. Irrespective of the type of water wall tubing offered for the evaporator, the design offered shall ensure that no readjustment of tube mass flow is required during entire operating regime of the Steam Generator for complete range of specified fuels. In case such readjustment becomes necessary over a period of five years from the date of successful completion of initial operation of respective Steam Generator, the cost of carrying out such flow readjustment/modifications including cost towards rectifying any damages to the Steam			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE	BID DOC. NO.: CS-2600- 001-9	TECHNICAL SPECIFICATIONS SECTION – VI, PART-B	SUB SECTION-A-03 STEAM GENERATOR & AUXILIARIES	PAGE 4 OF 33

CLAUSE NO.	TECHNICAL REQUIREMENTS				एनटीपीसी NTPC						
	Generator tubing resulting from the inappropriate mass flow in the tubes shall be borne by the Contractor. Contractor in his proposal shall indicate the approximate time required for such readjustment of tube mass flow and the period of unit shut down.										
3.02.02	A minimum allowance of 0.6 mm over and above the calculated thickness as per IBR shall be provided for entire water wall. An additional tube thickness of 1.0 mm over and above the tube thickness of water wall tubes calculated as per above shall be provided on all water wall tubes coming within a radius of one meter around each wall blower to guard against premature tube failure due to soot blowing steam erosion.										
3.02.03	Headers shall be located external to gas path and shall be completely drainable. If locating headers in gas path becomes unavoidable, then suitable erosion shields must be provided.										
3.02.04	Minimum tube thickness at the bends in no case shall be less than the minimum tube thickness for the straight tubes calculated in the manner described at 3.02.02 above. For this purpose appropriate thinning allowance shall be considered by the contractor while calculating the thickness of the bends.										
3.02.05	Provide adequate nos. of furnace observation and tapping points for local instruments, gauges, switches, test pockets etc.										
3.02.06	Incase water wall orifice are provided, these should be supplied with indexing holes and index pins.										
3.02.07	Alloy 625 type filler and cladding material to service temperatures below 450 °C. (such as cladding of membrane walls, evaporators and preheaters). Alloy 686 type filler and cladding material to service temperatures above 450 °C.										
3.03.00	The Steam Generator(s) shall be designed for the following minimum operational requirements at all loads and for the specified range of waste fuel(s). <table><thead><tr><th colspan="2">PARAMETER</th><th>REQUIREMENT</th></tr></thead><tbody><tr><td>(i)</td><td>Soot Blowing Frequency</td><td>Soot Blowing Frequency as per bidder's recommendation to ensure adequate cleaning of heating surfaces for specified range of waste fuels.</td></tr></tbody></table>					PARAMETER		REQUIREMENT	(i)	Soot Blowing Frequency	Soot Blowing Frequency as per bidder's recommendation to ensure adequate cleaning of heating surfaces for specified range of waste fuels.
PARAMETER		REQUIREMENT									
(i)	Soot Blowing Frequency	Soot Blowing Frequency as per bidder's recommendation to ensure adequate cleaning of heating surfaces for specified range of waste fuels.									
3.04.00	Provide the following: (a) Provision for future installation of additional Soot Blowers shall be made in the furnace so that after commissioning of each unit, the same can be installed, if the operational experience warrants the same. For this purpose the furnace construction shall preferably be provided with wall box openings. Necessary space provision in layout for providing approach and platform for future soot blowers shall be kept in the original design it self so that same can be installed whenever the future soot blowers are required. The loads for these platforms shall be considered in the boiler structure design. In case of such a necessity of installation of additional soot blowers, the Contractor shall install these soot blowers and associated access and platforms without any cost implication to the Employer.										
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		BID DOC. NO.: CS-2600- 001-9	TECHNICAL SPECIFICATIONS SECTION – VI, PART-B	SUB SECTION-A-03 STEAM GENERATOR & AUXILIARIES	PAGE 5 OF 33						

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	एनडीपीसी NTPC			
	(b) Erosion resistant shields for tubes/header affected by gas impingement/laning effects (e.g. in a between SH, Economizer etc.) (c) Tapping points at five levels for furnace vacuum monitoring (in addition to routine monitoring)			
3.05.00	Provide stainless steel expansion markers/indicator on all the four furnace walls to monitor thermal expansion. Predicted thermal expansion at different levels to be indicated.			
3.06.00	For continuous monitoring of water wall tube metal temperatures provide adequate numbers of thermocouples (as per vendors proven practice) outside the gas path as per specification specified elsewhere in the Technical Specification. Note: (a) The exact location and number of thermocouples shall be finalized during contract stage. However, Bidder shall furnish unit rates for addition/deletion of the thermocouples with respect to the numbers mentioned above. (b) Alarm set point for tube metal temperature shall not exceed the design temperature of respective tube			
4.00.00	STEAM GENERATOR CASING AND FRAMING			
4.01.00	Steam Generator casing/pent house (as applicable) shall be provided. The casing/pent house design shall ensure: (a) Complete enclosure of Steam Generator including superheater & economizer headers. (b) The casing/pent house and its supporting system shall be capable of taking additional loads due to accumulations of ash.			
4.02.01	Steam Generator casing/pent house shall: (a) Form rigid self containing structure, with adequate stiffening. (b) Be welded wall construction, sectionalized to allow easy removal/replacement of casing/penthouse wall sections. (c) Be weatherproof and water tight construction for protection from monsoon rains/winds. (d) Have all drainage arrangement like gutters, drain pipes etc., connected to plant drainage system at ground level. (e) Be provided with boiler roof arrangement of proven design & architecture.			
4.02.02	Provide at least two pent house ventilation/cooling/pressurizing fans with their air inlet openings at opposite ends.			
4.02.03	The casing/pent house shall be provided with: (a) Accesses and access platforms for easy and quick installation of scaffolding for furnace inspection/maintenance.			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		BID DOC. NO.: CS-2600- 001-9	TECHNICAL SPECIFICATIONS SECTION – VI, PART-B	SUB SECTION-A-03 STEAM GENERATOR & AUXILIARIES
				PAGE 6 OF 33

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	एनटीपीसी NTPC			
	(b) All necessary access, observation and cleaning doors with frame for building brickwork's and securing the casing shall be provided. The doors shall be insulated and perfectly air tight. It is considered highly important to ensure proper closure of doors to maintain minimum air-in-leakage.			
5.00.00	SUPER HEATERS			
	In addition to the sizing design criteria requirement elaborated Sub-section- A-02, following design requirements shall also be adhered:			
5.01.00	Construction of Superheaters(s) shall have following features:			
5.02.00	Heating surfaces arrangements			
	1	(a) Completely drainable tubes/banks/ sections for SH tube banks or shall have a drainable layout to the maximum possible extent.		
		(b) Banks/sections/tubes should be made from seamless tubes.		
	2	Minimum transverse tube pitching in the direction of gas flow path		
		(a) 600 mm for banks/sections placed in areas where gas temperature exceeds the FEGT (MHVT) value (or as per the vendors proven practice)		
	4	Supporting arrangement		
		All horizontal heat transfer surfaces shall be supported by steam/water cooled hanger tubes designed for a minimum of 2 times the calculated load so as not to cause any dislocation/damage to the tube banks/sections.		
	5	Arrangement of headers		
		Located out side the gas path, fully drainable. Wherever, locating the headers in the gas path becomes unavoidable these shall be suitably protected with erosion shields. Further, the nipples and studs of the header shall also be provided with wear resistance stainless steel shields of minimum 2.5 mm or higher thickness. The arrangement of headers shall be such that it does not cause the high localised flue gas velocity on tubes down stream side of the header.		
	6	Attemperators		
		(a) Location	At inlet or between the two SH stages	
		(b) Construction	i) Made from Corrosion/Erosion Resistant steel.	
			ii) Fitted with removable liners.	
5.03.00	Superheater(s) design shall cater to following operational requirements throughout the control range of Steam Generator, with whole range of specified fuels and under all operating conditions like, turbine bypass operation; secondary burner is in service etc.,			
5.03.01	For continuous monitoring of tube metal temperatures of SH elements, minimum number of thermocouples along with CJBs as per the following shall be provided:			
	(i)	As per vendors proven practice, required numbers of Chromel-Alumel thermocouples located outside the gas path for measurement of tube metal temperature covering all stages of Superheaters.		
	(ii)	As per vendors proven practice, required numbers of Acromat thermocouples located inside the gas path for measurement of gas side metal temperature covering all stages of Superheaters.		
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		BID DOC. NO.: CS-2600- 001-9	TECHNICAL SPECIFICATIONS SECTION – VI, PART-B	SUB SECTION-A-03 STEAM GENERATOR & AUXILIARIES
				PAGE 7 OF 33

CLAUSE NO.	 TECHNICAL REQUIREMENTS			
5.04.00	Note: (a) The exact location and number of thermocouples shall be finalized during contract stage or as per the vendors proven practice. However, Bidder shall furnish unit rates for addition/deletion of the thermocouples with respect to the numbers mentioned above. (b) Alarm set point for tube metal temperature shall not exceed the design temperature for respective tube. For maintenance/inspection of SH, provide: (i) 1.5 m clear cavity height between two sections/banks of horizontal heat transfer surfaces for personnel access. (ii) Access openings along with air/gas tight hinged doors for approach to above maintenance spaces without any hindrance from hanger tubes. (a) All access doors shall be of 500x500 mm size (minimum). (b) Access doors 800 mm above the nominal floor level shall have access platform. (c) Hanger tubes of horizontal banks shall have access opening for crossing over. (iii) Stainless Steel Erosion shields for all bends of outer most tube/coil of all SH sections and hanger tubes in areas where flue gas temperature is below FEGT. For erosion shield on the leading tubes and wherever else considered necessary by the Contractor as per the proven product is acceptable. (iv) Arrangement (structural steel/runway beams, motorized hoists, walkway platform alongwith runway beams etc.) for removing, handling and placement of tubes banks/section at ground level for repair/replacement.			
5.05.00	Headers and pipes, if made using X-20 Cr. MO V 121 to DIN 17175 material, shall have provisions to ensure that no site welding of this material with similar or dissimilar material is needed.			
5.06.00	Drum Drum shall have fusion welded construction and shall be designed as per IBR requirements. The drum shall be complete with internals, safety valves, level indicators, chemical feed, pressure gauges, vents and drains, sampling connections, acid washing connection and thermocouples etc			
6.00.00	ECONOMISERS			
6.01.01	In addition to the sizing design criteria requirement elaborated at Sub-section- A-02, Economizer design shall conform to the following criteria/requirements under all conditions of operation and for the complete range of specified fuels.			
6.02.00	Economizer shall be:			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE	BID DOC. NO.: CS-2600- 001-9	TECHNICAL SPECIFICATIONS SECTION – VI, PART-B	SUB SECTION-A-03 STEAM GENERATOR & AUXILIARIES	PAGE 8 OF 33

CLAUSE NO.	एनटीपीसी NTPC TECHNICAL REQUIREMENTS			
	SI. No.	DESCRIPTION	Primary SCAPH	Secondary SCAPH (if provided)
	(i)	Number of SCAPHs	As per requirement considering high moisture and low energy content RDF.	
7.02.02		Condensate from SCAPH shall lead to atmospheric flash tank in the boiler area or lead to condenser.		
7.02.03		Steam Coil Air Preheater shall have: (a) Modular construction. (b) Tube spacing to avoid choking by contamination in the entering air.		
7.02.04		Provide facilities for complete SCAPH isolation from the airflow path (or as per vendors proven practice).		
7.02.05		SCAPH shall be suitable to operate during all the operating conditions like start-up, low load operation of unit and at abnormal conditions when an increased air inlet temperature is considered desirable for the complete specified range of waste fuel.		
7.02.06		Provide: Handling facility (runway beam/hoist, platforms/approach etc.) for removal and placement of SCAPH modules on ground.		
08.00.00		WASTE FUEL PREPARATION AND FIRING SYSTEM		
08.01.00		PRIMARY AIR FANS		
		In addition to the sizing design criteria requirement elaborated at Sub- Section A-02, following design requirements shall also be adhered:		
08.02.01		Fan Characteristics (a) Shall be compatible with firing waste firing grate system resistance and boiler operation at rated loads, during boiler start up & low load operation, oil firing etc., (b) The system resistance curves shall always be sufficiently below the fan stall line. (c) Best efficiency point shall be close to full load operating point of fan.		
08.02.02		Fan control System : (a) Fan flow control (i) By VFD (ii) The actuators (if any) shall be compatible with selected automatic control system. (b) The system shall be designed to achieve: (1) Stable and satisfactory operation. (2) Primary air flow control (3) Primary air pressure control.		
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE	BID DOC. NO.: CS-2600- 001-9	TECHNICAL SPECIFICATIONS SECTION – VI, PART-B	SUB SECTION-A-03 STEAM GENERATOR & AUXILIARIES	PAGE 10 OF 33

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	एनटीपीसी NTPC			
08.02.03	(i) The system shall be capable of working on automatic mode for all regime of operation in a steady and stable manner. (ii) The final control element shall not have a backlash or play etc.			
	Primary air flow measurement			
	(a) Provision for measurement of PA flow required for total airflow measurement & control. (b) PA flow measuring devices shall be provided at air inlet to each grate portion (or as per the vendors standard proven practice). PA Fan inlet flow measurement shall be provided using fan inlet elbow. However, if such an arrangement is not possible flow element (venturi/aerofoil system) shall be provided with three pair of tapping points at suction of each PA Fan. (c) Location, type and design of flow measuring devices shall be subject to Employer's approval. (d) Necessary tapping points for temperature compensation in the flow measurement shall also be provided. (e) Independent tapping points with necessary isolating valves shall be provided for control, measurement & test.			
08.02.04	Fan casing shall be properly stiffened to minimum vibration and distortions during operation.			
08.02.05	Material of Construction			
	(a) Fan blades - high strength alloy with minimum hardness of BHN-75 (or as per vendors proven practice). (1) Base plate - cast iron or welded steel. (2) Casing - sheet steel of suitable thickness. (b) Fan inlet boxes, diffuser and intermediate pieces fabricated with sheet steel of thickness not less than 6.00 mm.			
08.02.06	Special construction Feature			
	(a) Fan components shall be designed for torsional stresses of three times the normal full load motor torque at all speed. (Note: Contractor shall submit detailed calculations, to confirm compliance with above requirements for all fan components, specifically for fan shafts, impeller hubs and impeller as a whole. Areas of high stress concentration and residual stresses, like welded attachments shall be avoided on the fan rotor/shafts. Combined static, dynamic as well as residual stresses shall be demonstrated to be within allowable limits. These fan components shall last the life of the plant with such combined stresses present in them.) (c) Pulsation shall be avoided by suitable design of fan and connecting ductwork. (d) The fan suction shall be provided with rigid bird (if taken from atmosphere) and trash screen assembly and shall have suitable arrangement to prevent rainwater from directly entering the fan (in general the suction to be taken from waste pit) (e) The fan suction shall be so located that it does not suck-in dirty air / flying waste particles.			
08.02.07	Fan bearing lubrication system			
	(a) The rotor assembly shall be supported over a oil lubricated bearing assembly consisting of antifriction/sleeve bearing adequately sized to take care of radial thrust			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		BID DOC. NO.: CS-2600-001-9	TECHNICAL SPECIFICATIONS SECTION – VI, PART-B	SUB SECTION-A-03 STEAM GENERATOR & AUXILIARIES
PAGE 11 OF 33				

CLAUSE NO.	TECHNICAL REQUIREMENTS				एनडीपीसी NTPC		
	loads. (b) For mounting of vibration pads/pickups, flat surfaces shall be provided both in X and Y directions, by the Contractor on the bearing housing. (c) In case of oil lubricated bearing the design shall be such that bearing are lubricated by external oil lubricating system in which oil is cooled by external cooler. In addition sump lubrication with ring shall also be provided. (d) Two nos. Duplex RTD, (100 ohm at 0 deg.) and temperature indicators shall be provided for local and remote monitoring of each bearing metal temperature of fans for each bearing.						
08.02.08	Fan lubrication System						
	(a) The lubricating system shall be complete in all respect, compact and frame mounted. (b) The lube oil pressure shall be higher then cooling water pressure. (c) Sealing shall be provided at each end of the bearing housing to prevent leakage of oil. (d) Each bearing shall be provided with an oil level indicator and screwed drain plug.						
08.02.09	Fan Vibration Monitoring						
	All accessories/ arrangements like flat surfaces, vibration pads/ pick ups etc shall be provided for fan vibration monitoring as per OEM recommendations						
08.02.10	Silencers shall be provided to limit the noise level to specified values.						
08.02.11	Fan housing shall be designed for ease of maintenance and access to the fan wheel or impeller. The casing shall be split type to provide easy removal of the fan wheel or impeller for replacement and repairs. The casing section shall have gasket joints to ensure air-tight sealing.						
08.02.12	Access doors shall be provided in each suction chambers, casing and diffuser.						
08.02.13	Drain connections shall be provided at the bottom most point of the fan housing.						
09.00.00	FUEL OIL SYSTEM						
09.01.00	GENERAL						
	LDO firing requirements of Steam Generators and Auxiliary Boiler, as per characteristics specified at Sub-Section-I-B of Part A.						
	The fuel oil system shall comprise of:						
	(a) Fuel oil preparation and firing system.						
09.02.00	Fuel oil Preparation and Firing System						
	Fuel oil preparation and firing system shall comprise of LDO firing system of Steam Generators.						
	(a) LDO Firing System LDO shall be used for initial start-up, low load operation and as secondary fuels for waste fuel flame stabilization at the startups/low load operation. The fuel oil shall be drawn from the storage tank. The oil requirement of oil burners of the Steam						
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		BID DOC. NO.: CS-2600- 001-9	TECHNICAL SPECIFICATIONS SECTION – VI, PART-B	SUB SECTION-A-03 STEAM GENERATOR & AUXILIARIES	PAGE 12 OF 33		

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	Generator shall be tapped off from oil tanks. Means of automatic pressure regulating valve and all facilities required for functioning of fuel oil supply to the burners under certain operating conditions etc. shall be incorporated in the design.			
09.03.00	Fuel Oil Preparation and Firing System			
	In addition to the sizing design criteria requirement elaborated at Sub- Section A-02, following design requirements shall also be adhered:			
09.03.01	The Fuel oil preparation and firing system shall be designed to function in total association with the Burner Management System;			
09.03.02	The LDO firing system, shall have following design features:			
	(a) Oil relief valves, on larger section of fuel oil pipes which can be isolated (d) For all in line items on fuel oil flow meters, filters, control valves etc, required to be taken out for maintenance, adequate isolation valves needs to be provided.			
09.03.03	Filters			
	Provide filters of required quantity and size.			
09.03.04	Trip and Nozzle Valves			
	LDO oil trip valves & individual burner nozzle valve solenoid shall be:			
	(i) Of single coil heavy duty construction having class 'H' insulation. (ii) Having closing time less than one (1) second (iii) De-energized/air fail to close type. (iv) Designed for operating voltages as under: (a) Trip valve solenoid 24 Volts DC (b) Nozzle valves solenoid 24 Volts DC			
	LDO Trip valves and nozzle valves shall be suitable to handle oil at temperature/pressure required at the burners. Further, these valves shall confirm to ANSI leakage Class-VI under shut off pressure conditions of LDO (or as per equivalent code).			
09.03.05	Oil Burners/Burner Components			
	(a) Suitable type of burner for LDO firing shall be designed by the vendor. (b) Burner maintenance systems along with accessories			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		BID DOC. NO.: CS-2600- 001-9	TECHNICAL SPECIFICATIONS SECTION – VI, PART-B	SUB SECTION-A-03 STEAM GENERATOR & AUXILIARIES
				PAGE 13 OF 33

CLAUSE NO.	TECHNICAL REQUIREMENTS				एनटीपीसी NTPC					
09.03.06	(c) Handling facility for burner components. The design of fuel oil system shall ensure that compliance with the following operational requirements: (a) Facilities for Auto start of secondary oil burner in case the furnace temperature falls below the required 950 Degree C with 2 sec residence time. (b) Facility for automatic as well as manual start/ignition of oil burners (in association with BMS) (d) Maximum turn down ratio, for the oil burners. (f) Separate flame viewing opening/facility for boiler operation and for flame monitoring at each burner from out side of the boiler viewing heads to have provision: (i) To keep it cool below 75°C (ii) To keep optical system clean during firing/non firing by pressurized air. (g) Means of determining oil flow to each burner like calibration curves and pressure measurements at the burner as a minimum requirement.									
09.03.07	Following features shall be provided for interfacing with other systems/equipment's (a) Adequate local instrumentation such as temperature, pressure, differential pressure, flow switches for independent high and low signaling contacts required for Burner management system and other interlock/alarm. (b) Adequate potential free contacts for status of individual valves.									
09.04.00	Piping fitting, Tanks and valves in fuel oil firing system:-									
09.04.01	The Piping in fuel oil (LDO) firing shall confirm to following codes as per vendors proven practice. The required size of LDO tanks needs to be provided along with all the necessary safety provision.									
09.04.02	Piping fittings shall be of carbon steel butt welded connection (where possible) conforming to ASTM-A 234 (or approved equivalent standard). All the flange connections shall conform to IS:6392 (or approved equivalent standard) and shall be suitable to withstand design conditions of system, to which they are connected.									
09.04.03	Valves shall conform to following requirements: <table><thead><tr><th>S.No.</th><th>Parameter</th><th>Requirement</th></tr></thead><tbody><tr><td>i)</td><td>Type of valves (for oil services)</td><td>Suitable for oil application (metallic seated), leak proof, fire safe as per the requirement of API 6FA (or equivalent)</td></tr></tbody></table>				S.No.	Parameter	Requirement	i)	Type of valves (for oil services)	Suitable for oil application (metallic seated), leak proof, fire safe as per the requirement of API 6FA (or equivalent)
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KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE	BID DOC. NO.: CS-2600-001-9	TECHNICAL SPECIFICATIONS SECTION – VI, PART-B	SUB SECTION-A-03 STEAM GENERATOR & AUXILIARIES	PAGE 14 OF 33						

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
09.04.04	Instrument root valves on oil lines shall be of 40 NB size, flanged OS & Y type, with body rating in ASA as per process condition.			
10.00.00	DRAFT PLANT In addition to the sizing design criteria requirement elaborated of Sub section A-02, following requirements shall also be adhered:			
10.01.00	Both FD fans and both ID fans shall operate with highest possible efficiency which shall be nearly equal at the full load and test block points.			
10.02.00	Fan components along with VFD mechanism shall be designed to withstand and continuously operate with the maximum air or flue gas temperature that these fans will be required to handle. ID fan component shall also be designed to withstand the possible temperature excursions in flue gas (if any – due mal functioning of water spray in the gas quenching tower). Such temperature excursion will not inhibit the safe and smooth operation of fans or cause any damage or increased maintenance.			
10.03.00	The construction of FD & ID fans shall also comply with following requirements			
	DESCRIPTION	FD Fans (if provided)	ID Fans	
	Type of fan	Centrifugal	Centrifugal	
	Blade material	As per the proven practice of the fan manufacturer for this application		
	Air/Flue gas flow	VFD		
	Fan critical speed	not less than 125% of fan maximum operating speed	not less than 125% of fan maximum operating speed	
	Fan component design*	to withstand torsional stresses three (3) times the normal/full load motor torque at all speeds	to withstand torsional stresses three (3) times the normal full load motor torque at all speeds	
	Fan casing material thickness	6.00 mm (min.)	Abrasion and wear resistant, high BHN steel having minimum 8.0mm thickness or 12mm mild steel with liner of thickness 10mm (min.)	
	Fan Housing design	for shut off head of fan	for shut off head of fan	
	*Note:			
	(a) Contractor shall submit detailed calculations, for Employer's approval, to confirm compliance with above requirements for all fan components, specifically for fan shafts, impeller hubs and impeller as a whole. Areas of high stress concentration and residual stresses, like welded attachments shall be avoided on the fan rotor/shafts. Combined static, dynamic as well as residual stresses shall be demonstrated to be within allowable limits. These fan components shall last the life of the plant with such combined stresses present in them.			
	(b) Although employer envisages installation of a highly efficient electrostatic precipitator to control particulate emission, however, bidder shall select the ID fan components			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		BID DOC. NO.: CS-2600-001-9	TECHNICAL SPECIFICATIONS SECTION – VI, PART-B	SUB SECTION-A-03 STEAM GENERATOR & AUXILIARIES
				PAGE 15 OF 33

CLAUSE NO.	TECHNICAL REQUIREMENTS																
	such as blades, hubs, casing etc. to encounter the high dust burden. The minimum wear life of ID fan components shall not be less than 25000 hours of operation from the date of commissioning.																
10.04.00	Fan Bearings (a) Bearing shall be provided with oil bath to prevent damage in case of complete loss of plant auxiliary power when the fans must coast down without power. (b) Size oil reservoir in bearings housing for maintaining lubrication for extended periods in case of oil circulation system is out of service. (c) Cooling air circulation to be provided across main bearing (d) Atleast two (02) numbers of duplex Pt-RTD (100 ohm at 0 degree Celsius) and temperature indicator shall be provided for each bearing. Local as well as remote monitoring features shall be provided.																
10.05.00	Fan balancing (a) The fans shall be statically and dynamically balanced before shipment. (b) Balancing of each fan shall be checked and adjusted at site, if necessary. (c) Natural frequency of all fan components shall be established by vibration testing to ensure that no part of the wheel is adversely excited by any force generated at operating speeds. (d) The fan blade shall be subjected to natural frequency test. The other components of ID & FD fan wheels need not be subjected to natural frequency test if supplier can prove that these components are very rigid and have very high natural frequency compared to the operating frequency of respective fans giving justification.																
10.06.00	FD and ID fans shall meet following operational requirements. <table><tr><td></td><td>Description</td><td>FD Fans</td><td>ID Fans</td></tr><tr><td>(a)</td><td>Fan control system</td><td>i) capable of operating in automatic mode for all regimes of operation in a steady and stable manner ii) The final control element shall not have any backlash, plays etc., and shall operate in the range of 20% to 80% depending upon generating loads upto Full load.</td><td>i) capable of operating in automatic mode for all regimes of operation in a steady and stable manner iii) The final control element shall not have any backlash, plays etc., and shall operate in the range of 20% to 80% depending upon generating loads upto Full load.</td></tr><tr><td>(c)</td><td>Bearing metal temperature monitoring</td><td>shall be possible from remote as well as locally, using atleast two(02) nos. of duplex platinum RTD's per bearing(100 ohms at 0</td><td>Shall be possible from remote as well as locally, using three (03) nos. of duplex platinum RTD's (100 ohms at0 deg. C) per</td></tr></table>						Description	FD Fans	ID Fans	(a)	Fan control system	i) capable of operating in automatic mode for all regimes of operation in a steady and stable manner ii) The final control element shall not have any backlash, plays etc., and shall operate in the range of 20% to 80% depending upon generating loads upto Full load.	i) capable of operating in automatic mode for all regimes of operation in a steady and stable manner iii) The final control element shall not have any backlash, plays etc., and shall operate in the range of 20% to 80% depending upon generating loads upto Full load.	(c)	Bearing metal temperature monitoring	shall be possible from remote as well as locally, using atleast two(02) nos. of duplex platinum RTD's per bearing(100 ohms at 0	Shall be possible from remote as well as locally, using three (03) nos. of duplex platinum RTD's (100 ohms at0 deg. C) per
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KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		BID DOC. NO.: CS-2600-001-9	TECHNICAL SPECIFICATIONS SECTION – VI, PART-B	SUB SECTION-A-03 STEAM GENERATOR & AUXILIARIES	PAGE 16 OF 33												

CLAUSE NO.	 TECHNICAL REQUIREMENTS			
deg.C) bearing 10.07.00 10.08.00 10.09.00 10.10.00 11.00.00 11.01.00 11.01.01	Flow Measuring Devices (a) The draft plant shall include flow measuring devices in the air system for total air flow measurements and control with adequate number of tapping points. (b) The location, type and design of the flow measuring devices shall be subject to Employer's approval. (c) Three independent pairs of tapping points with the necessary isolating valves shall be provided for control, measurement and test. (d) Two nos. duplex temperature element with thermowells for temperature compensation shall be provided. (e) Fan inlet flow measurement shall be provided using fan inlet elbow. However, if such an arrangement is not possible, flow element (venture/aerofoil) shall be provided with three pairs of tapping points at suction of each FD fan. Fan Casing : (a) The fan casing shall be split to provide easy removal of the fan hub/impeller for replacement and repairs. (b) The sections shall have gasket joints to ensure airtight sealing. (c) Access doors shall be provided in each suction chamber casing and diffuser. Drain Connection: Drain connections shall be provided at bottom most point of the fan housing to the nearest trench. Fan Suction: (a) Silencers shall be provided at the suction of FD fans to limit the noise level as specified. (b) FD fan suction shall be provided with rigid bird and trash screen assembly and shall have suitable arrangement to avoid rainwater from directly entering the fan (It can have the provision of taking suction from waste pit or as per vendors proven practice). DUCT WORK AND DAMPERS: In addition to the sizing design criteria requirement elaborated at Sub section A-02, following requirements shall also be adhered: Loads for Duct and Structure Design The duct design shall take into account following loads all occurring together: (a) Wind loads as specified.			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE	BID DOC. NO.: CS-2600- 001-9	TECHNICAL SPECIFICATIONS SECTION – VI, PART-B	SUB SECTION-A-03 STEAM GENERATOR & AUXILIARIES	PAGE 17 OF 33

CLAUSE NO.		TECHNICAL REQUIREMENTS								एनडीपीसी NTPC	
		(b)	Dead weight including weight of insulation, lining, wash water and the vertical live load.								
		(c)	Horizontal ducts to be designed for minimum 245 kg/m ² additional fly ash loading on the surface or for one fourth of duct full of ash or for maximum possible accumulation of ash in the ductwork, under all normal, upset or abnormal operating conditions, whichever is higher. For flue gas ducts downstream of Fabric bag filter, additional fly ash loading on the surface or for one tenth of duct full of ash or for maximum possible accumulation of ash in the ductwork, under all normal, upset or abnormal operating conditions, whichever is higher.								
		(d)	Expansion joint reaction.								
		(e)	The following minimum load factors shall be applied to the design loads:								
			Temperature (Deg C)	27	37	93	149	205	260	316	321
			Loading factor	1.00	1.02	1.12	1.19	1.25	1.29	1.34	1.42
		(f)	The ductwork and its structure shall take into account loads due to duct between ID fan outlet and chimney inlet transition piece.								
11.01.02	Duct design pressure:										
		All flue gas duct, air ducts and the wind boxes shall also be designed for maximum conceivable pressure of the relevant fans, at 67% of yield strength of material.									
11.01.03	Duct Slope										
		All interconnecting gas ducts between the boiler / flue gas conditioning tower and the Fabric bag filter shall have a minimum slope of 45 degree with respect to horizontal so that any chance of accumulation of ash particles in the duct can be avoided under all normal/abnormal operating conditions.									
11.01.04	Type of duct construction:										
		The ducts shall be preferably of rectangular cross-section and shall be of all welded construction. Unless absolutely necessary (certain locations) Circular ducts are accepted as per vendors proven practice. Following requirements shall be complied with:									
		(a)	Min. 6 mm thick steel plates for gas ducts.								
		(b)	Min. 5 mm thick steel plates for air ducts.								
		(c)	A corrosion allowance of 1.5 mm shall be considered for stress calculation for the flue gas ducting.								
		(d)	Duct stiffening shall be by means of rolled sections.								
		(e)	The thickness of the duct plate shall be suitably increased, if required, in the transition zone at Steam Generator outlet where the flue gases change direction, to increase the wear life of the duct plates.								
11.01.05	Material of Construction:										
		(i)	Duct plates, turning vanes perforated plates	ASTM A 36 or equivalent (For ducts operating above 400 ⁰ C gas temperature, suitable Alloy Steel material shall be provided to Employer's approval)							
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		BID DOC. NO.: CS-2600-001-9			TECHNICAL SPECIFICATIONS SECTION – VI, PART-B			SUB SECTION-A-03 STEAM GENERATOR & AUXILIARIES			PAGE 18 OF 33

CLAUSE NO.	TECHNICAL REQUIREMENTS			
11.01.06	(ii) Structural shapes ASTM A 36 or equivalent (iii) Pipe struts, trusses, bracing ASTM A 53 or equivalent seamless steel pipe. (iv) Erection tools for ducts ASTM A 307 or equivalent (v) Bolts for connection to structural steel ASTM A 325, AISI 325 (friction type) or equivalent (vi) Stainless Steel ASTM A 316 L (vii) Gaskets "Relrosil" by Hitco or equivalent (viii) Access & inspection doors Reinforced Steel Plates. Insulation & Lagging (a) Thermal insulation shall be applied to all air/gas ducts to comply with the requirements as specified at separate 'Thermal Insulation chapter'.			
11.01.07	Specific Requirements (a) The stiffeners provided on the ducts walls shall be of such a design and layout that no rainwater can accumulate on the duct surfaces. (b) The flanges at the bolted joints shall have adequate stiffeners to avoid damages to the flanges. (c) All necessary wall boxes and floor collars shall be provided where the ductwork pass through walls, floor and roof. (d) The floor collars shall be fitted with a high combing to prevent water and dust falling through the hole. (e) The ductwork shall be fitted with a steel hood to cover the opening. (f) Weatherproof flashing shall also be provided wherever necessary. (h) Air and gas ducts shall not counter internal bracings, which cause excessive pressure drop. (i) Duct plates shall be designed for one-way beam action over stiffeners and considered fully continuous over all supports. (j) The deflection of the plate, assumed continuous, shall be less than one-half the plate thickness.			
11.01.08	Duct Work Structure (a) Ductwork sections between expansion joints shall be investigated with regard to their ability to transmit loads to supports. Care shall be exercised to identify uplift condition. (b) Internal stiffeners: (1) Duct shape shall be maintained by providing internal stiffening elements at or near supports. However, these internal stiffeners shall be used, if and only if, it is not possible to provide external stiffeners. (2) Internal stiffening elements shall consist of trusses, preferably comprised of extra-strong steel pipes (min. dia. 76.2 mm) acting in conjunction with external stiffeners. Such internal stiffeners for the flue gas duty between boiler and Fabric Bag filter shall be provided with erosion protection shields. (3) The number of internal trusses shall be limited to the minimum required for structural integrity and shaped so as to offer least resistance to gas flow and			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE	BID DOC. NO.: CS-2600- 001-9	TECHNICAL SPECIFICATIONS SECTION – VI, PART-B	SUB SECTION-A-03 STEAM GENERATOR & AUXILIARIES	PAGE 19 OF 33

CLAUSE NO.	 TECHNICAL REQUIREMENTS			
11.01.09	to minimize the accumulation of fly ash in the bottom of duct. (4) Conceptual data of internal stiffeners of the ducting shall be furnished along with the offer. (5) All the detailed design data shall be furnished to the Employer before the duct support column foundation data submission. (c) Corner angles shall be used on all inside corners of all ducts to provide adequate continuity. (d) Inside welds of corner angles to duct plate shall be continuous and seal welded. Where inside surface of ducts will be coated, welds shall be full throat. (e) Field welding and all connections of bracing (stiffening elements) to stiffeners shall be well designed in order to develop full strength of the members. The gusset plates shall be of 10 mm minimum thickness. (f) The duct, plates, trusses, stiffeners, bracings and ductwork shall be designed as structures in accordance with relevant Indian Standards. (g) All openings in ducts shall be reinforced for all design loads. (h) Ductwork supports may be hangers or sliding bearing, guides and anchorages. A coefficient of sliding friction of 10% can be used with self-lubricated plates such as "LUBRITE" or "MECHANITE", a coefficient of sliding friction of not less than 35% shall be used for steel-on-steel contact. The allowable bearing stress for self-lubricated plates shall be 70 Kg/sq.cm.			
	Fabrication Requirements (a) Fabrication shall be as per IS specification for Design, fabrication and erection of 'Structural Steel for Building. (b) Welding shall be in accordance with Section IX of ASME code. (c) Ducts shall be strength welded and seal welded to produce a gas tight duct. Alignment holes shall be provided in mating flange sections. (d) Ducting shall be detailed and fabricated in a few pieces as practical, taking into account, shipping and erection considerations. (e) Materials improperly detailed or fabricated necessitating extra work during erection on field, shall be the responsibility of the Contractor.			
11.01.10	Expansion Joints i) Metallic type expansion joints suitable for the service conditions shall be provided. The expansion joint design shall conform to the requirements of the EJMA Standards. ii) Expansion joints shall not support the ductwork. iii) The expansion joints shall be of heavy duty construction. The expansion joint material shall be compatible with the flowing medium, the external environment and			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE	BID DOC. NO.: CS-2600- 001-9	TECHNICAL SPECIFICATIONS SECTION – VI, PART-B	SUB SECTION-A-03 STEAM GENERATOR & AUXILIARIES	PAGE 20 OF 33

CLAUSE NO.	 TECHNICAL REQUIREMENTS			
	the operating temperature. Suitable corrosion and erosion allowances shall also be taken. iv) All parts of expansion joints shall be suitably designed for all stresses that may occur during continuous operation and for any additional stresses that may occur during installation and also during transient condition. No movement of the expansion joint due to duct misalignment, if any, shall be imposed which has not been anticipated and designed into the movement capability of the expansion joint. v) For the flue gas ducts or for air ducts where ingress of ash/dust particles from atmosphere or air preheaters etc. is expected, the expansion joints shall be designed with suitable internal cover/canopy fixed at one end and freely supported (sliding type) at the other end in the direction of flow to avoid dust accumulation. The cover/canopy should be suitably designed so as not to interfere with any internal duct support and material should be selected taking into account expansion at the operating temperature. vi) If expansion joints are procured as bought out items then complete installation of expansion joint shall be under supervision of the expansion joint manufacturer. vii) The expansion joints shall be tested as per requirements specified elsewhere in the Technical Specification. viii) Contractor shall furnish the complete ducting system drawings clearly specifying the location of all anchors, guides, supports, fixed points and expansion joints. The anchors and guides must be suitable for the highest pressures to be applied to the system. Anchors, guides and duct supports shall be installed in strict accordance with the ducting system drawings. ix) The minimum trouble free operational life of expansion joint shall be not be less than 20000 hrs of operation from the date of commissioning. x) Expansion joints weighing more than 250 kg shall be provided with lifting lugs. xi) Each joint shall have a permanently attached brass or stainless steel metal tag indicating the tag numbers and other salient design features. xii) Every expansion joint shall be provided with installation instructions which shall describe the simple, straightforward requirements that must be followed to insure a trouble-free installation. Further, shipping bars shall be installed on the expansion joint to maintain the proper shipping length. Shipping bars shall be painted yellow. 11.01.11 Blanking Plates Bolted plates or other positive closure shall be supplied in order to permit pressure testing of the Steam Generator enclosure. 11.01.12 The horizontal flat surface of air and gas ducts shall be pitched for drainage. Where necessary, stiffeners shall be arranged to avoid formation of pockets. 11.01.13 Access & Inspection doors of hinged type with matching heavy duty surface shall be provided.			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE	BID DOC. NO.: CS-2600- 001-9	TECHNICAL SPECIFICATIONS SECTION – VI, PART-B	SUB SECTION-A-03 STEAM GENERATOR & AUXILIARIES	PAGE 21 OF 33

CLAUSE NO.	TECHNICAL REQUIREMENTS 			
11.01.14 11.01.15 11.02.00 11.02.01 11.02.02 11.02.03 11.02.04	Access and inspection door shall be of minimum 450 mm x 450 mm size. The door closing devices should be designed to force the doors to make an air or gas tight seal when closed. DAMPERS Power operated gas tight isolation dampers along with their drives shall be provided at all locations required for carrying out internal repair and maintenance of Bag filter and gas conditioning tower when the Steam Generator is on load. As a minimum following locations shall be provided with power operated gas tight dampers/gates: (a) As per the vendors proven practice (b) On each inlet and outlet to each Bag filter (if bag filters has separate streams) (c) Before gas conditioning tower and after bag filter (as per vendors proven practice) (f) At discharge of each of PA and FD fans (as per vendors proven practice) (g) Before and after each SCAPH or in bypass line (as per vendors proven practice) Heavy Duty multi louver dampers shall be provided at locations not requiring tight shut off duty. All pneumatically operated interlocked dampers actuators shall be provided with solenoid valves. For open and close feed back of hot air gates, Proximity (i.e non–contact) type limit switches(2NO+2NC) shall be provided. These shall be suitable for working hot & dust environment. Dampers/Gates : (a) General (1) All dampers shall be designed to withstand the operating air and flue gas temperature without distortion. (2) All regulating dampers/vanes/blade pitch controls coming under auto regulation shall be able to provide the desired relationship between percentage opening and the flow. (3) The auto regulating dampers shall be capable of being operated between 20% to 80% opening as per the optimal requirements of control systems so as to achieve stable, steady and smooth automatic control of the plant and processes under all operating conditions. (4) There shall not be any backlash, play, etc. with linkage mechanism, actuator and final control element. (5) Thermal expansion of ducting shall not produce stress in louvers, linkage arrangement etc. (6) Weather hood to prevent rainwater entry & accumulation shall be provided at each damper top. (7) If grease lubrication is required, grease connection shall be accessible. Grease lines of copper/steel shall be run from all greasing points on each damper to a convenient and easily accessible location adjacent to the respective damper and terminated with suitable clamps and grease nipples on a steel frame to facilitate easy lubrication.			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE	BID DOC. NO.: CS-2600- 001-9	TECHNICAL SPECIFICATIONS SECTION – VI, PART-B	SUB SECTION-A-03 STEAM GENERATOR & AUXILIARIES	PAGE 22 OF 33

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	(8) Open and closed positions shall be clearly marked on the dampers. (9) All dampers shall be arranged to facilitate local manual operation also from a gallery or floor level (a) Guillotine gate All guillotine gates shall be located in horizontal duct to avoid fly ash build up when in closed position and shall be of top entry type. (b) Multilouver Dampers (1) The damper shall be of heavy duty rigid construction to prevent bending, vibrations and distortion. (2) Shall operate without bind or fluttering under all operating conditions. (3) The spindles shall be adequately sized and bearings suitably insulated to protect overheating. (4) The shaft bearings shall be mounted outside the damper box channel and arranged for convenient inspection. All bearings for spindles or damper operating gear shall be arranged for efficient grease lubrication. (5) Stuffing boxes shall be provided on all damper blade shafts. (6) The damper shaft shall be rigid and shall have side bearing, plate. (7) Horizontal shaft shall be provided wherever possible. (8) For preventing hot air or gases from escaping around damper shaft, double gland type stuffing boxes with graphite impregnated asbestos packing material acceptable to the Employer shall be provided on all damper blade shafts. (9) The dampers in flue gas paths shall be so located that the build up of grit behind the damper blades is reduced to a minimum. (10) The multilouver dampers shall be capable of effectively stopping the flow when in closed position and while in full open position shall cause minimum pressure drop. The isolating damper design shall provide positive shutoff when closed. (11) The force required to operate the damper shall be limited to 35 kg (maximum) at the rim of the hand wheel. (12) The operating gear shall be fitted with a graduated indicator and shall be designed such that the damper may be retained in any position. (13) The isolating dampers shall in addition be fitted with locking devices to permit locking in the fully open and shut positions. (14) All powered dampers shall also have provision for manual operation during emergency/maintenance along with graduated local position indicator. (15) Suitable all round approach and platform for manual operation of dampers and for carrying out maintenance on damper shall be provided. (16) Attachment of all louvers to the dampers spindles shall be by means of key fittings. (17) The double multilouver type damper sealing efficiency shall be 99.5% on flow without seal air, however with seal air it shall be 100%.			
12.00.00	STEAM GENERATOR INTEGRAL PIPING, VALVES, FITTINGS AND MOUNTINGS			
12.01.00	General In addition to certain specific requirements indicated in the subsequent paragraphs below, the Steam Generator integral piping, valves, fittings and mounting shall also comply with all specifications requirements indicated in other subsections of Part-B.			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE	BID DOC. NO.: CS-2600-001-9	TECHNICAL SPECIFICATIONS SECTION – VI, PART-B	SUB SECTION-A-03 STEAM GENERATOR & AUXILIARIES	PAGE 23 OF 33

CLAUSE NO.	TECHNICAL REQUIREMENTS				एनडीपीसी NTPC										
12.01.01	Safety valves and relief valves shall have minimum discharge capacities as under: <table><thead><tr><th>Valve</th><th>Minimum Discharging Capacities</th></tr></thead><tbody><tr><td>(i) Spring loaded safety valves</td><td></td></tr><tr><td>a) Drum & Superheater</td><td>Combined capacity 105% Full load (BMCR).</td></tr><tr><td>(ii) Electromatic Relief Valve or spring loaded safety valve (as per vendor's proven practice) at:</td><td></td></tr><tr><td>a) Super heater outlet</td><td>15 %BMCR</td></tr></tbody></table>					Valve	Minimum Discharging Capacities	(i) Spring loaded safety valves		a) Drum & Superheater	Combined capacity 105% Full load (BMCR).	(ii) Electromatic Relief Valve or spring loaded safety valve (as per vendor's proven practice) at:		a) Super heater outlet	15 %BMCR
Valve	Minimum Discharging Capacities														
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a) Super heater outlet	15 %BMCR														
12.01.02	Other means of operation (Opening and Closing) for all valves shall be in line with control and monitoring philosophy specified under 'Control and Instrumentation'.														
12.01.03	Provide : (a) Two valves in series one motorized, isolating and one motorized regulating type (low noise, erosion resistant type) on all drains and vents required to be operated during startup and shutdown of unit (b) Silencers on all start up vents and lowest set pressure safety valves . (c) Temperature element on all drain lines, including soot blower drain line. (d) Motorized remote operated air release valves at locations, two in series, as required connected to a funnel, leading drains to drain trench. (e) Start-up vents shall be sized for a minimum flow of 15% at turbine start-up pressure. Note : Contractor to submit the following documents for Employer's approval: (i) Complete valve schedule in Employer's approved format indicating in make and model no. power supply requirements tube of control station etc. (ii) Control valve sizing calculation, characteristics, and data sheets.														
12.01.04	Provide drain valves (two in series, one manually operated isolation and one motorized regulating) for draining furnace wall, super heater, economizer and feed water lines. Arrangement of drainage system shall comply with following requirements: <table><thead><tr><th>Parameters</th><th>Requirements</th></tr></thead><tbody><tr><td>(i) Sizing of Drainage system</td><td>To enable drainage of complete pressure parts in one (1) hour or as per vendors proven practice</td></tr><tr><td>(ii) Type of drain valves</td><td>Low noise, erosion resistant</td></tr><tr><td>(iii) Limiting noise level through regulating drain valves</td><td>90 dBA</td></tr><tr><td>(iv) Flow velocity through valves</td><td>90 m/sec.</td></tr></tbody></table>					Parameters	Requirements	(i) Sizing of Drainage system	To enable drainage of complete pressure parts in one (1) hour or as per vendors proven practice	(ii) Type of drain valves	Low noise, erosion resistant	(iii) Limiting noise level through regulating drain valves	90 dBA	(iv) Flow velocity through valves	90 m/sec.
Parameters	Requirements														
(i) Sizing of Drainage system	To enable drainage of complete pressure parts in one (1) hour or as per vendors proven practice														
(ii) Type of drain valves	Low noise, erosion resistant														
(iii) Limiting noise level through regulating drain valves	90 dBA														
(iv) Flow velocity through valves	90 m/sec.														
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		BID DOC. NO.: CS-2600-001-9	TECHNICAL SPECIFICATIONS SECTION – VI, PART-B	SUB SECTION-A-03 STEAM GENERATOR & AUXILIARIES	PAGE 24 OF 33										

CLAUSE NO.	TECHNICAL REQUIREMENTS	एनटीपीसी NTPC		
12.01.05 12.01.06 12.01.07 12.01.08 12.01.09 12.01.10 12.01.11 12.01.12 12.01.13 12.01.14	Provide plugging/locking for each isolating drain valve such that to open the valve, the key has to be inserted and key can be withdrawn when the valve is closed. Drain lines upto drain valves and drain valves to be designed for the maximum operating parameters of main process line to which it is connected. Provide two in series, blowdown valves, at the lowest point of each water wall header comprising of one manually operated isolation valve and one motorized regulating valve. Valves shall have plugging/locking keys as indicated as specified at clause no 14.01.05 of this chapter and shall be located at appropriate location for convenient operation. Piping from this blow down valve shall be connected to atmospheric flash Tank. For all remote operated control valves provide: (a) 100% bypass control valves, remote operated and exactly identical to main control valve. (b) Separate power operated isolation valve on upstream side of each of main and bypass control valve. (c) Separate manual isolation valves on down stream side of each of main and bypass control valve. (d) Pressure gauge at inlet and outlet of each control station. If the control valve is local operated, systems from (a) to (d) shall be provided with 100%, local operated control valve. Drains from drum, headers, gauge glasses, and integral piping of Steam Generator shall be terminated into one or more drain collection headers, which in turn will be connected to atmospheric flash Tank. All valves and piping for the blow down system shall be provided upto and including the atmospheric flash Tank. Provide a connection at an approved location fitted with a non-return valve, size not less than 100 mm nominal dia, a stop valve and the related pipe work in the boiler fill line. Provide all required sampling points along with root valves including that for feed water at economizer inlet, separator drain, Drum outlet steam pipes, superheated steam. The exact location of the isokinetic sample shall be finalized at a later stage. The sampling probes shall be provided as per relevant section of the latest ASME power test code. For laboratory samples, necessary sample coolers with valves and cooling water pipes shall be provided. In addition two spare coolers shall be provided. The root valves shall be of stainless steel. The impulse pipe size shall be to the approval of the Employer. Sampling arrangement shall include valve, pipe work and the necessary connection. The cooling water shall be taken from the main cooling water system. Drain from sample coolers shall be terminated at basement floor level. Each steam and water terminal connection for vent, drain, instrument tapping point and sampling shall be equipped with two valves. Provide tapping points for all the instrumentation and controls and guarantee tests with Employer approved orientation on the pipeline. Provide remote, motorized operation			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE	BID DOC. NO.: CS-2600- 001-9	TECHNICAL SPECIFICATIONS SECTION – VI, PART-B	SUB SECTION-A-03 STEAM GENERATOR & AUXILIARIES	PAGE 25 OF 33

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	एनटीपीसी NTPC			
12.01.15	(a) For all valves (including drain, vent and air release valves) required to be operated during startup/shut down of Steam Generator. (b) For valves located in inaccessible locations. Provide valves/actuators, remote operation facility etc. so as to enable startup, shutdown, and load monitoring of Steam Generators from unit control room.			
13.00.00	SOOT BLOWING SYSTEM			
13.01.00	Type of Soot Blowers : (as per vendors proven practice)			
	(i) For furnace chamber :Short Rotary, Single nozzle retractable type (ii) For horizontal heat exchanger :Long Rotary, Multiple nozzle, section retractable type (iii) Air-preheaters : If flue gas to air preheater is provided			
13.02.00	Soot Blowing System shall be (a) Fully automatic sequentially controlled through SG C&I control system. (b) Capable of effectively removing deposited ash from Steam Generator heat transfer surfaces with on load cleaning devices.			
13.03.00	The soot blower design shall be of self draining type.			
13.04.00	Material of Construction			
	(i) Soot Blower Elements : Extra heavy seamless tubing from solid bars with heat, corrosion & erosion protection for parts in permanent contact with hot gases. (ii) Blowing element : High temperature alloy steel			
13.05.00	Requirement for soot blower nozzles :			
	(a) Single or multiple row of nozzle welded to prevent falling out during service. (b) Venturi or straight bore nozzles shall be installed as required.			
13.06.00	Retractable Soot Blowers (RSB)			
	(a) Shall be retractable even during emergencies such as : (1) Drop in steam supply pressure, (2) Low steam flow, etc. (b) Long RSBs shall be half of Steam Generator width on each side. (c) Double helix cleaning pattern shall be used. (d) Dual electric drives, one for rotary and other for linear motion shall be provided for each soot blower. Alternatively, soot blower design having both linear as well as			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE BID DOC. NO.: CS-2600-001-9 TECHNICAL SPECIFICATIONS SECTION – VI, PART-B SUB SECTION-A-03 STEAM GENERATOR & AUXILIARIES PAGE 26 OF 33				

CLAUSE NO.	TECHNICAL REQUIREMENTS				एनटीपीसी NTPC															
	rotary motion achieved through single drive motor shall also be acceptable. (e) Controlled from soot blower panel. 13.07.00 The location of elements, travel and nozzle angles shall be such that maximum cleaning is obtained with a minimum of flowing medium. 13.08.00 Soot blowers Motor Control Centre (MCC) shall be as per Electrical Sub-section. 13.09.00 The soot blowing system shall be capable of performing functions as specified in Control & Instrumentation Sub section of this Specification. 13.10.00 Warm up of complete piping system before the start-up of soot blowing operation shall be facilitated by providing adequate number of pneumatic flow control valves. Each pneumatic flow control valve shall have bypass line with adequately sized orifice plate for draining the system when the valve is closed. 13.11.00 Temperature detectors along with temperature transmitters on the drain lines shall be provided to ensure satisfactory warming up and initiation of soot blowing operation. 13.12.00 All soot blowers shall be suitable for local and remote automatic sequential operation. 13.13.00 The lubricants, if any shall be suitable to withstand hot conditions. 13.14.00 Platforms/galleries shall be provided at and around all the soot blowers to facilitate, maintenance, inspection. 13.15.00 The soot blowers shall be accessible from local operating platform. 13.16.00 Provision shall be made to maintain the soot blower heads free of deposits during the periods when they are retracted and not in operation. 13.17.00 Provision shall be made for additional soot blower installation(s), if required in future. In case, after the unit is commissioned, if the operational experience warrants the necessity of additional soot blower(s), Contractor shall install additional soot blowers(s)along with proper approach and platform(s), as specified for other soot blowers, without any cost implication. 14.00.00 WALK WAYS, PLATFORMS AND STAIRS Access platforms, walkways, handrails, stairs, ladders and gratings etc.for proper approach during maintenance shall be provided for steam generator, all auxiliaries, equipments and accessories in the scope of this package. Walkways, platforms, stairs & ladders shall be provided in accordance with following requirements unless specified otherwise: <table><tr><th>Sl.No.</th><th>Description</th><th>Minimum clear width***</th></tr><tr><td>1.</td><td>Main access walkways</td><td>1500 mm</td></tr><tr><td>2.</td><td>Maintenance access walkways</td><td>1000 mm</td></tr><tr><td>3.</td><td>Staircase</td><td>1200 mm</td></tr><tr><td>4.</td><td>Ladders</td><td>450 mm</td></tr></table>					Sl.No.	Description	Minimum clear width***	1.	Main access walkways	1500 mm	2.	Maintenance access walkways	1000 mm	3.	Staircase	1200 mm	4.	Ladders	450 mm
Sl.No.	Description	Minimum clear width***																		
1.	Main access walkways	1500 mm																		
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KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE	BID DOC. NO.: CS-2600- 001-9	TECHNICAL SPECIFICATIONS SECTION – VI, PART-B	SUB SECTION-A-03 STEAM GENERATOR & AUXILIARIES	PAGE 27 OF 33																

CLAUSE NO.	 TECHNICAL REQUIREMENTS			
14.01.01	5. Platforms 1500 mm Ladders shall be acceptable only in such cases where it is not possible to provide stairs and shall be subject to specific approval of NTPC except at places where ladders have been specifically specified. Clear width shall be without any interruption from the intervening pipes, columns, actuators, instrument enclosures, racks etc. Platforms shall be provided at all equipment levels, all around the furnace, such that: (a) There is adequate space for operation, service and maintenance of all burners and associated auxiliaries. (b) The platforms are minimum 3000 mm wide and shall extend from furnace walls. (c) Platforms shall allow complete burner withdrawal within boiler room enclosure. (d) Platforms at each burner elevation shall be continuous and run at the same level without any interruptions from intervening steps, obstructions etc. The platforms with hydraulic oil station shall be welded steel checkered-plate with welded-in-place drains to prevent oil spillage from spreading. Major equipment platforms shall have direct access to elevator, unless levels are so close together that the 3500 mm minimum elevator door spacing does not permit separate elevator opening at each level. Access stairs to each equipment platform level shall also be provided.			
	14.01.02 Platforms of minimum clear width of 1500 mm shall be provided on at least three sides of the control station/ equipment. The platforms shall be all along the length of soot blower control station, Fuel oil control station, SH spray control stations SCAPH control station, steam/water sample coolers, APH station etc. Access through Elevator, staircase and main access walkways for reaching the platforms shall be provided.			
	14.01.03 Soot blowers shall have platforms on both sides along the entire length of retractable soot blowers and adequate space and service area for removal and handling of rotary blower elements in one piece. All LRSB's shall have minimum 1500 mm wide platforms on both sides along the entire length of soot blowers. Platform width should provide adequate space and service area for removal and handling of blower elements in one piece. Access through Elevator/staircase and main access walkways for reaching the LRSB platforms shall be provided. For soot blower locations which are envisaged / identified for future installation, provision shall be kept in the layout space and their loads shall be accounted for in the structure design so that the necessary access/platforms, as required, can be installed in future.			
	14.01.04 All manholes, all access doors, all observation ports, all instruments including flame scanners, flame cameras & ash level indicators/, Junction Boxes for control and instrumentation, all instrument test/sampling points shall be accessible from main access walkway/platforms. In case the lowest point of the manhole/access door/ exceeds 800 mm and of observation ports/ dirty pitot tube & fuel sampling points/instruments exceeds 1200			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE	BID DOC. NO.: CS-2600- 001-9	TECHNICAL SPECIFICATIONS SECTION – VI, PART-B	SUB SECTION-A-03 STEAM GENERATOR & AUXILIARIES	PAGE 28 OF 33

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	एनडीपीसी NTPC mm from the nearest walkway/platforms level then suitable intermediate platform to each of the above access doors, observation port, sampling points, instruments etc. along with suitable approach from nearest platform level shall be provided. Minimum height of the observation port shall be 500 mm from the platform/intermediate platform.			
14.01.05	Suitable all round platform for manual operation of all valves, for all dampers , for ash hoppers, for all lubricated equipment bearings and equipments requiring access during operation for normal day to day inspection & maintenance shall be provided. Suitable access to these platforms shall also be provided.			
14.01.06	All around platforms of adequate size to permit at least two persons to simultaneously work (1.5 sq.m. minimum) shall also be provided for all damper actuators, valve actuators, safety valves, instrument source connection point, Y pieces, Expansion joints and other areas requiring access only monthly or annually. Suitable access to above platforms with walkways, stairs/ladders etc shall be provided.			
14.01.07	Platforms together with ladders shall be provided for access to all maintenance hoists.			
14.01.08	Maintenance access areas, where access is only required for painting, re-insulation or replacement of components which have a service life of 10 years or more shall have facilities to enable the Employer to erect scaffolding, temporary ladders, platforms and safety nets to safely perform the work involved.			
14.01.09	Access to all pent house cooling doors shall be provided through maintenance walkways.			
14.01.10	Walkways/platforms/Staircase etc. shall comply with following requirements also: (a) Platforms at same elevation on each side of Steam Generator shall have a walkway connecting the two sides and other passes of steam generator (multi pass boiler) (b) Platforms requiring access from the elevator shall extend to the elevator entrance by main access walkways and be attached to the elevator steel as required. (c) Minimum headroom (free height) under all floors, walkways and stairs shall be 2.3m. (d) The interconnection between two platforms/floors at different elevations shall be through proper staircase. Ladders shall be considered only in exceptional case where provision of staircase is not possible. (e) Hand railings shall be provided for all walkways, platforms, openings, staircases etc. complying with the requirements specified in chapter of “civil works”, Part B of the Technical Specification. (f) Gratings shall comply with all requirements specified in chapter of “civil works, Part B of the Technical Specification. (g) If material is stacked or stored on a platform or walkway, or near a floor opening, kick plate/toe guard must be increased in height or solid or mesh panels of appropriate height must be installed to prevent the material from falling. (h) All areas subject to lube oil or chemical spills will be provided with curbs and drains.			
14.01.11	Contractor shall furnish detail floor plan drawings covering all platforms and shall clearly indicate all the dimensions of platforms and clear platform floor area in each drawing.			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		BID DOC. NO.: CS-2600-001-9	TECHNICAL SPECIFICATIONS SECTION – VI, PART-B	SUB SECTION-A-03 STEAM GENERATOR & AUXILIARIES
PAGE 29 OF 33				

CLAUSE NO.	एनटीपीसी NTPC TECHNICAL REQUIREMENTS			
15.00.00	ELEVATORS			
15.01.00	Elevators shall be designed based on following criteria :			
	(i)	Type of service	:	one (1) no passenger-elevator and one (1) no passenger cum goods elevator (for boiler).
	(ii)	Design/construction/ installation codes	:	(a) Latest edition of IS:14655 (All parts) AND also meeting any additional requirements of IS:4666, IS:1860 and IS:3534.
				(b) Any other equivalent code, subject to Employer's approval.
	(iii)	Load carrying capacity	:	680 Kgs. (equivalent to 10 person) for passenger elevator & 3000 kgs for passenger cum goods elevator.
	(iv)	Rated speed	:	0.55 meter/sec. for 3 Ton elevator and 1.0 m/sec for 680 kg elevator.
	(v)	Total Travel	:	As per Steam Generator supplier's recommendations subject to Employer's approval.
	(vi)	Number of floors to be served	:	As per vendors proven practice
	(vii)	Entrances	:	As per vendors proven practice
	(viii)	Entrance and platform size	:	As per design/installation codes at (ii) above
	(ix)	Drive/motor	:	As per Electrical Specifications.
	(x)	Method of control	:	As per Electrical Specifications.
	(xi)	Position of machine room	:	Directly above the lift shaft.
	(xii)	Elevator landings (min.)	:	(a) Major equipment floor (as per vendors proven practice) subject to Employer's approval.
15.02.00				Landing doors of the elevators shall have fire resistance of atleast one hour. These doors shall also be smoke tight as far as possible.
15.03.00				Construction of the elevators shall specifically meet all requirements of the codes indicated at Cl. 15.01.00 (ii) and shall have following additional features:
	(i)	Flooring of Cabin	:	Passenger cum goods elevator - 6 mm thick Checkered Plate flooring.
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE	BID DOC. NO.: CS-2600- 001-9	TECHNICAL SPECIFICATIONS SECTION – VI, PART-B	SUB SECTION-A-03 STEAM GENERATOR & AUXILIARIES	PAGE 30 OF 33

CLAUSE NO.	TECHNICAL REQUIREMENTS एनटीपीसी NTPC			
	Passenger Elevator - 6 mm thick Checkered Plate flooring. (ii) Design, Construction and finish of car & car door : Car inside enclosure including inner side of door shall be of stainless steel plate of grade SS:304 of bright finish. (iii) Car entrance and landing doors : As per BS: 476 (Part 20 & 22) (iv) Door construction : Hollow metal construction from 16 gauge thick steel sheet spray painted. (v) Signals : Car position informer in car both visual and audio, hall position indicator at all floors, telltale lights at all floors, battery operated alarm bell and emergency light with suitable battery, charger & controls. (vi) Type of Indicators : Soft touch keys and digital luminous display in car operating panel and on all floors landings. (All fixtures in stainless steel face plates).			
15.04.00	Technical requirements of Electrical items shall be as per details given in Electrical Sub-Section, Part-B.			
15.05.00	Provide sound reducing material below machines in machine room.			
15.06.00	Provide special corrosion resistant treatment on all elevator components. The protective treatment shall be subject to Employer's approval.			
15.07.00	Elevators shall have provisions to meet following operational requirements: (i) Selective collective, automatic operation with or without operator through illuminated push button station located inside the lift car. (ii) Power operated with automatic opening/closing car and landing doors. (iii) Two push buttons, one for upward movement and the other for downward movement at each intermediate landing, and one push button at each terminal landing shall be provided in order to call the car. (iv) Push buttons shall be fixed in the car for holding the doors open for any length of the time required.			
15.08.00	Fireman's switch shall be provided for each elevator.			
16.00.00	THERMAL INSULATION, LAGGING, CLADDING & REFRACTORIES			
16.01.00	In addition to the sizing design criteria requirement elaborated at Sub section A-02, refer separate chapter of "THERMAL INSULATION "			
17.00.00	PAINTING			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE	BID DOC. NO.: CS-2600- 001-9	TECHNICAL SPECIFICATIONS SECTION – VI, PART-B	SUB SECTION-A-03 STEAM GENERATOR & AUXILIARIES	PAGE 31 OF 33

CLAUSE NO.	 TECHNICAL REQUIREMENTS			
	Supply of paints including painting of all surfaces, equipment's and structures for Steam Generator shall be as per Employer's standard color coding scheme. Painting of various surfaces shall be as separate chapter on "Painting".			
18.00.00	BLOW DOWN SYSTEM In addition to the sizing design criteria requirement elaborated at Sub section A-02, following requirements shall also be adhered:			
18.01.00	The blow down system shall comprise of an atmospheric flash tank and drain receiving vessel, 2 X 50% condensate transfer pumps located in Steam Generator area and shall be complete with all necessary valves, piping, level control system etc			
18.02.00	Atmospheric flash tank design shall not allow discharge of any free water from vent. Water drops leaving vent pipe shall have sizes not more than 0.127 mm. The size of vent pipe shall ensure no pressurization of atmospheric flash Tank. Steam velocity through the vent pipe shall not exceed 90M/Sec. Calculation to this effect shall be submitted. The steam from the atmospheric flash tank shall be vented out to the atmosphere above steam generator roof level. Emergency drain shall be connected to the sewage after the same has been cooled by the cooling water. Necessary cooling system for this shall also be provided. Suitable arrangements to prevent overflow in this tank shall be provided.			
18.03.00	Design/Construction of Atmospheric flash tank and drain receiving vessel shall conform to following:			
18.03.01	Tanks shall be designed and fabricated as per requirements of IS : 2825/BS:806.			
18.03.02	Provide wear plates in the tank to prevent erosion due to high pressure/velocity drains.			
18.03.03	All drain connection to the Tanks to be tangential.			
18.03.04	Provide mating flanges for level switches and other instruments.			
18.03.05	Provide manholes with bolted doors on BDT. Doors shall be hung on hinges.			
19.00.00	TYPE TEST			
19.01.00	Full scale type tests using actual equipment shall be conducted by the Contractor for the equipment mentioned in the subsequent clauses below:			
19.01.01	Full range and full scale performance testing shall be conducted at shop on one number each of the following Fans as per BS 848, Part-1: (a) Induced Draft Fan (b) Forced Draft Fan (c) Primary Air Fan (d) GR Fan (if applicable)			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE	BID DOC. NO.: CS-2600- 001-9	TECHNICAL SPECIFICATIONS SECTION – VI, PART-B	SUB SECTION-A-03 STEAM GENERATOR & AUXILIARIES	PAGE 32 OF 33

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	एनटीपीसी NTPC (e) Hydraulic actuators for grate and feeding system (f) Grab cranes for waste pit, hopper crane and Ash crane (g) Boiler recirculation pump (if any) Physical model testing for the following 1. SNCR 2. Bag filter 3. Flue gas cleaning & Treating (Activated carbon / lime spray system) The performance testing at shop shall be conducted using actual fans			
19.02.00	The Bidder shall indicate the charges for each of these type tests separately in the relevant price schedule of Bid Proposal Sheet (BPS) and the same shall be considered for the evaluation of the Bids. The type test charges shall be paid only for the test(s) actually conducted successfully under this contract and upon certification by the Employer's Engineer.			
19.03.00	The type tests shall be carried out in presence of the Employer's representative. Contractor shall inform the Employer about his readiness for conducting the type test and issue such notice to the Employer 30 days in advance, alongwith schedule of the type tests. The Contractor shall obtain the Employer's approval for the type test procedure before notifying the Employer about his readiness for conducting the type test. The type test procedure shall clearly specify the test set-up, instruments to be used, procedure, acceptance norms, recording of different parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out.			
19.04.00	Irrespective of the requirement of conducting the type tests under this contract, the Contractor shall submit the reports of the type tests listed above in clause no. 19.01.00 and carried out within last five years from the date of bid opening. These reports should be for the tests conducted on the equipment similar (model / type / size / rating) to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. The Employer reserves the right to waive conducting of any or all of the specified type tests under this contract, in which case the type test charges shall not be payable for the type tests waived by the Employer.			
19.05.00	All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.			
20.00.00	THERMAL INSULATION, LAGGING, CLADDING & REFRACTORIES Thermal Insulation along with aluminum cladding shall be provided for all the equipments/surfaces having skin temperature more than 60 degree Celsius. The insulation shall be sized & designed based on criteria's specified in Sub section A-11, Part-B, Section-VI. However the thickness of the insulation shall not be less than 75 mm in any case.			
21.00.00	Refer Sub- Section A-10, Part B, Section VI for painting requirements.			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE	BID DOC. NO.: CS-2600- 001-9	TECHNICAL SPECIFICATIONS SECTION – VI, PART-B	SUB SECTION-A-03 STEAM GENERATOR & AUXILIARIES	PAGE 33 OF 33

SUB-SECTION–A-04

NOT USED

SUB-SECTION–A-05

LAYOUT REQUIREMENTS

CLAUSE NO.	TECHNICAL REQUIREMENTS		एन टी पी सी NTPC		
1.00.00	LAYOUT REQUIREMENTS				
1.01.00.1	Broad Guidelines for General Layout Plan				
1.01.01	General layout plan indicating the area for WTE plant for proposed project is as shown in the tender drawing. It shall form the basis for further elaboration by the Bidder for the plant facilities, which are in his scope. Plant to be installed within the area allocated for the WTE plant. However, Bidder may optimize the space utilization from erection, good operation and maintenance aspects.				
1.01.01.1	Bidder shall develop detailed layout for the equipment offered in the main plant block considering sequential erection & ease of operation and the same are to be clearly brought out in the bid. Further while preparing the detailed layout, planning the facilities in the Bidder's scope and deciding upon the transportation and construction/ erection strategy and functional requirements, the bidder shall ensure the following aspects: a) Face of the buildings and facilities shall be located in such a way so as to have an offset of minimum 20 m with respect to centre line of double lane road and 15 meter with respect to centre line of single lane road. The spacing between various buildings and facilities shall be suitably decided so as to avoid interference between the foundations. b) All the buildings and facilities shall be approachable by fire tenders. c) All statutory requirements including safe distances between various facilities as per applicable rules/acts/laws including local bye-laws shall be met.				
1.02.00	Equipment layout				
1.02.01	While developing the layout, the Bidder shall ensure the following minimum requirements:				
	1.	Number of Maintenance Bays	Minimum Two (2) nos. (one no. each side of waste pit) for grab crane. Min. One (1) in T.G building. Further additional bays may be provided as per system/layout requirements.		
	2.	Common Control Room and Control Equipment Room and other C&I rooms.	Common Control room for the grab Cranes and other control system of the project shall be provided at elevation above bunker level to view entire waste bunker and waste pit area maintenance bays. The Control Equipment Room, UPS, Battery Charger & Battery Room and Programmer Room shall be located adjacent to Control Room.		
	3.	Passage way between TG Hall and first row of boiler column	9m. Further, free access of fire tenders to be ensured in this passage way.		
	4.	Arrangement of TG set	Longitudinal		
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		BID DOC. NO.- CS-2600-001-9	TECHNICAL SPECIFICATIONS	SUB-SECTION- LAYOUT REQUIREMENTS	PAGE 1 OF 4

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	5. Basement, Pits & Trenches Regular Basement floors are not acceptable in Main Plant Building 6. Clear walkways of Power House. a) 1.5 m width at all the levels 7. Minimum clear working space around the equipment 1200mm 8. Minimum width of all staircase 1200mm 9. Clear Head room at different floors within TG Building below pipes, ducts, structures & cable trays etc. 2.5m (Minimum) 10. No. of Fire Escape staircases in the main plant with fire doors at each landing. Min-2 Nos. per unit- However the number shall meet the requirement of insurance companies. 1.02.02 Arrangement for the removal/handling of equipment to the maintenance bay to be provided. Further, adequate space and provision for handling/removal of pumps, motors, fans, Switchgear Panels, Transformers and other equipment during maintenance shall be provided with proper approach. 1.02.03 In TG bay at EOT crane rail level, chequered plate walkway of minimum 500mm clear width from face of the column to the hand rail (excluding hand rail) on crane side to be provided at column sectional depth for full length of the building. 1.02.04 Proper approach shall be provided for access to all equipment during normal operation and maintenance. Unless otherwise specified, platforms, staircases and ladders shall follow the stipulations specified elsewhere in this specification. 1.02.05 Equipment requiring monitoring during regular operation shall be approachable from the nearest floor level through staircase. Staircase with minimum width of 1200 mm shall be provided for approach to elevated structures at 5m height from the nearest platform. Below this height a vertical ladder with minimum clear width of 600 mm may also be acceptable. 1.02.06 Valves including actuators and instrument tapings shall be located in accessible positions and operating/maintenance platform for the same shall be provided. All piping shall be routed at a clear height of 2500mm (min.) from the nearest access level to clear man movement. 1.02.07 Separate entry and exit paths for trucks carrying waste to Tipper area to be provided. 1.02.08 Lift landing levels shall be provided for Control Room, Control Equipment Room, each floor and up to the topmost floor of Boiler Building. Location of Lifts shall be fixed during detail engineering stage while finalizing Plant Layouts. For further technical details refer respective portion of the Technical Specification.			
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE	BID DOC. NO.- CS-2600-001-9	TECHNICAL SPECIFICATIONS	SUB-SECTION- LAYOUT REQUIREMENTS	PAGE 2 OF 4

CLAUSE NO.	TECHNICAL REQUIREMENTS	एन टी पी सी NTPC		
1.02.09	Interconnecting platform(s) between Turbine building and WTE Boiler to be provided at T.G floor level. Further, interconnecting platform(s) also to be provided at Common Control room level between WTE Boiler and Control tower.			
1.02.10	(a) All safety requirements as per Factories Act, National Electricity Code etc. shall be complied with while developing the layout. (b) Switchgear room shall be provided with alternate exits in case of fire/accidents as per requirements of Factories Act and TAC. Further minimum two number fireproof double door shall be provided in Cable vaults and Switch gear rooms.			
1.02.11	Local Pits/trenches in Main Plant building are to be avoided. However pits/sumps which are unavoidable shall be provided with required permanent dewatering arrangements by means of drainage pumps and piping. Drain network shall be provided to collect effluent generated from floor wash, equipment drain and process drain in various plant areas for further disposal up to effluent treatment area (as specified elsewhere in the specification) . Underground pipes for this purpose shall not be acceptable.			
1.02.12	Cable trenches/slits, if unavoidable, shall be provided with adequate cushioning of sand and the same shall be covered with PCC.			
1.02.13	For the routing of cable trays & piping which includes fuel oil/ gas, Water piping, Ash handling system piping, Fire Fighting pipes etc. & ducting and conveyors, Bidder to ensure the following- I. Trestle height in outlying area shall be 3.0 M (headroom) except for Fly ash pipes. For Fly ash pipes trestle height shall be minimum 8.0M or higher as per the system requirement. II. Cable/Pipe trestles, conveyor galley and any other structure height at road crossings shall be min. 8M (headroom). III. Fire water pipes in Boiler area shall be routed either on trestle or shall be supported from main plant structure or shall be buried wherever not feasible. Wherever fuel oil/ gas pipes and steam pipes are running over the trestle, fire water pipes shall not be routed on the same trestle. Further, all other pipes shall be routed over ground either on pedestals or on trestle in plant area. No trenches for pipes shall be envisaged as far as possible. All Road/rail crossing of pipes shall be through PCC/RCC encasement only. IV. A walkway of 600mm (minimum width) with hand rails & toe guards shall be provided all along length of the trestle for installation and maintenance of cables. Ladders for approach to these platforms shall be provided near roads, passage ways and turning points. In the trestle where ash conveying pipes are routed, grating platform all along the length and for full width of the trestle shall be provided. Further, one walkway of 600mm clear width shall be ensured on the tier meant for routing the ash conveying pipes. V. Head room for personnel movement shall be 2.1m over the walkways in Pipe/cable Trestle galleries for all tiers.			
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE	BID DOC. NO.- CS-2600-001-9	TECHNICAL SPECIFICATIONS	SUB-SECTION- LAYOUT REQUIREMENTS	PAGE 3 OF 4

CLAUSE NO.	TECHNICAL REQUIREMENTS				एन टी पी सी NTPC
	VI. Wherever, fly ash pipes are routed on the top most portion of the pipe/cable trestles, a clear head room of 2.1M over the walkways of dry ash pipe rack shall be ensured. VII. Height of trestles at approach roads to various buildings/facilities shall be 8M. In case building are located in off-site area and are adjacent to each other, then as a good engineering practice, the height of trestle shall be maintained all over as 8.0M. VIII. Height of Ash conveyor gallery shall be min. 8.0M at all rail, road and vehicle passage ways crossings.				
1.02.14	Electrical MCC/switchgear rooms 1. The following clearances shall be maintained for HT/LT Switchgear. a.) Front Clearance: i) For one Row of Swgr. - 2.0 M (Min) ii) For two Rows of Swgr. - 2.5 M (Min) b.) Back Clearance - 1.5 M (Min.) c.) Side Clearance: Min. 800 mm, however provision to be made for any additional panel in future at both ends. Therefore end clearance shall be 800+width of panel (including spare panels/dummy panels etc.) 2. Height of HT/LT Switchgear Room: i) With Bus Duct – 4.5 m (min) ii) Without Bus Duct – 4.0 m (min)				
1.02.15	Cable vault shall have 800 mm wide and 2.1 m high movement passage all around the cable trays in the cable vault for easy laying/maintenance of cables. Proper unit wise segregation / separation of cables shall be provided in cable vault area. Switchgear and control panel shall be placed at different elevations.				
1.02.16	The Transformer fencing shall be at 1.0 M (minimum) distance from the pit wall. The Height of fencing shall be 2.5 M (minimum) and fencing shall have personal entry gate and removable type fencing/gate for transformer withdrawal.				
1.02.17	For all outdoor transformers a pit shall be provided all around at a distance of 1.0 m (minimum) from transformer outer edge. A sump pit shall be provided for each pit.				
1.03.00	Laydown area for maintenance and overhauling: 1. The layout of the steam turbine building/units shall permit sufficient lay down area for all the parts/components to enable carrying out maintenance and overhauling operations without any restrictions and without any hindrance to the operating personnel of other units. 2. The Bidder shall furnish general arrangement drawings indicating the equipment lay down area with details such as blocks indicating orientation of dismantled items, travel path etc.				
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		BID DOC. NO.- CS-2600-001-9	TECHNICAL SPECIFICATIONS	SUB-SECTION- LAYOUT REQUIREMENTS	PAGE 4 OF 4

SUB-SECTION–A-06

STEAM TURBINE & AUXILIARIES SYSTEM

CLAUSE NO.	TECHNICAL REQUIREMENTS		एनटीपीसी NTPC																														
1.00.00	STEAM TURBINE AND AUXILIARY SYSTEMS																																
1.01.00	Steam Turbine Rating The steam turbine generator unit shall conform to the following design and duty conditions: <table><tr><td>(i)</td><td>Output under economic maximum continuous rating (EMCR) at generator terminals</td><td>At least 14.9 MW or as quoted by the bidder</td></tr><tr><td>(ii)</td><td>Turbine throttle steam pressure</td><td>To be optimized by the bidder corresponding to guaranteed gross power output condition (Load Point 1).</td></tr><tr><td>(iii)</td><td>Turbine throttle main steam temp.</td><td>To be optimized by the bidder corresponding to guaranteed gross power output condition (Load Point 1).</td></tr><tr><td>(v)</td><td>Design & operational requirement including variations in rated steam temp. & pressure</td><td>Generally as per IEC 45 or otherwise specified elsewhere in the specification</td></tr><tr><td>(vi)</td><td>Condenser pressure</td><td>120 mm to 135 mm of Hg (abs) at 40 °C ambient To be optimised in the range given</td></tr><tr><td>(vii)</td><td>Turbine speed</td><td>As optimized by the bidder to suit the grid condition.</td></tr><tr><td>(viii)</td><td>Frequency variation range around rated frequency of 50 Hz</td><td>+ 3% to - 5% (47.5 Hz to 51.5 Hz)</td></tr><tr><td>(ix)</td><td>DM water make up to thermal cycle under EMCR condition</td><td>3% of throttle steam flow</td></tr><tr><td>(x)</td><td>Turbine protection against water induction</td><td>As per ASME-TDP-I-latest edition</td></tr><tr><td>Xi</td><td>Steam Extraction for heating/cooling/ industrial use</td><td>Internally controlled extraction to provide up to 60% of the steam at the upstream of the extraction point to provide steam at 8 ata at</td></tr></table>			(i)	Output under economic maximum continuous rating (EMCR) at generator terminals	At least 14.9 MW or as quoted by the bidder	(ii)	Turbine throttle steam pressure	To be optimized by the bidder corresponding to guaranteed gross power output condition (Load Point 1).	(iii)	Turbine throttle main steam temp.	To be optimized by the bidder corresponding to guaranteed gross power output condition (Load Point 1).	(v)	Design & operational requirement including variations in rated steam temp. & pressure	Generally as per IEC 45 or otherwise specified elsewhere in the specification	(vi)	Condenser pressure	120 mm to 135 mm of Hg (abs) at 40 °C ambient To be optimised in the range given	(vii)	Turbine speed	As optimized by the bidder to suit the grid condition.	(viii)	Frequency variation range around rated frequency of 50 Hz	+ 3% to - 5% (47.5 Hz to 51.5 Hz)	(ix)	DM water make up to thermal cycle under EMCR condition	3% of throttle steam flow	(x)	Turbine protection against water induction	As per ASME-TDP-I-latest edition	Xi	Steam Extraction for heating/cooling/ industrial use	Internally controlled extraction to provide up to 60% of the steam at the upstream of the extraction point to provide steam at 8 ata at
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KAWAS WTE PROJECT (2× 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-06 TURBINE GENERATOR AND AUXILIARIES PAGE 1 OF 28																														

CLAUSE NO.	TECHNICAL REQUIREMENTS एनटीपीसी NTPC		
1.02.00			the terminal point.
	TMCR: The term “TMCR” (Turbine maximum continuous rating) appearing in the technical specification shall mean 4 MW electrical power output at generator terminals under rated steam parameters, 0% cycle make-up and design condenser pressure unless used in conjunction with a different cycle make-up and/or a different condenser pressure and /or a different throttle steam pressure. EMCR: The condition corresponding to economic continuous maximum rating (EMCR) at generator terminal shall be 4 MW output under rated steam conditions with cycle make up of 3% of throttle steam flow and design condenser pressure. VWO: The condition corresponding to valves wide open to generate peak output at the generator terminal at rated steam parameters and design condenser pressure. In case of static excitation system, the EMCR/TMCR/VWO output at generator terminal shall be at least 14.9 MW plus excitation power requirement. MATERIAL REQUIREMENTS The proposal shall include the schedule of materials used in turbine construction indicating chemical composition and designation of materials for following components: Description (i) Turbine Casing Turbine casing Turbine blade carrier (ii) Turbine Shaft and Shaft Coupling (iii) Moving Blades First stage Other stages (iv) Fixed Blades First stage Other stages (v) Casing Joint Bolts (vi) Turbine steam admission valves Valve Body Valve Spindle Valve seat The steam turbine shall be built up using materials which are proven for rated turbine inlet steam temperature. 1.03.00 MAINTENANCE REQUIREMENTS		
KAWAS WTE PROJECT (2× 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-06 TURBINE GENERATOR AND AUXILIARIES PAGE 2 OF 28

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	(i) Turbine Preservation:	(a) Provide Portable Turbine preservation system to protect against corrosion during idle periods.		
		(b) Write-up on the recommended system to be furnished.		
1.04.00	TURBINE CASING			
1.04.01	The turbine casing design shall have following features:			
	(a)	Turbine casing design: Maximum pressure & temperature to be encountered during service including as specified under operational capabilities.		
	(b)	Adequate drainage facility with temp. sensing devices in casings, strainers housings, stop and control valves, extraction lines etc. and drain lines.		
	(c)	Provide pressure relief bursting diaphragm for turbine casing to limit the exhaust hood pressure within a safe margin from design pressure.		
	(d)	Provide a completely self contained exhaust hood spray system for turbine casing to protect the turbine against excessive temperature due to windage at no load / low load and turbine bypass operations.		
	(e)	Bearing inspection should be possible without necessity of dismantling the turbine casing.		
1.05.00	STEAM TURBINE ROTORS			
	(a)	Maximum permissible shaft vibration measured at bearing housing will be as per zone A of ISO 7919 and maximum permissible bearing vibration measured at bearing housing will be as per zone A of ISO 10816-2.		
	(b)	Critical speed of composite rotor and blade assembly shall not be within - 10% and +15% of rated speed.		
	(c)	Turbine assembly radial seal clearances at rotor blade tip and inter stage area shall not be less than 0.8 mm.		
1.06.00	NOZZLES AND BLADES			
	(a)	Ensure that there is no resonance of turbine blading in the continuous operating frequency range of 47.5 Hz. to 51.5 Hz. Furnish Campbell diagrams for all free standing blade stages.		
	(b)	Ensure independent tuning of all free standing turbine blades to avoid resonance frequency in the operating frequency range of 47.5 Hz. to 51.5 Hz.		
KAWAS WTE PROJECT (2× 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-06 TURBINE GENERATOR AND AUXILIARIES	PAGE 3 OF 28

CLAUSE NO.	TECHNICAL REQUIREMENTS			
1.07.00	BEARINGS			
	(a) Provide adequate number of Journal and thrust Bearings with:			
	(1) Tin base babbit lining properly secured to the bearing shell.			
	(2) Pressure lubrication.			
	(3) Provision for measuring bearing temperature as near the point of heat generation as possible and for measuring the oil temperature leaving the bearing.			
1.08.00	TURNING GEAR			
	(a) Provide suitable turning gear device, either High-speed hydraulic type or motorised turning gear as per standard proven practice of the Bidder.			
	(b) Ensure automatic engagement / disengagement with shaft speed decrease/increase at preset value.			
	(c) Provide manual hand barring facility also for manually cranking the turbine in case of emergency including A-C power failure. Ensure availability of lube oil to the bearings during manual barring operation.			
	(d) Provide instrumentation & control for remote operation (from unit control room).			
	(e) Ensure proper interlocks of lubrication system with operation of turning gear.			
1.09.00	GLAND SEALING SYSTEM FOR STEAM TURBINE			
1.09.01	DESIGN REQUIREMENT			
	(a) Gland sealing system for the T.G set shall comprise of:			
	(1) Spring back Labyrinth seal or seals as per standard practice of the bidder.			
	(2) Turbine shaft glands sealed with steam.			
	(b) Fully automatic gland sealing steam supply system including necessary piping, valves, fittings and control and Instrumentation as required.			
	(1) Gland Steam condenser to condense and return to cycle all gland leak off steam along with 2x100% capacity exhausters (AC motor drive) to remove air and non-condensable gases. The exhaust gases shall be left outside the TG hall roof level.			
1.10.00	STEAM ADMISSION VALVES (EMERGENCY STOP AND CONTROL VALVES)			
1.10.01	Design, constructional and operational requirement:			
KAWAS WTE PROJECT (2× 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-06 TURBINE GENERATOR AND AUXILIARIES	PAGE 4 OF 28

CLAUSE NO.	TECHNICAL REQUIREMENTS			
1.11.00	(a) Designed to allow blowing out of Steam leads prior to start-up. (b) Locate the steam admission valve close to the turbine casing for limiting turbine over speeding to safe limits because of entrapped steam volumes. (c) Lagged with insulation and provided with lifting eyebolts. (d) Provide Temporary & Permanent steam strainers for Emergency stop or control valves. In case there is no provision for temporary strainer, one set of strainers per unit shall be provided in addition to the permanent strainer. The strainers shall be arranged to permit easy inspection and cleaning. (e) Provide hydraulically operated valves, fail safe type & equipped with test device.			
	INSULATION (STEAM TURBINE)			
	(a) The turbine cylinder, steam chest and other parts of turbine as considered necessary and all associated piping and valves shall be efficiently insulated with inner thermal insulating materials. In case the noise limit as specified elsewhere in the specification is exceeded ,the insulated portion of the steam turbines shall be covered with fabricated steel cover, provided with suitable anti-drumming and sound pressure attenuating material inside. The insulation and steel covering should be so designed and erected as to provide easy accessibility to parts requiring frequent inspection.			
	(b) Suitable stainless steel lugs shall be tack welded on turbine casing to support the insulation. In places where welding is not permitted, suitable alternative arrangement shall be provided by the Contractor. The design of the support shall be so as to involve minimum number of lugs.			
	(c) The thermal insulation designed, furnished and installed by the Contractor shall be such that the following items of performance shall be guaranteed, and the specific design and application features adopted shall be so as not to exceed the stipulated limits in temperature differentials. The Employer shall have the option to have any random check of specimen as per his choice, to establish conformity to guaranteed particulars:			
	(1) The difference in temperature between upper and lower metallic parts of the turbine casing in the zone of governing stage/ steam admission shall not be more the 40°C during cooling of the casing.			
	(2) The difference in metallic temperatures of upper and lower halves of turbine casing, during normal operating conditions shall not be more than 15°C.			
	(d) Applicable Standards:			
	1. IS15402 Ceramic mattress insulation			
	KAWAS WTE PROJECT (2× 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-06 TURBINE GENERATOR AND AUXILIARIES

CLAUSE NO.	TECHNICAL REQUIREMENTS एनटीपीसी NTPC
1.12.00 1.13.00 1.14.00	2. IS - 9742 Sprayed mineral wool thermal insulation. 3. IS - 5696 Loose mineral wool. 4. IS - 3677 Unbonded rock and slag wool for thermal insulation. 5. IS - 8183 Lightly bonded mineral wool for thermal insulation. 6. IS - 7413, IS - 3144, IS - 9482 (e) The use of asbestos in any form for insulation and elsewhere is not permitted. TURBINE GOVERNING SYSTEM (a) Capable of controlling with stability the turbine speed between zero to maximum power output. (b) Overspeeding of turbine during full load loss shall be limited to turbine overspeed trip value. (c) Provide adjustable steady state speed regulation between +3% to +8% of rated speed. (d) Ensure dead band at rated speed and at any power output within rated output shall not exceed 0.06% of rated speed. TURBINE PROTECTIVE DEVICES (a) Emergency Governor (1) Bidder shall provide overspeed trip of the Unit at 110% of rated speed in case speed governor fails to limit the turbine overspeed. (2) The emergency governor resetting shall be as per manufacturer's standard practice. However, it shall meet the IEC-45 requirements for overspeed trip. (3) Bidder shall provide means for testing the operation of emergency governor when the machine is on load without exceeding the rated speed of the unit. (b) Emergency Hand Trip Bidder shall provide emergency local hand trip device to facilitate manual tripping of the unit along with facility to trip turbine from UCB. VACUUM BREAKER Bidder shall provide D.C operated device for rapid reduction of vacuum in condenser for turbine rotor to be brought to rest as quickly as possible.
KAWAS WTE PROJECT (2× 350 TPD) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9 SUB SECTION-A-06 TURBINE GENERATOR AND AUXILIARIES PAGE 6 OF 28

CLAUSE NO.	TECHNICAL REQUIREMENTS			
1.15.00	TURBINE LUBRICATION OIL SYSTEM			
	(a) A self contained LUBRICATION oil system for each TG Unit consists of: 1. Centrifugal / gear type, Main oil pump (MOP) directly driven by Turbine as per Bidder's standard practice with capacity to cater control oil, lube oil for bearings & emergency seal oil requirement (if applicable for bidder design). In addition of above 2x100% AC Aux. oil pumps for start up, shut down of TG unit and as standby to M.O.P. for automatic operation shall be provided. Each pump shall also be capable of start up, shut down of TG unit and stand by to each other for automatic operation. OR 2x100% AC oil pumps as per Bidder's standard practice with capacity to cater control oil, lube oil for bearings & emergency seal oil requirement (if applicable for bidder design). Each pump shall also be capable of start up, shut down of TG unit, normal operation and stand by to each other for automatic operation. (2) One DC motor driven emergency oil pump with sufficient capacity for meeting lube oil requirement of bearings during emergency with automatic starting on low lube oil pressure preset value. (3) 1x100% each AC & DC jacking oil pumps (if required) with an interlocking not to start till lube oil pressure is established. Provision of jacking oil shall be as per proven practice of the OEM. If jacking oil system is not offered, then bidder shall provide supporting documents to establish its proven practice. (4) Each Unit Lube Oil tank to have capacity to allow 5 to 8 oil charges per hour (at normal operating level), fitted with non-corrodable strainers, level measuring device & local indicators and necessary manholes, 2x100% duty vapour extraction fans, platforms, railings, necessary piping, supports and accessories etc. 5) Lube oil cooler (i) Configuration: 2x100%, DM water cooled having oil pressure greater than water pressure. Lube oil coolers to be provided with Manual 3-way valve on oil side for changeover of coolers. (ii) Type: Either shell & tube type or plate type heat exchanger as per the standard practice of the turbine manufacturer. (iii) Heat transfer area: Lube oil coolers to be provided with 15% excess tube / plate surface			
KAWAS WTE PROJECT (2× 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-06 TURBINE GENERATOR AND AUXILIARIES	PAGE 7 OF 28

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	area. Thermal calculation considering fouling factor, overall heat transfer coefficient, corrosion allowance, plate / tube thickness etc. shall be furnished for employer's approval. (iii) Material of construction: The tube / plate material shall be SS316. Further the material of any other part of the lube oil cooler which is coming in contact of lube oil shall be SS316. (iv) Design codes: (a) Shell and tube type: TEMA (latest). (b) Plate type: Pressure parts as per ASME Sec-VIII. (v) Other features: Temperature measurement device to be provided at inlet and outlet of oil and water side of the lube oil coolers. (b) Purification System Provide permanently Connected, Continuous Oil Purification system having following major equipment / features. (1) Capacity and purity: Oil purification system having capacity to purify 20% of total oil charge in system per hour. Purified oil shall have moisture not more than 500 PPM & max. particle size conforming to code 15/12 as per ISO 4406 or requirement of the turbine manufacturer which ever is better. The above particle size and moisture content shall be demonstrated with inlet oil quality conforming to 21/18 as per ISO: 4406 and 15000 PPM moisture respectively in one pass. All components of the oil purification system which are coming in contact with oil shall be constructed from high grade stainless steel. (c) Filters & Strainers Provide duplex type filters/strainers with stainless steel element, with differential pressure devices with alarm at common oil supply line. The filter elements size shall be of five (5) microns or a size suited to TG manufacturer's requirements. In addition to above, the Bidder may provide filter/strainers at oil supply line to /oil return lines from bearing and generator seals as per his standard practice. (d) Oil Piping & fittings (1) Provide double oil piping or equivalent shielding arrangement for all high pressure lines and all pipes close to hot pipes and parts to protect against fire hazards.			
KAWAS WTE PROJECT (2× 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-06 TURBINE GENERATOR AND AUXILIARIES	PAGE 8 OF 28

CLAUSE NO.	TECHNICAL REQUIREMENTS			
1.15.00	(2) Ensure oil return lines from bearings fitted with illuminated sight fittings, or any other device to see the flow of oil depending upon the standard proven practice of the bidder. (3) All the piping, fittings, valves, Main Oil Tank and complete strainers including body and element shall be of stainless steel. Further all the parts of lube oil coolers (tubular or plate type) which are coming in contact of lube oil shall be of stainless steel.			
	GEAR BOXES (1) Type Double helical gear by hobbing process, dynamically balance. The high speed pinion of heat treated forged steel and low speed gear of forged steel. The gear casing shall be horizontally split and accurately machined to provide oil tight joints. The gears shall be enclosed in an oil and dust proof gear casing made of grained cast iron or fabricated steel. Oil used to be same as for the pump, motor and turbine and supplied from pump lubrication system. Gear to be designed for continuous service. (2) Instrumentation Suitable oil level / flow indicator on gear casing for local monitoring. (3) Service Factor Between turbine and generator 2.0 (4) Bearings Gear box with separate thrust bearings or combined journal cum thrust bearings as per their standard practice shall be provided to meet worst duty conditions. (5) Applicable Code : AGMA 420 and 421 (Latest)			
1.16.00	STEAM TURBINE BYPASS SYSTEM (a) Ensure turbine bypass aggregate capacity not less than 65% of the main steam flow at BMCR condition considering rated main steam parameters at the upstream of valves & downstream parameters matching with those of Turbine exhaust steam. The bypass system shall have 1X100% or 2x50% capacity valves as per bidder's standard practice. In addition, the aggregate capacity of Bypass valve shall be adequate to evacuate the required minimum steam flow from the boiler under various start up conditions (viz. Cold/warm/hot start up) as per combined boiler turbine start up curve. (c) Seat tightness of the bypass valves shall be equivalent to block valve tightness conforming to MSS SP61.			
KAWAS WTE PROJECT (2× 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-06 TURBINE GENERATOR AND AUXILIARIES	PAGE 9 OF 28

CLAUSE NO.	TECHNICAL REQUIREMENTS			
1. 17.00	(e)	Provide bypass station spray water requirement from a point as optimised by the bidder. Spray system to include spray water control valves, NRVs and isolating valves.		
	(g)	Ensure all valves (both in steam and spray water service) to be electro hydraulically operated.		
	(h)	Provide separate oil system with 100% redundant pumps, motors, accumulators and control cubicles etc. for bypass system. Accumulators shall be sized to take sufficient number of stroking operations of all actuators under a condition of loss of oil supply from the pumps.		
	(j)	Provide warming up arrangement of bypass valves and associated piping.		
	(k)	Capable of operation in parallel with turbine.		
	(l)	Facilitate hot/warm restarting following a trip from full/part loads, controlled shutdown and cold start-up following a long shut down.		
	(m)	Ensure that boiler operation is not affected in the event of loss of load on the turbine, by disposing off the steam produced in the boiler automatically by providing a quick opening device. The full stroking time of valve under quick action shall be within 2 to 3 seconds.		
	PERFORMANCE REQUIREMENTS			
	(a)	The steam Turbine Generator set apart from being capable of operation on base load shall also be suitable for cyclic load variations as the unit is expected to operate in automatic load frequency control system.		
	(b)	Bidder to provide adequate temperature measurement and other instrumentation etc. for adequately guiding the operator to regulate loading of unit to keep the thermal stresses and fatigue levels within safe limit.		
	(c)	Ensure normal make-up to cycle in the condenser hotwell at 3% which at times may go upto 5% and emergency make-up shall be sized for 5% BMCR, 10% BMCR & 15% BMCR for Min/Normal/Maximum flow respectively.		
	(d)	Ensure during bypass operation deaerator shall heat feed water to saturation temperature corresponding to deaerator pressure optimized by the bidder.		
	(e)	Ensure all recoverable cycle drains to condenser as per the standard practice of the bidder. Bidder to however note that manifolds on condenser shall not be acceptable. Start-up drains to be led to atmospheric flash tank.		
	KAWAS WTE PROJECT (2× 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-06 TURBINE GENERATOR AND AUXILIARIES

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	(f) Under all conditions of operation, the steam turbine generator set shall perform continuously without the noise levels of its components and auxiliaries (individually or collectively) exceeding the limits as specified under General Technical Conditions. (g) Maximum permissible vibration for auxiliaries shall conform to Zone-A of ISO-10816. (h) The plant, it's unit (s) and its all auxiliaries equipment/systems shall be designed to operate with all the specified margins for continuous operation without any limitations under any of the conditions indicated in the Technical Specification. (i) The major operating capability for the plant shall be to operate continuously with turbine under VWO condition with rated steam parameters, design condenser pressure and 3% cycle make up.			
1.18.00	Heat balance Diagrams:			
1.18.01	Following Heat balances complete in all respects to be computed & furnished for the conditions stipulated with units indicated in MKS system & IAPWS-IF 97 steam tables. Pressure (in ata), temperature (in deg C), enthalpy (in kcal/kg) and flow (in tonnes/hr) to be indicated at all required locations to facilitate manual checking by the Employer. i. VWO output under rated steam condition at design condenser pressure, with 0% & 3% make up. ii. 100% of rated load under rated steam conditions at design condenser pressure with 0% make-up. (Guarantee Gross Power Output) iii. VWO Output under rated steam conditions at worst condenser pressure with 0% & 3% make-up. iv. Bypass operation under rated steam conditions with steam generator output of 65% of BMCR. v. Bypass operation under rated steam conditions with bypass valves open to full capacity and turbine on house load operation. vi. Steam generator output corresponding to BMCR flow under rated steam conditions, turbine in parallel operation with bypass valves open to full capacity vii. Steam Generator output corresponding to BMCR flow under rated steam condition, turbine under VWO operation, design condenser pressure, 0% & 3% make up. Difference of BMCR flow and VWO steam flow through turbine shall be assumed to be drawn of from Main steam line. Same quantity of flow to be added to condenser as additional make up. Note: a. Bidder to submit all of the above Heat Balances for system/ equipment design as specified elsewhere in the specification. b. Any additional heat balances deemed necessary by the Employer or for sizing calculations shall be furnished. All the heat balances shall show turbine output, mechanical and electrical losses in turbine and generator and input to shaft driven auxiliaries, if any.			
KAWAS WTE PROJECT (2× 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-06 TURBINE GENERATOR AND AUXILIARIES	PAGE 11 OF 28

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	c. Steam supply to de-aerator shall be from a point as per optimised cycle of the bidder and the minimum de-aerator pressure shall be a pressure optimized by the bidder during low-load operation and Bypass operation. The optimised pressure should be same during warm, hot startup conditions and bypass operation.			
1.18.02	Furnish turbine expansion line diagrams for EMCR load point along with group efficiencies.			
1.18.03	Furnish thermal kit data for plant performance by DDCMIS. .			
1.18.04	Furnish turbine clearance diagram indicating values for radial & axial clearances and leakage rate from glands.			
2.00.00	CONDENSING PLANT Design, manufacturing and testing as per Heat Exchanger Institute, USA (latest edition) for air cooled condenser with proven design. The condenser shall be designed for heat load corresponding to Valves Wide Open (VWO) conditions, 3% make-up, at ambient temp 40 Deg C, design condenser pressure, and conditions given in Table A at clause 2.04.00. Condensate temperature at all loads shall be near to the saturation temperature corresponding to condenser pressure. The Condensate tank shall be sized for three (3) minute storage capacity (between normal & low-low level) of total design flow with the turbine operating at VWO condition, 3% make-up, design condenser pressure. The low-low level of hotwell shall be at least 200 mm above the bottom of hotwell.			
2.01.00	TYPE: Direct air cooled, forced cooling.			
2.01.01	(a) The exhaust steam from the turbine shall be cooled using an Air Cooled Condenser with forced convection air as a cooling medium. Expanded steam from the Steam Turbine after passing through hot box and then through main steam duct is condensed through the condenser tubes. Cooling air is drawn over the condenser tubes by motor fans to produce condensate. The condensate is collected in a common condensate tank and returned to the feed water tank / deaerator via the condensate pumps. (b) Design of air removal section to cool the air and vapour mixture to at least 4.17 deg. C below saturation temperature corresponding to design condenser pressure. Connections to air evacuation pumps shall be made at this section.			
KAWAS WTE PROJECT (2× 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-06 TURBINE GENERATOR AND AUXILIARIES	PAGE 12 OF 28

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	(c) Provision of air evacuation pumps: Condenser to be designed for minimum air leakage and under normal operating conditions, the air leakage in condenser not to exceed more than 50% of design value taken for sizing of vacuum pumps. (d) Suitable for (site specific) ambient air conditions. (e) Suitable lifting/handling arrangement shall be provided for Air Cooled Condenser and its all associated systems. (f) The supplier to provide all galleries, crawl beams, platforms, handrails, ladders necessary for safe and efficient access to the fan deck and other equipments for erection, Operation & Maintenance (g) Provision for leakage testing of ACC and associated system along with blanking arrangement. (h) Stand pipes with necessary connections for instruments, with water level gauges and isolation valves. (i) ACC shall include : i. Condenser modules, finned heat exchanger tube bundles, steam and condensate collection header. ii. Complete air moving system incl. fans, speed reducer, couplings, electric motors, fan support bridges and equipment required for safe operation. iii. Steam distributing system from steam turbine outlet to the ACC unit including main steam duct, steam distribution manifold, steam header, as defined elsewhere in the specification. iv. Condensate tank including connections for make up water with condensate strainer, standpipe, manholes, nozzles connection, insulation, hand railing etc. v. Connections for Steam turbine bypass connections. vi. Fin tube cleaning system of semi-automatic type as per HEI is to be provided. The fin tube bundles shall be cleaned using high pressure water. Cooling fins shall be designed to withstand the cooling water jet pressure. vii. Necessary vacuum breaker valves and provision of rupture devices as per HEI. viii. Provisions for accommodating expansion and contraction with changes in thermal load. ix. Painting of all exposed parts of ACC and structure shall be as specified elsewhere in the specification.			
KAWAS WTE PROJECT (2× 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-06 TURBINE GENERATOR AND AUXILIARIES	PAGE 13 OF 28

CLAUSE NO.	TECHNICAL REQUIREMENTS		
2.02.00	xv. Provision for isolating the individual street (from steam, condensate and air evacuation side) for maintenance purpose while unit is on load.		
	Design requirement:		
	(a)	The ACC is to be designed to sustain and operate in all climatic conditions, max./min ambient temperature and effects of wind excess without damage.	
	(b)	The ACC shall be designed taking into account the environmental conditions and seismic conditions.	
	(c)	Corrosion allowance shall be as per HEI.	
	(d)	The inlets to each fan shall be protected with a screen capable of preventing objects/foreign materials.	
	(e)	Design for full vacuum and min. internal pressure 0.5 bar (g). Minimum shell side design temperature 121 deg. C. It should not be less than the maximum pressure and temperature which the ACC may be exposed to during transient conditions.	
	(f)	Steam dumping device to accept the steam from turbine bypass with necessary spray water including abnormal conditions.	
	(g)	Design for exhaust steam from steam turbine, turbine bypass system, boiler drains (if any) during start up, low load and abnormal conditions and other miscellaneous drains.	
	(h)	Bidder to also consider exhaust steam quality and back pressure, Site meteorological data, site topography, maximum height limitations and compact layout for Air Cooled Condenser Design.	
2.03.00	(i) The gearbox shall be designed as per AGMA and design life of the gearbox shall be 100 000 hours. Gear box shall be designed for continuous operation. All the bearings in the gearbox shall be designed for a life of 100,000 hours. Gear box shall have self-contained lubrication arrangement of sump oil / oil pump type as per standard practice of the bidder. All couplings shall be as per standard practice of the bidder.		
	2.04.00		
Leakage Testing as per HEI			
Table-A			
1.Condenser Design Parameters:			
(i)	Design pressure	to be optimised by the bidder in the range of 120 to 135 mm of hg	
KAWAS WTE PROJECT (2× 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-06 TURBINE GENERATOR AND AUXILIARIES
		PAGE 14 OF 28	

CLAUSE NO.	TECHNICAL REQUIREMENTS एनटीपीसी NTPC		
2.05.00	(ii)	Design ambient temperature	40 Deg C
	(iii)	Ambient temperature corresponding to worst vacuum	45 Deg C
	(iv)	Tube type and material	As per standard practice of the bidder
	(v)	Fouling Resistance	As per HEI
	(vi)	Margin on heat transfer area	5% Margin over steam flow corresponding to output under rated steam conditions, 3% makeup at design ambient temperature and design condenser pressure.
	(vii)	Wind velocity	5.0m/s (any direction)
	(vii)	Air Cooled Condenser (ACC) design pressure	Full vacuum and 0.5 bar(g)
	(vii)	Minimum ACC design temperature	121 deg.C
	2. Condenser air evacuation system design parameters		
	(i)	Source of vacuum pump heat exchanger cooling water	ACW system
	(ii)	Source of sealing water	Condensate
	(iii)	Source of make-up water	Condensate
	(iv)	Design Pressure(cooling water side) for vacuum pump	Vacuum(0.1 kg/cm2(abs) heat exchanger & as per ACW system design pressure
	(v)	Pressure of make-up water	CEP discharge pressure
	(vi)	Maximum temperature of cooling water	3 deg C above design cold water temp.
	(vii)	Duty code	HEI (latest)
	(viii)	Design back pressure	25.4 mm(1 inch) of Hg (abs)
	Operational requirement: (a) Steam dumping device for dumping of desuperheated steam from turbine bypass along with all accessories and instrumentation. (b) Provision for maximum deaeration and removal of non-condensable gases from steam and make-up water. Air removal section to be suitably baffled to prevent water carryover.		
KAWAS WTE PROJECT (2× 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-06 TURBINE GENERATOR AND AUXILIARIES PAGE 15 OF 28

CLAUSE NO.	TECHNICAL REQUIREMENTS			
2.06.00	Type test(s) to be conducted: Following type tests are to be carried out for the metallic expansion joint between turbine and air cooled condenser : i) Life cycle test, meridional yield rupture test and squirm test on metallic expansion joint(s) of each type and size in steam duct between turbine and air cooled condenser. For life cycle test, minimum number of test cycle shall be 10,000. In case metallic expansion joint size is more than 3 m diameter, then the type test shall be conducted on scaled down model keeping same thickness, no of convolution, convolution pitch, etc.			
2.07.00	CONDENSER AIR EVACUATION PUMPS i) The unit shall consist of 2x100% vacuum pumps for holding operation and one (01) start up hogging pump with all accessories and instrumentation for condenser air evacuation. Pumps shall be sized as per latest HEI requirements. Capacity of each pump in free dry air at standard condition with condenser operating at design pressure of 1 inch (25.4 mm) of Hg (abs) and sub cooled to 4.17 deg.C below temperature corresponding to absolute suction pressure shall be suitable for the intended application. Vacuum pump capacity in SCFM shall be under standard condition i.e. 760 mm Hg (abs) and 21.1 deg C. ii) All three pumps running together should be able to bring condenser pressure from atmospheric pressure to 10 inch of Hg (abs) in 30 minutes. (a) Single/two stage liquid ring type with both stages (if two stage pumps provided) mounted on a common shaft. (b) Each pump and its accessories shall be mounted on common steel base plate. Pump shall be connected to motor by flexible coupling. (c) The stand-by pump shall cut in automatically in case running pump fails or when condenser pressure falls back to a preset value. (d) No cavitation under all operating conditions without air ejector. (e) Noise levels should not exceed limitations as specified in Section of General Technical Requirements and vibration levels shall be Zone A of ISO 10816.			
2.08.00	Type Test(s) to be Conducted Following type tests are to be carried out on one vacuum pump.			
KAWAS WTE PROJECT (2× 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-06 TURBINE GENERATOR AND AUXILIARIES	PAGE 16 OF 28

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	(i)	Cavitation test		
	(ii)	Wet air test		
3.00.00	CONDENSATE EXTRACTION PUMP			
3.01.00	i)	Pump sizing		
	a)	Design Capacity:		
		Capacity of 1X100% condensate extraction pumps to be based on 15% margin over highest Condensate flow envisaged during unit operation (excluding turbine bypass operation).		
		Design Head:		
		Corresponding to above considering 10% margin over deaerator pressure.		
	b)	Best efficiency point:		
		Capacity of 1X100% CEP shall be based on TG unit EMCR and corresponding head. Best efficiency point of the selected pump shall be preferably corresponding to above point.		
	ii)	Motor Rating:		
		Motor rating at 50 deg.C ambient temperature shall not be less than the maximum load demand of its driven equipment in its entire operation at frequency variations from 47.5Hz to 51.5Hz and motor shall not be overloaded during any mode of operation of driven equipment.		
3.02.00	(a)	Configuration:		
		2 X 100 % Condensate extraction pumps per unit.		
	(b)	Drive		
		Constant speed squirrel cage induction motor with speed of 1500 rpm (synchronous)		
	(c)	Constructional Requirements		
		Vertical, Multistage, Canister type, Centrifugal, diffuser type with double suction first stage impeller. Alternatively Horizontal, Multistage, Centrifugal, diffuser type with double suction first stage impeller.		
	(d)	Shaft sealing		
		Either mechanical seals or packed type with external water sealing designed to prevent air ingress to condenser even when the pump under shut down and exposed to condenser.		
KAWAS WTE PROJECT (2× 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9		SUB SECTION-A-06 TURBINE GENERATOR AND AUXILIARIES
PAGE 17 OF 28				

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	(e)End Connections Discharge and suction connection of weld neck type, raised steel flange as per ANSI B. 16.5 and to be located above floor mounting flange. (f)Thrust Bearing Thrust bearing for the combined thrust load of pump and motor with a rigid coupling between pump and motor or individual thrust bearings for pump and motor with a flexible coupling between motor and pump. (g)NPSH Margin NPSH (R) at 3% head drop shall not be more than half the NPSH(A) at design flow with low-low hotwell level and NPSH(R) at 3% head break shall be well below NPSH(A) under all conditions. (h)Motor bottom level Bottom of motor to be above zero meter by suitably considering the pit level and motor stool dimensions. (i)Minimum recirculation flow Common recirculation line for CEP shall be provided. (j)Performance curve Characteristic curve of pumps should be continuously rising type with decrease in flow and shut off head shall be between 115% to 130% of TDH at design point. (k)Critical Speed First critical speed in water shall not be within 20% of design speed. (l)First stage impeller life Life due to wear due to Cavitation of first stage Impeller not less than 40,000 running hours. (m)Peripheral speed at the eye of the impeller Not to exceed 20m/sec. (n)Suction specific speed Suction specific speed of first stage impeller not to exceed 11,000 U.S. units based on 3% head break of that impeller at design point. (o)Interchangeability Complete interchangeability in all respects of the pumps and their components. (p)Design Pressure			
KAWAS WTE PROJECT (2× 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-06 TURBINE GENERATOR AND AUXILIARIES	PAGE 18 OF 28

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	(1)Bowls and discharge components design pressure shall correspond to shut off head at 51.5 Hz and operating specific gravity and maximum suction condition. (2)Suction components shall be designed for 8 ata and full vacuum. (q)The pump internals to be capable of being lifted out of casing after removal of motor and disconnecting discharge flange but not disturbing the discharge piping. (r)Applicable Code HIS (Latest Edition)			
4.00.00	DEAERATOR			
4.01.00	The deaerator shall be designed such that maximum oxygen content shall be 0.005 cc/litre at deaerator outlet measured as per ASTM D5543-09 or Indigo Carmine method at all operating conditions. Based on 6 (six) minutes of BMCR flow (approx.) between normal operating level and low-low level with a filling factor of 0.66. This capacity shall be exclusive of the volume of internal piping, baffles and volume of the dished end. It shall be designed for maximum incoming steam flow when working under turbine bypass condition. Low-low level from bottom of the vessel shall not be less than 200 mm.			
4.02.00	(a)Horizontal, Spray-cum-tray with integral direct contact vent condenser mounted on horizontal storage tank. (b)Alternatively, Spray type STORK or Equivalent with minimum two (2) spray control valves of disc type or equivalent, in order to ensure fine atomisation of incoming condensate and rapid heating up by the steam. In case spray type Deaerator is provided, Bidders to provide cladding on internal surfaces of storage tank and/or stainless steel vessels to meet HEI requirements. (c)Design and construction as per Indian Boiler Regulations (if applicable), ASME code for unfired pressure vessels, Section-VIII or any other equivalent code. (d)Reinforced wide mesh strainer and antivortex baffles at discharge connections from deaerator. (e)All pressure parts like shell, heads and nozzles shall be of carbon steel as per ASTM A-516 Gr. 70. Shell plate min. thickness 15.8mm of welded construction. (f)Hardened 400 series stainless steel impingement plates for flashed drain inlet from HP heaters, BFP recirculation, boiler startup drains etc.			
KAWAS WTE PROJECT (2× 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-06 TURBINE GENERATOR AND AUXILIARIES	PAGE 19 OF 28

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	(g) All water spray valves, splash plates, trays, vent condenser and other elements in contact with undeaerated water or non-condensable gases shall be of stainless steel SS-304 or SS-410. (h) Floating pressure type. Deaerator pegging pressure during cold, warm, hot startup and during turbine bypass operation, shall be as optimized by the bidder and shall be suitable to ensure required deaeration and water quality required for boiler. The optimised pressure should be same during warm, hot startup conditions and bypass operation. Deaerator pressure shall vary with load when it gets steam from turbine extraction. Design pressure & temp. shall not be less than extraction pressure or worst operating condition with sufficient margins above the same. (i) Sources for heating: (1) Extraction steam from turbine (normal operation) as optimized by the bidder. (2) Steam from an Auxiliary steam header till extraction steam (normal source) pressure is available. Such auxiliary steam header should necessarily be connected to a source upstream of MS stop valves of same unit and suitably interconnected with the other unit(s). (j) Design to withstand full vacuum and pressure decay. (k) Shell thickness corrosion allowance 3.2 mm. (l) Size of vent orifice for one half percent of TMCR extraction steam flow to deaerator (m) Provision of access platforms and ladders along with hand rails on deaerator and storage tank. Provision of manholes of 450 mm dia (min) on deaerator and storage tank for access to and removal of internals including trays.			
5.00.00	BOILER FEED PUMP			
5.01.00	Pump sizing 1) Design capacity and design head: Capacity of 1x100% boiler feed pump to be based on 10% margin over feed flow corresponding to turbine V.W.O condition, 3% makeup, design condenser pressure and corresponding head. In case continuous overpressure operation of unit is envisaged then the capability of pump for such an operation shall be verified. 2) Best efficiency point:			
KAWAS WTE PROJECT (2× 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-06 TURBINE GENERATOR AND AUXILIARIES	PAGE 20 OF 28

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
5.02.00	Capacity of 1x100% BFP shall be based on TG unit EMCR and corresponding head.			
	3) Emergency point:			
	One boiler feed pump to be capable of generating the discharge pressure not less than steam generator highest safety valve set pressure corresponding to 105% of boiler maximum continuous rating (at 0% make up).			
	(a)	Configuration	2 x 100 % Motor driven feed pump per unit.	
	(b)	Drives	Constant speed squirrel cage induction motor with hydraulic coupling between motor and main pump.	
	(c)	Construction Requirements	Horizontal, centrifugal type, multistage, outer casing barrel type with end rotor removal.	
	(d)	Shaft Sealing	Mechanical seals for boiler feed pump.	
	(e)	NPSH Margin	The ratio between NPSH (A) and NPSH (R) at 3% head drop for boiler feed pump shall be not less than 1.5 at design point corresponding to Low-Low level of deaerator.	
	(f)	Performance curve	The characteristic curves of pump should be continuously rising type with decrease in flow and shut off head shall be in the range of 115% to 130% of TDH at design point.	
	(g)	Minimum recirculation	(1) The minimum flow of the pump shall not be less than 25% of design flow. (2) Minimum recirculation valve with valve body designed for 40% of design flow. (3) Seat tightness of recirculation valve shall conform to MSS SP61.	
(h)	Inter-changeability			
KAWAS WTE PROJECT (2× 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-06 TURBINE GENERATOR AND AUXILIARIES	PAGE 21 OF 28

CLAUSE NO.	TECHNICAL REQUIREMENTS			
5.03.00	Identical design of boiler feed pumps, motors, hydraulic coupling and major equipment in order to provide complete interchangeability.			
	(i)	Motor drive start up time		
	Motor shall be able to accelerate the pumps from standby conditions to rated pumping conditions in less than 15 seconds after receipt of starting signal while operating either singly or in parallel with other operating pump. BFP and associated auxiliaries to be designed for auto startup on failure of running equipment/auxiliaries.			
	(j)	BFP lube oil system		
	Common lubricating oil system for BFP, motor and hydraulic coupling complete with shaft driven lube oil pump, AC motor driven auxiliary oil pump, working oil cooler / lube oil cooler / oil filters / strainers, valves, fittings, instruments etc.			
	(k)	Critical speed		
	The first critical speed in water with internal clearance 150% of new clearance shall be more than 130% of design speed.			
	(l)	Dry running		
	Capable of accepting complete loss of water due to incidents such as inadvertent complete closure of suction valve and brought down to rest in controlled manner from design condition with simultaneous closure of suction valve.			
	(m)	First stage suction specific speed		
Not in excess of 8000 (US units) based on 3% head break down of that impeller of pump at design point.				
(n)	Casing design pressure			
TDH at minimum flow and maximum pump speed at 51.5 Hz for BFP under lowest operating density plus maximum suction pressure.				
(o)	Thrust bearing			
Two times the worst thrust under maximum speed of BFP, pump at shut off head and internal clearances 200% of new clearance. Thrust bearing should be suitable for reverse rotation.				
(p)	Applicable Code	:	HIS (latest edition)	
	Operational and maintenance requirement:			
(a)	Warm up arrangement			
KAWAS WTE PROJECT (2× 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9		SUB SECTION-A-06 TURBINE GENERATOR AND AUXILIARIES
PAGE 22 OF 28				

CLAUSE NO.	TECHNICAL REQUIREMENTS			
5.04.00	Suitable warm up arrangement (if required) to start the pump rapidly shall be provided. However, pump should preferably be capable of starting from any conditions without having any warm up in emergency.			
	(b) Emergency Lubrication of BFP			
	Pressure lubrication (if necessary) of BFP at the time of coasting down of the boiler feed pump set in the event of AC power failure shall be arranged by Bidder.			
	(c) Handling arrangement			
	BFPs to be accessible to Turbine hall EOT crane for their erection and maintenance.			
	Mechanical Seals			
	(a) Type : Fully cartridge design.			
	(b) Seal face Materials : Not inferior to rotating silicon Carbide and Stationary Carbon seal face combination.			
	(c) Life : Not less than 20,000 running hours between overhauls and having dry running withstand capability as specified.			
	(d) Supporting system			
5.05.00	Each seal to be provided with 2x100% magnetic filters, 2x100% tubular coolers, Piping, Valves, Control and instrumentation etc. Each cooler to be designed with margin of 20% over worst condition of heat generated in seals. Further in case of AC power failure, seal should be able to withstand without cooling water.			
	HYDRAULIC COUPLING			
	(1) Type			
	Combined fluid Coupling/Gear box type, Electric actuator and linkages alongwith necessary amplifier units.			
	(2) Rating			
Adequately rated to meet the requirement of pump characteristics while operating in the range of capacities specified.				
(3) Material and other accessories				
KAWAS WTE PROJECT (2× 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9		SUB SECTION-A-06 TURBINE GENERATOR AND AUXILIARIES
PAGE 23 OF 28				

CLAUSE NO.	TECHNICAL REQUIREMENTS		
5.06.00	Complete with stainless steel impellers, bearings, pillow blocks and Kingsbury or Mitchell thrust bearing or proven thrust bearing as per bidder's standard practice for input/output with removable Covers, oil sump, duplex filters to remove all particles upto 25 microns, oil temperature and pressure gauges, Control pump for oil regulation if provided, regulating Valves, stainless steel scoop tube, 1x100% lube oil cooler, 1x100% Working oil cooler, one portable type oil purifier of adequate capacity to be included to form the centralized lubrication system for BFP set. Material for oil cooler: Tubes of type 304 stainless steel and shell of mild steel construction. Suitable Corrosion allowance shall be added to all carbon steel and iron parts including shell, flanges etc. If plate heat exchanger type oil cooler is provided, plate material shall be SS 316 and material of other components shall be compatible for the application. Type Test(s) to be conducted Following type tests to be carried out; (i) NPSH (R) Test on one BFP (ii) Dry running withstand capability test on one BFP (iii) Complete strip down test of BFP which undergone above tests Bidder to ensure that after the type test, the pump is properly cleaned and dried , so that during transportation there is no damage/rusting in the pump.		
	6.00.00	EOT CRANES	
	6.01.00	TURBINE HALL EOT CRANE:	
	(i) RATING		
	(a) Capacity	One (1) number of Electrically operated overhead travelling cranes of single/double girder type shall be provided.	
		EOT crane shall be capable of lifting at least 105% of the weight of single heaviest component/ equipment, including lifting beam and slings etc. (as applicable) to be handled in TG hall for erection as well as maintenance of the equipment provided in AB bay.	
	(b) Auxiliary Hoist Capacity	Not less than 3 Tonne	
	(c) Crane span	To suit the span of turbine hall	
KAWAS WTE PROJECT (2× 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-06 TURBINE GENERATOR AND AUXILIARIES
		PAGE 24 OF 28	

CLAUSE NO.	एनटीपीसी NTPC TECHNICAL REQUIREMENTS		
	(i.e. centre to centre of rail tracks) (d) Total height of crane Top most level of crane w.r.t. the top of runway rail level shall be approximately 4.5m (e) Main/Aux. hook levels (Above operating floor level & below ground floor level) To suit handling requirements of equipment (f) Top of Rail Elevation To be confirmed by the vendor (g) Creep speed of main hook and auxiliary hook 10% of max. speed (ii) Type Single/double girder type Electrically operated indoor travelling. (iii) Applicable codes (a) Design and duty of crane structure, main hoist, auxiliary hoist, cross travel, long travel in accordance with class M5 of IS: 3177 (latest edition). (b) All other structure of cranes in accordance with IS-807. (iv) Buffer (a) Suitable buffer to be fitted to each end of carriage assembly and crab. (b) Buffers to be designed to bring the loaded crane to rest from a speed of 50% of the rated speed. (v) Operator's cabin and platform (a) Open type for indoor service to be located at B-row column. Cabin shall be designed as per IS3177 so as to have unrestrictive view of load from operator's cabin.		
KAWAS WTE PROJECT (2× 350 TPD) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-06 TURBINE GENERATOR AND AUXILIARIES	PAGE 25 OF 28

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	(b) A foot operated electric warning horn of double bell type suitable for 240 V AC. of noise level 95 dBA at 3.5 m. (c) One brass gong suspended outside the Cabin and operated from inside. (d) A distinct type alarm with conspicuous warning lights on either side of the crane bridge to indicate overloading of crane. (vi) Safety (a) To meet the requirements of Factories Act. (vii) Over load test ,travel and hoist speed checks etc. shall be demonstrated as per IS 3177 (latest edition)			
7.00.00	PRECOMMISSIONING ACTIVITIES The pre-commissioning activities including some of the important checks & tests for certain major equipment/ systems are mentioned under respective equipments, although it is the Contractor's responsibility to draw up a detailed sequential & systematic list of checks / tests and various activities / procedures connected with pre-commissioning of the complete facilities with all systems, sub-systems and equipment supplied and installed by him and get the same approved by the Employer.			
8.00.00	COMMISSIONING OF FACILITIES Upon completion of pre-commissioning activities/test the Contractor shall initiate commissioning of facilities. During commissioning the Contractor shall carryout system checking and reliability trials on various parts of the facilities. Contractor shall carry out these checks/tests at site to prove to the Employer that each equipment of the supply complies with requirements stipulated and is installed in accordance with requirements specified. Before the plant is put into initial operation the Contractor shall be required to conduct test to demonstrate to the Employer that each item of the plant is capable of correctly performing the functions for which it was specified and its performance, parameters etc. are as per the specified/approved values. These tests may be conducted concurrently with those required under commissioning sequence.			
09.00.00	NOISE LEVEL In case the noise level pertaining to equipments covered under the scope exceeds the specified values, as given in relevant clause of General Technical requirement portion of Technical Specification, suitable acoustic enclosures alongwith all accessories in order to			
KAWAS WTE PROJECT (2× 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-06 TURBINE GENERATOR AND AUXILIARIES	PAGE 26 OF 28

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	complete the system shall be provided to achieve the specified values. The acoustic enclosures & accessories shall be designed as per internationally accepted standards and shall be subject to Employer's approval.			
10.00.00	INSULATION (a) Bidder shall provide insulation for all equipments, valves, piping etc. with surface temperature more than 60°C. The insulation and sheet covering should be so designed and erected as to provide easy accessibility to parts requiring frequent inspection. (b) The density of the mineral fiber felt shall be carefully controlled at about 200 kg/m³ and the thermal conductivity of mineral wool shall be 0.052kcal/m. hr. °C at mean temperature. (c) The mineral wool shall be capable of passing standard combustibility test, both immediately after application and also after being subjected to its maximum operating temperature for not less than 100 hours. The mineral wool shall be free from objectionable odour at the ambient conditions in which it is used. The mineral wool shall not contain substances, which will support pests or encourage growth of fungi. The mineral wool shall not suffer permanent deterioration as a result of contact with moisture due to condensation. The mineral wool shall not suffer quality deterioration under the specified conditions of use. In this connection, both hot and cold face temperatures are relevant. The mineral wool shall be capable of being applied to the surface concerned without causing corrosion of the surface being insulated or the cladding on it under normal site conditions. (d) The temperature difference between the cold face of finished insulation and ambient shall not be more than 20°C. The ambient temperature shall be considered as 40°C.			
12.00.00	All stand-by turbine auxiliaries shall be designed for auto start up, on failure of running auxiliaries with minimum time delay and without runback on unit load.			
12.01.00	Adequate maintenance facilities shall be provided as required for assembly, disassembly, alignment work particularly in respect of turbine casing, inner and outer casings, diaphragm glands, steam valves, journal bearings, thrust bearings, turbine rotors, generator rotor, particularly end rings, shaft seals, generator bearings, hydrogen coolers, condenser waterbox , vacuum pumps, condensate extraction pumps and boiler feed pump catridges, , regenerative feed heaters, turbine oil coolers and pumps, etc. The offer shall give details like components requiring replacement or repairs during the life cycle of the plant, meantime between failures and list of tasks to be carried out during major overhauls.			
13.00.00	PAINTING			
KAWAS WTE PROJECT (2× 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-06 TURBINE GENERATOR AND AUXILIARIES	PAGE 27 OF 28

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	a) All un-insulated equipments, pipes, valves etc covered in this sub-section shall be painted with paint not inferior to Epoxy resin based paints with minimum DFT of 150 micron. The paint shall be applied in three stages i.e primer, intermediate and finish coats in following manner. ➤ Primer coat -Epoxy based Zinc phosphate ➤ Intermediate- Epoxy based TiO2 pigmented coat ➤ Finish Coat- Epoxy based Finish coat/ Two pack polyurethane coat. b) Equipment, pipes etc. with high temperature shall be painted with Heat Resistant Aluminium Paint (to be selected based on the service condition of component as per IS-13183). Two coats of paint shall be applied with total DFT 40 microns. c) Surface Preparation before painting shall be carried out according to requirement indicated in other chapter of the technical specification and international standard.			
14.00.00	TYPE TESTS			
14.01.01	The contractor shall carry out the type tests as listed in the "TYPE TEST(S) TO BE CONDUCTED" on the equipment mentioned therein. The Bidder shall indicate the charges for each of these type tests separately in the relevant schedule of BPS and the same shall be considered for the evaluation of the Bids. The type test charges shall be paid only for the test(s) actually conducted successfully under this contract and upon certification by the Employer's Engineer.			
14.01.02	The type tests shall be carried out in presence of the Employer's representative, for which minimum 15 days notice shall be given by the Contractor. The Contractor shall obtain the Employer's approval for the type test procedure before conducting the type test. The type test procedure shall clearly specify the test set-up, instruments to be used, procedure, acceptance norms, recording of different parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out.			
14.01.03	Irrespective of the requirement of conducting the type tests under this contract, the Contractor shall submit the reports of the type tests listed in the "TYPE TEST(S) TO BE CONDUCTED" and carried out within last five years from the date of bid opening. These reports should be for the tests conducted on the equipment same (model / type / size / rating) to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. The Employer reserves the right to waive conducting of any or all of the specified type tests under this contract, in which case the type test charges shall not be payable for the type tests waived by the Employer.			
KAWAS WTE PROJECT (2× 350 TPD) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-06 TURBINE GENERATOR AND AUXILIARIES	PAGE 28 OF 28	

SUB-SECTION–A-07

POWER CYCLE PIPING

CLAUSE NO.
TECHNICAL REQUIREMENTS
POWER CYCLE PIPING
1.00.00
SIZING CRITERIA
1.01.00
GENERAL

- (a.) The design, Engineering, fabrication, erection, testing & commissioning etc. of the complete piping systems shall be to the requirements of power piping code ASME 31.1 (latest edition). In addition to this, requirements as laid down in Indian Boiler Regulations (latest edition) shall also be met completely for piping systems under the purview of IBR.
- (b.) All the piping systems and equipment supplied shall be designed to operate without replacement and with normal maintenance for a plant service life of not less than twenty five (25) years and shall withstand the operating parameter fluctuations and cycling which can be normally expected during this period.

1.02.00
PIPE SIZING

- (a.) Pipe shall be sized for the flow requirements corresponding to the worst (i.e. maximum - flow, temperature and pressure values) operating conditions for each system. The velocity limits for calculating the inside diameters are listed below:

(b.)	Main steam Piping	76 M/sec
	Turbine bypass Piping	100 M/sec
	Feed Water Suction	2.0-3.0 M/sec
	Feed water Discharge	4.0-6.0 M/sec
	Extraction steam-Super heated (if applicable)	60 M/sec
	Extraction steam-Saturated (if applicable)	30 M/sec
	Condensate suction	1.5 M/sec
	Condensate discharge	3.0-5.0 M/sec
	Other piping	As per good engg. Practice

inside diameters thus calculated for various piping systems shall be checked for the allowable pressure drop for the system.

- (c.) Pressure drop in main steam line shall not be more than 90% of the allowable pressure differential between superheater outlet header and turbine inlet valves at BMCR.

1.03.00
DESIGN PARAMETER SELECTION:

- (a.) Design parameters shall be selected based on the provisions of latest editions of ASME B31.1 and IBR 1950 with sufficient margin as per good engineering practice. While selecting the design parameters, due consideration shall be given to the maximum occasional pressure and temperature variations expected in each system during its service. However, notwithstanding anything contained in these codes, standard & regulations, following specific requirement shall also be met.
- (b.) The design pressure of MS piping system from super heater outlet header up to turbine stop valve shall not be less than the design pressure of final Super heater outlet header.
- (c.) The design pressure for BFP discharge piping up to and including last block valve at downstream of feed regulating station (FRS) shall be pressure corresponding to Motor driven BFP trip speed (frequency 51.5Hz) at shut off head flow condition.

CLAUSE NO.	TECHNICAL REQUIREMENTS		
	(d.) The design pressure of complete feed water discharge piping system from last block valve downstream of feed regulating station (FRS) shall be at least 1.05 times the maximum operating pressure at BFP discharge nozzle or as required by IBR/ASME/other international codes whichever is higher (e) The design pressure and temperature, down-stream of any pressure reducing valve up to and including the first block valve shall be the same as that at up-stream of pressure reducing valve. (f) The piping at downstream of de-super heater shall be designed for spray failure condition. Selection of design temperature shall be derived from equivalent enthalpy method between upstream and downstream points of de-superheater at spray failure condition. The minimum length of piping considered for spray failure condition at downstream of de-super heater shall not be less than the length required for proper mixing & evaporation of spray water as recommended by respective de-super heater supplier. First bend down stream of any de-superheater shall be provided only after de-superheater manufacturer recommended minimum required straight pipe length for proper mixing of spray water with steam. (g) Complete boiler feed pump recirculation piping up-to deaerator nozzle shall be designed for full pump shut off head pressure.		
1.04.00	MATERIAL SELECTION: Piping system shall be of carbon steel for design temperature up to & including 400 deg. C and alloy steel for design temperature above 400 deg. C.		
1.05.00	PIPE WALL THICKNESS: For IBR piping, straight pipe thickness calculation shall be as per ASME B31.1 & IBR and higher value of the two calculations (after adding manufacturing tolerance) shall then be selected from standard thickness schedules (e.g. Sch.-40, Sch-80, etc) as contained in ASME B36.10 for OD controlled pipes and from manufactures' thickness schedules for ID controlled pipes . For Non-IBR piping, thickness calculation shall be made as per ASME B31.1. To Account for losses due to corrosion, erosion etc. during the plant service life, an allowance of 1.6 mm/0.75mm shall be considered in the minimum wall thickness calculation of pipes (both alloy steel & carbon steel) as per ASME B31.1/IBR respectively.		
1.06.00	END CONNECTIONS : Pipes, fittings & valves in power cycle piping systems shall in general be provided with butt welding ends as per ANSI B 16.25 for sizes 65NB & above and socket welding ends as per ANSI B 16.11 for 50NB & below. However, in certain cases specific edge preparation on pipe welding end may be required to be done to match equipment terminals, valves, specialties, connection to flanges, etc.		
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI ,PART-B Bidding Doc No. CS-2600-001-9	SUB SECTION –A-07 Power Cycle Piping Page 2 of 5

CLAUSE NO.

TECHNICAL REQUIREMENTS

1.07.00

SPECIFICATION FOR PIPES & FITTINGS :

	Alloy Steel	Carbon Steel
A. PIPES		
a) Material	ASTM A335 Gr.P22 / P11	ASTM 106 Gr. B/ ASTM 106 Gr.C
b)Construction	Seamless	Seamless
B. FITTINGS		
a) Material for sizes above 50NB	ASTM A234GR. WP22 / WP11	ASTM A234 Gr. WPB with A 106 Gr. B piping and ASTM A234 Gr. WPC for A106 Gr. C piping.
b) Material for sizes 50 NB and below	ASTM A182 Gr. F22 / F11	ASTM A105
d) Construction	Seamless	Seamless

NOTES: Piping system shall be of carbon steel (i.e. A 106 Gr.B / Gr.C) for design temperature up to & including 400 deg. C and alloy steel (i.e. A335 P11 / P22) for design temperature up to & including 510 deg. C.

1.08.00

SPECIFICATION FOR VALVES:

Sl. No	Description	Valve size ≤ 50 NB			Valve size > 50 NB		
		Carbon steel	Alloy Steel	Stainless steel	Carbon steel	Alloy Steel	Stainless steel
1	Body Material	A105	A182 F11/F22	A182 F316/F304	A216 WCB/WCC or A105	A217 WC6 or A182 F11/F22	A351 CF8/CF8M or A182 F316/F304
2	Construction	Forged			Casting or Forged		
3	Manufacturing Standard	ANSI B16.34 or equivalent.					
4	Materials for Internals	Suitable to with stand design parameters & Service conditions.					

NOTES:

- Valves shall be tested in accordance to ANSI B 16.34. And Valve closure test shall be as per ANSI B16.34 and MSS-SP-61.
- Valves 50NB and below shall be globe type unless otherwise specified elsewhere.

1.09.00

STRESS ANALYSIS:

- Flexibility/stress analysis for power cycle piping systems shall be as per the requirement of ASME B31.1/IBR.
- Cold pulling is not permitted. The contractor shall so design the piping systems that there will be no requirements of cold pulling for meeting allowable reaction/stress values.

1.10.00

DRAINS & VENTS:

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	1) Vents shall be provided at all high points & drains at all low points in piping system. Provisions of drains on steam piping shall be as per ASME code TDP-1. However, Minimum bore /ID of drain piping shall not be less than 19mm. 2) All drain, vent, air release, sampling and instrument root lines in piping system with design pressure 40 Kg/cm2 (g) and above or with temperature above 350 deg.C or with vacuum service shall be provided with two(2) valves in series (i.e. double valved).			
1.11.00	HYDROSTATIC TEST OF PIPES (IBR & NON-IBR): Hydro test for power cycle piping systems shall be as per the requirement of ASME B31.1/IBR.			
1.12.00	SPECIFIC REQUIREMENTS: PIPES AND FITTINGS 1. Manufacturing tolerances on pipe diameter and thickness shall be as per ASTM A-530/ A999M, as applicable. 2. Bend thinning allowance shall be provided for all bends as per the recommendations of ASME B 31.1. However, bidder/contractor shall ensure that the minimum wall thickness at any point in the finished bend shall not be less than the calculated minimum straight pipe wall thickness. 3. Elbows shall be generally of long radius type. 4. Wherever ASTM 106 Gr. B/Gr. C or A - 105 material are used the maximum carbon content shall be limited to 0.30% (Max.).			
1.13.00	SPECIFIC REQUIREMENTS: VALVES AND SPECIALITIES 1) Manual gear operators shall be provided to open/close the valve against the maximum differential pressure across the valve such that the effort required to operate the valve does not exceed 35 kgf. 2) All gate, and globe valves of size 50 mm and below in vacuum service shall have extra deep gland packing without requiring water gland sealing. All gate and globe valves of size 65 mm Nb and above in vacuum services shall have adequately deep gland packing and shall be equipped with lantern rings to admit pressurized water for gland sealing.			
1.14.00	STEAM TRAPS AND STRAINERS Steam traps shall be of inverted bucket/thermo static type with integral or separate Y-type strainers. All Y-type strainers shall have stainless steel screen of not more than 20 mesh size. Screen open area shall be at least four (4) times the pipe cross sectional area. Traps shall have stainless steel internals.			
2.00.00	SPECIFICATION FOR HANGERS/SUPPORTS			
2.01.00	Design, selection and Manufacture of Hangers/Supports shall conform to ASME B 31.1, MSS-SP-58, MSS-SP-89.			
2.02.00	SPRING HANGERS			
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI ,PART-B Bidding Doc No. CS-2600-001-9	SUB SECTION –A-07 Power Cycle Piping	Page 4 of 5

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	(a.) Constant load hangers shall generally be used when vertical displacement exceeds 40 mm or where the supporting effort variation of available variable spring exceeds 25%. (b.) Variable spring hangers shall have supporting effort variation of not more than 25% throughout the total travel range. (c.) Spring hangers shall be adjusted to the cold position before shipment and locked in that position. The cold and hot position shall be clearly marked on the travel indicator scales.			
3.00.00	THERMAL INSULATION:			
	Refer to Sub Section A-11 for thermal insulation on Power Cycle Piping.			
4.00.00	SPECIFICATION OF SURFACE PREPARATION & PAINTING:			
	Refer to Sub Section A-10 for specification of surface preparation & painting of Power Cycle Piping.			
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI ,PART-B Bidding Doc No. CS-2600-001-9	SUB SECTION –A-07 Power Cycle Piping	Page 5 of 5

SUB-SECTION–A-08

LOW PRESSURE PIPING

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC																																					
	<u>LOW PRESSURE PIPING</u>																																								
1.00.00	EQUIPMENT SIZING CRITERIA																																								
1.01.00	For all Low Pressure piping systems covered under this specification, sizing and system design shall be to the requirements of relevant codes and standard indicated. In addition to this, requirements of any statutory code as applicable shall also be taken into consideration.																																								
1.02.00	Inside diameters of piping shall be calculated for the flow requirements of various systems. The velocities for calculating the inside diameters shall be limited to the following: a) Water Application <table><thead><tr><th colspan="2"></th><th colspan="3">Water Velocity in m/sec</th></tr><tr><th></th><th>Pipe Size</th><th>Below 50 mm</th><th>50-150 mm</th><th>200 mm & above</th></tr></thead><tbody><tr><td>(a)</td><td>Pump suction</td><td>-----</td><td>1.2-1.5</td><td>1.2-1.8</td></tr><tr><td>(b)</td><td>Pump discharge and recirculation</td><td>1.2-1.8</td><td>1.8-2.4</td><td>2.1-2.5</td></tr><tr><td>(c)</td><td>Header</td><td>-----</td><td>1.5-2.4</td><td>2.1-2.4</td></tr></tbody></table> Pipe line under gravity flow shall be restricted to a flow velocity of 1 m/sec generally. Channels under gravity flow shall be sized for a maximum flow velocity of 0.6 m/sec. WILLIAM & HAZEN formula shall be used for calculating the friction loss in piping systems with the following "C" value: <table><tbody><tr><td>(i)</td><td>Carbon steel pipe</td><td>100</td></tr><tr><td>(ii)</td><td>Ductile Iron.</td><td>140</td></tr><tr><td>(iii)</td><td>Rubber lined steel pipe</td><td>120</td></tr><tr><td>(iv)</td><td>Stainless steel pipe</td><td>100</td></tr></tbody></table> For calculating the required pump head for pump selection, at least 10% margin shall be taken over the pipe friction losses and static head shall be calculated from the minimum water level of the tank/ sump/ reservoir from which the pumps draw water. (b) Compressed Air Application Compressed air 15.0 m/sec.						Water Velocity in m/sec				Pipe Size	Below 50 mm	50-150 mm	200 mm & above	(a)	Pump suction	-----	1.2-1.5	1.2-1.8	(b)	Pump discharge and recirculation	1.2-1.8	1.8-2.4	2.1-2.5	(c)	Header	-----	1.5-2.4	2.1-2.4	(i)	Carbon steel pipe	100	(ii)	Ductile Iron.	140	(iii)	Rubber lined steel pipe	120	(iv)	Stainless steel pipe	100
		Water Velocity in m/sec																																							
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1.03.00	The pipes shall be sized for the worst (i.e. maximum flow, temp. and pressure values) operating conditions.																																								
KAWAS WTE PROJECT (2x350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB-SECTION- A-08 (LOW PRESSURE PIPING)	PAGE 1 OF 8																																					

CLAUSE NO.	TECHNICAL REQUIREMENTS																				
1.04.00	Based on the inside dia. so established, thickness calculation shall be made as per ANSI B 31.1 OD and thickness of pipes shall than be selected as per ANSI B 36.10/IS-1239 Heavy grade/IS-3589/ASTM-A-53/API-5L/ANSI B 36.19 as the case may be.																				
1.05.00	Corrosion allowance of 1.6 mm will be added to the calculated thickness being considered (except stainless steel piping).																				
1.06.00	Compressed air pipe work shall be adequately drained to prevent internal moisture accumulation and moisture traps shall be provided at strategic locations in the piping systems.																				
1.07.00	Threaded joints shall be provided with Teflon sealant tapes.																				
2.00.00	TECHNICAL SPECIFICATION																				
2.01.00	Pipes and fittings																				
2.01.01	All low pressure piping systems shall be capable of withstanding the maximum pressure in the corresponding lines at the relevant temperatures.																				
2.01.02	For rubber lined ERW pipes, beads shall be removed.																				
2.01.03	Inspection holes shall be provided at suitable locations for pipes 800 Nb and above as required for periodic observations and inspection purposes.																				
2.02.00	Material																				
2.02.01	Alternate materials offered by Bidder against those specified shall either be equal to or superior to those specified.																				
2.02.02	Material of construction for pipes carrying various fluids shall be as follows:																				
	<table><tr><th>SI N</th><th>Type of Fluid</th><th>Material</th></tr><tr><td>1.</td><td>i) Ordinary Water (Raw Water, Clarified Water, etc.) ii) Equipment cooling water including Both primary & secondary circuit (DMCW pH-corrected & ACW)</td><td>IS-2062 Gr.-E-250B/ASTM A-36/ASTM A-53 type 'E' Gr. B/IS-3589 Gr. 410 /IS-1239 Heavy.</td></tr><tr><td>2.</td><td>i) Demineralised water, ii)Alkaline solution (ECW system chemical dosing)</td><td>Stainless Steel to ASTM A312, Gr. 304 welded for sizes 65 mm NB and above. Stainless steel to ASTM A312, Gr. 304 sch.40s seamless for sizes 50mm and below</td></tr><tr><td>3.</td><td>i) Drinking (potable) water ii)Compressed air (Instrument & service air)</td><td>ASTM A-53 type E Gr. B galvanized/ IS 1239 Gr heavy galvanized/IS 3589 Gr 410 galvanized. Galvanized shall be to IS- 4736 or equivalent.</td></tr><tr><td>4.</td><td>(Condensate) spill water</td><td>ASTM A 106 Gr. B</td></tr><tr><td>5.</td><td>Effluents from Neutralization pit</td><td>MSRL</td></tr></table>			SI N	Type of Fluid	Material	1.	i) Ordinary Water (Raw Water, Clarified Water, etc.) ii) Equipment cooling water including Both primary & secondary circuit (DMCW pH-corrected & ACW)	IS-2062 Gr.-E-250B/ASTM A-36/ASTM A-53 type 'E' Gr. B/IS-3589 Gr. 410 /IS-1239 Heavy.	2.	i) Demineralised water, ii)Alkaline solution (ECW system chemical dosing)	Stainless Steel to ASTM A312, Gr. 304 welded for sizes 65 mm NB and above. Stainless steel to ASTM A312, Gr. 304 sch.40s seamless for sizes 50mm and below	3.	i) Drinking (potable) water ii)Compressed air (Instrument & service air)	ASTM A-53 type E Gr. B galvanized/ IS 1239 Gr heavy galvanized/IS 3589 Gr 410 galvanized. Galvanized shall be to IS- 4736 or equivalent.	4.	(Condensate) spill water	ASTM A 106 Gr. B	5.	Effluents from Neutralization pit	MSRL
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KAWAS WTE PROJECT (2x350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB-SECTION- A-08 (LOW PRESSURE PIPING)	PAGE 2 OF 8																	

CLAUSE NO.	TECHNICAL REQUIREMENTS			
2.02.03	In water lines, pipes up to 150mm Nb shall conform to ANSI B36.10/ASTM-A-53, Type-E Gr. B /IS:1239 Gr. Heavy and minimum selected thickness shall not be less than IS:1239 Grade Heavy except for demineralised water, drinking water and condensate spill lines. Pipes of above 150mm Nb shall be to ANSI B 36.10/ASTM A-53/IS 3589 Gr.410.			
2.02.04	Instrument air, Plant (service) air lines and Drinking water lines shall be to ASTM A 53 type E grade B/ANSI B 36. 10/IS 3589, Gr. 410 / IS: 1239 Heavy and galvanized to IS 4736 or any equivalent internationally reputed standard. The fittings shall be of either same as parent material or malleable iron to IS-1879 (galvanized).			
2.02.06	Spiral welded pipes as per API-5L/IS-3589 are also acceptable for pipe of size above 150 NB.			
2.03.00	Pipe Joints In general all water lines 65mm NB and above, are to be joined generally by butt welding except the locations where valves/fittings are to be installed with flanged connections and 50mm and below by socket welding unless mentioned otherwise specifically. All air lines shall be of screwed / flanged connection and rubber lined pipes of flanged connections.			
2.04.00	Bends / elbows / mitre bends / Tees / Reducers & other fittings			
2.04.01	For pipe fittings such as elbows (long radius), reducers, tees, etc. the material shall be to ASTM-A-234 Gr. WPB/ASTM-105 up to 300 NB. For pipe fittings above 300 NB, the fittings may be fabricated conforming to parent pipe material. Provision of compensation pads shall be kept as per ANSI B 31.1. The fitting shall conform to the dimensional standard of ANSI B-16.9/ 16.11. Further branching in pipes for sizes 65nb and above is also acceptable (ANSI B 31.1). However, for pipes up to 150 NB, pipe fittings may be supplied with material and dimension conforming to IS 1239 in case parent pipes also conform to IS 1239.			
2.04.02	For pipe size 350Nb and above mitre bends may be used for all pipes except rubber lined pipes. The bend radius shall be 1½ times the nominal pipe diameter. 90 deg. bends (mitre) shall be in 4 pieces (3 cuts) and 45 deg. mitre bends shall be in 3 pieces 22½ deg. Fabrication of mitre bends shall be as detailed in BS 2633/BS534.			
2.04.03	For pipes, above 1200 NB, reducer and tees shall be to dimensional standard of AWWA-C-208.			
2.04.04	Stainless steel fittings shall conform to either ASTM-A-182 Gr. 304 or ASTM-A-403 Grade WP. 304 Class-S, for sizes up to and including 50 mm NB, i.e. the fittings shall be of seamless construction. However, for stainless fittings above 50 mm NB, the same shall conform to ASTM-A-403 Gr. WP 304 Class W i.e. the fittings shall be of welded construction strictly in accordance with ASTM-A-403.			
2.04.05	In no case, the thickness of fittings shall be less than the thickness of parent pipe, irrespective of material of construction.			
2.05.00	Specific technical requirement of laying buried pipe with anti-corrosive treatment The pipe in general shall be laid with the top of the pipe minimum 1.0 (one) meter below finished general ground level.			
2.05.01	Trench bed preparation and back filling			
KAWAS WTE PROJECT (2x350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB-SECTION- A-08 (LOW PRESSURE PIPING)	PAGE 3 OF 8

CLAUSE NO.	 TECHNICAL REQUIREMENTS			
2.05.02	(a) Bed preparation in general shall conform to IS 5822 or any equivalent international standard. Coating and wrapping/ Anti corrosive Protection Coal tar tape a. Buried piping shall be coated and wrapped, after completion of welded and/or flanged connections, and after completion and approval of Hydro testing. Materials to be used for coating and wrapping of underground pipelines are: (1) Coating primer (coal tar primer) (2) Coating enamel (coal tar enamel) (3) Wrapping materials. All primer/coating/wrapping materials and methods of application shall conform to IS: 10221 except asphalt/bitumen material. Materials (primer/coating/wrapping) as per AWWA-C-203 are also acceptable. Total thickness of completed coating and wrapping shall not be less than 4.0 mm. b. Alternatively, the anti-corrosive protection for buried pipes can consist of anti-corrosive protection Coal-tar tapes. Material and application of tapes shall conform to IS 15337 or equivalent. These-tapes shall be applied hot over the cold coal tar primer in steps of 2mm thickness so as to cover the spiral edges of the first tape by the application of second tape. The total nominal thickness of the finished protective coating shall be 4.0 mm.			
2.06.00	Specification for hangers and supports			
2.06.01	All supports and parts shall conform to the requirement of power piping code ANSI B 31.1 or approved equivalent.			
2.06.02	The maximum spans of the supports of straight length shall not exceed the recommended values indicated in ANSI B 31.1.			
2.06.03	At all sliding surfaces of supports suitable arrangement is to be provided to minimize sliding friction.			
2.07.00	Design/Construction/Material Particulars of Gate/ Globe /Check /Butterfly valves.			
2.07.01	GENERAL (a) All valves shall have indicators or direction clearly marked on the hand-wheel so that the valves opening/closing can be readily determined. (b) All valves shall be provided with embossed name plate giving details such as tag number, type, size etc. (c) Wherever required valves shall be provided with chain operator, extension spindles and floor stands or any other arrangement approved by employer so that they can be operated with ease from the nearest operating floor. Wherever necessary for safety purpose locking device shall be provided. Further, necessary small platforms for facilitating easy valve operation shall be provided by the contractor wherever			
KAWAS WTE PROJECT (2x350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB-SECTION- A-08 (LOW PRESSURE PIPING)	PAGE 4 OF 8

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC																
2.07.02	necessary in consultation with project manager within the bid price at no extra cost to employer. VALVE BODY MATERIAL Valve body material for various services shall be as follows: Valve body material for ordinary water and Drinking water shall be cast iron for sizes 65NB and above; gun-metal for sizes 50 Nb and below. For compressed air application, valve body material shall be cast carbon steel or forged carbon steel (both galvanized) for sizes 65 mm NB & above and Gun metal for sizes 50 NB and below. DM water: SS body and disc along with SS internals. However for butterfly valves, Cast Iron /Ductile Iron/SG iron/carbon steel body and disc with elastomer lining are also acceptable. Condensate: Cast Carbon Steel / Forged Carbon Steel.																			
2.07.03	Valves in general shall conform to the requirements of the following standards. Standards and Codes <table><tr><td>AWWA-C-504</td><td>Rubber seated butterfly valves.</td></tr><tr><td>BS-5155/EN-593</td><td>Cast iron and steel body butterfly valves for general purpose.</td></tr><tr><td>IS-778</td><td>Gun-metal gate, globe and check valves for general purpose.</td></tr><tr><td>BS-5152</td><td>Specification for cast iron globe valves.</td></tr><tr><td>BS-5153</td><td>Cast iron check valves for general purpose.</td></tr><tr><td>ANSI B 16.34</td><td>Standard for valves.</td></tr><tr><td>API-594</td><td>Standard for Dual-check valves.</td></tr><tr><td>API-600</td><td>Steel gate valves.</td></tr></table>				AWWA-C-504	Rubber seated butterfly valves.	BS-5155/EN-593	Cast iron and steel body butterfly valves for general purpose.	IS-778	Gun-metal gate, globe and check valves for general purpose.	BS-5152	Specification for cast iron globe valves.	BS-5153	Cast iron check valves for general purpose.	ANSI B 16.34	Standard for valves.	API-594	Standard for Dual-check valves.	API-600	Steel gate valves.
AWWA-C-504	Rubber seated butterfly valves.																			
BS-5155/EN-593	Cast iron and steel body butterfly valves for general purpose.																			
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BS-5153	Cast iron check valves for general purpose.																			
ANSI B 16.34	Standard for valves.																			
API-594	Standard for Dual-check valves.																			
API-600	Steel gate valves.																			
2.08.00	Gate/Globe/Check Valves (a) All steel and stainless steel body valves of sizes 65 mm and above shall have flanged or butt welding ends. Valves of sizes below 65mm shall have flanged or socket welded ends. (b) All gun metal body valves shall have screwed ends. (c) All gate and globe valves shall be provided with back seating arrangement to enable on line changing of gland packing. The valves shall be preferably outside screw & yoke type.																			
KAWAS WTE PROJECT (2x350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB-SECTION- A-08 (LOW PRESSURE PIPING)	PAGE 5 OF 8																

CLAUSE NO.	TECHNICAL REQUIREMENTS			
2.08.01	(d) All gate and globe valves shall be rising stem type.			
	(e) All valves except those with rising stems shall be provided with continuous mechanical position indicators; rising stem valves shall have only visual indication through plastic/metallic stem cover for sizes above 50 mm nominal bore.			
	MATERIAL OF CONSTRUCTION (GATE/GLOBE/CHECK VALVE)			
	(a) The materials shall generally comply with the following:			
	(1) Cast Steel Valves			
	Body & bonnet	ASTM A 216 Gr. WCB/ ASTM A 105		
	Disc for non-return Valves	ASTM A 216 Gr. WCB/ ASTM A 105		
	Trim.	ASTM A 182 Gr. F6 or Equivalent		
	(2) Stainless steel valves			
	Body & Bonnet	SS 304		
Disc	-do-			
Trim.	SS 316			
2.09.00	(3) Cast iron valves			
	Body & bonnet	BS 1452 Gr. 14/ IS-210 Gr. FG 260		
	Seating surfaces and rings	13% chromium steel/ 13% Chrome overlay		
	Disc for non-return valves	BS 1452 Gr. 14/IS-210 Gr FG 260		
	Hinge pin for non-return valves	AISI 316		
	Stem for gate globe valves	13% chromium steel or Equivalent		
	Back seat	13 % chromium steel / 13% Chrome overlay		
	(4) Gun Metal valves			
	Body and bonnet	IS 318 Gr. 2/ Equivalent Standard		
	Trim.	-do-		
2.09.01	Forged carbon steel valves are also acceptable in place of Gun metal valves.			
	Butterfly valves			
Design/Construction				
KAWAS WTE PROJECT (2x350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9		SUB-SECTION- A-08 (LOW PRESSURE PIPING)
PAGE 6 OF 8				

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
2.09.02	(a) The valves shall be designed for the design pressure/temperature of the system on which it is installed and in accordance with AWWA-C-504, EN-593 or any other approved equivalent standard latest edition. Fabricated steel (IS: 2062 GR. E-250B) butterfly valves instead of cast iron body valves are also acceptable for size above 300 mm Nb diameter.			
	(b) The valves shall be suitable for installation in any position (horizontal/vertical etc.) and shall be generally of double-flanged construction. However, for sizes 600 NB and below the valves of Wafer construction are also acceptable			
	Material of Construction (Butterfly Valves)			
	Materials and other design details shall be as indicated below:			
	(a) Cast Iron Butterfly Valves			
	Body & Disc	ASTM A48, Gr. 40 with 2% Ni / IS: 210. Gr. FG-260, with 2% Ni / SG iron BSEN 1563, Gr EN GJS-400-15 with 2%Ni and epoxy coated		
	Shaft	BS 970 431 S: 291 / EN 57, or AISI-410 or AWWA-permitted shaft material equivalent to EN-57/AISI-410 or better.		
	Seat ring	18-8 Stainless steel		
	SEAL	NITRILE RUBBER		
	(b) Stainless Steel Butterfly Valves			
	Body & Disc	SS 304		
	Shaft	SS 316		
	Seat Rings	EPT/BUNA-N/Neoprene		
(c) Carbon steel Butterfly Valves				
	Body & Disc	ASTM A 216, Gr. WCB		
	Shaft	SS 304		
	Disc & Seat Rings	EPT/BUNA-N/Neoprene		
(d) Elastomer lined Butterfly Valves				
	Body & Disc	ASTM A48, Gr. 40 / IS: 210. Gr. FG-260 / SG Iron (ductile iron) IS 1865 Gr 400-15 or BSEN 1563, Gr EN GJS-400-15 / ASTM A 216, Gr. WCB with elastomer lining.		
	Shaft	SS 316		
2.09.03	Proof of Design Test (Type Test) for Butterfly Valves			
KAWAS WTE PROJECT (2x350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB-SECTION- A-08 (LOW PRESSURE PIPING)	PAGE 7 OF 8

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	Proof of Design (P.O.D.) test certificates shall be furnished by the bidder for all applicable size-ranges and classes of Butterfly valves supplied by him, in the absence of which actual P.O.D. test shall be conducted by the bidder. All valves that are designed and manufactured as per AWWA-C-504 / AWWA-C-516 shall be governed by the relevant clauses of P.O.D test in AWWA-C-504/AWWA-C-516. For Butterfly valves, designed and manufactured to EN-593 or equivalent, the P.O.D. test methods and procedures shall generally follow the guidelines of AWWA-C-504 in all respect except that Body & seat hydro test and disc-strength test shall be conducted at the pressures specified in EN-593 or the applicable code. Actuators shall also meet requirements of P.O.D. test of AWWA-C-504/AWWA-C-516.			
2.10.00	Tanks and Accessories			
2.10.01	The designer and manufacturer of storage tanks shall comply with and obtain approval of all currently applicable statutory regulations and safety codes in the locality where the equipment will be installed. The tanks shall conform to IS 803/IS804/IS 805/ IS 2825/ API 650/ IS 4049/ IS 4682 (part-I) and IS 4864 to 4870/ ASME B & PV code Sec.-VIII as the case may be.			
KAWAS WTE PROJECT (2x350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB-SECTION- A-08 (LOW PRESSURE PIPING)	PAGE 8 OF 8

SUB-SECTION–A-09

NOT USED

SUB-SECTION–A-10

SURFACE PREPARATION & PAINTING

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
1.00.00	Specification of surface preparation & painting			
1.01.00	Surface preparation methods and paint/primer materials shall be of the type specified herein. If the contractor desires to use any paint/primer materials other than that specified, specific approval shall be obtained by the contractor in writing from the employer for using the substitute material.			
1.02.00	All paints shall be delivered to job site in manufacturers sealed containers. Each container shall be labelled by the manufacturer with the manufacturer's name, type of paint, batch number and colour.			
1.03.00	Unless specified otherwise, paint shall not be applied to surfaces of insulation, surfaces of stainless steel/nickel/ copper/brass/ monel/ aluminum/ hastelloy/lead/ galvanized steel items, valve stem, pump rods, shafts, gauges, bearing and contact surfaces, lined or clad surfaces.			
1.04.00	All pipelines shall be Colour coded for identification as per the NTPC Colour-coding scheme, which will be furnished to the contractor during detailed engineering.			
1.05.0	SURFACE PREPARATION			
1.05.01	All surfaces to be painted shall be thoroughly cleaned of oil. Grease and other foreign material. Surfaces shall be free of moisture and contamination from chemicals and solvents.			
1.05.02	The following surface preparation schemes are envisaged here. Depending upon requirement any one or a combination of these schemes may be used for surface preparation before application of primer. SP1 Solvent cleaning SP2 Application of rust converter (Ruskil or equivalent grade) SP3 Power tool cleaning SP4 Shot blasting (shot blasting shall be used as surface preparation method for hot worked pipes prior to application of primer) SP4* Shot blast cleaning/ abrasive blast cleaning to SA21/2 (near white metal) 35-50 microns SP5 Shot blasting/ abrasive blasting. SP6 Emery sheet cleaning/Manual wire brush cleaning.			
1.06.00	APPLICATION OF PRIMER/PAINT			
1.06.01	The paint/primer manufacturer's instructions covering thinning, mixing, method of application, handling and drying time shall be strictly followed and considered as part of this specification. The Dry film thickness (DFT) of primer/paint shall be as specified herein.			
1.06.02	Surfaces prepared as per the surface preparation scheme indicated herein shall be applied with primer paint within 6 hours after preparation of surfaces.			
1.06.03	Where primer coat has been applied in the shop, the primer coat shall be carefully examined, cleaned and spot primed with one coat of the primer before applying intermediate and finish coats. When the primer coat has not been applied in the shop, primer coat shall be applied by brushing, rolling or spraying on the same day as the surface is prepared. Primer coat shall be applied prior to intermediate and finish coats.			
1.06.04	Steel surfaces that will be concealed by building walls shall be primed and finish painted before the floor is erected. Tops of structural steel members that will be covered by grating shall be primed and finish painted before the grating is permanently secured.			
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS- 2600-001-9	SUB-SECTION - A- 10 SURFACE PREPARATION & PAINTING	Page 1 of 7

CLAUSE NO.	TECHNICAL REQUIREMENTS	एनटीपीसी NTPC		
1.06.05	Following are the Primer/painting schemes envisaged herein: PS3 - Zinc Chrome Primer (Alkyd base) by brush/Spray to IS104. PS3* - Zinc Chrome primer (Alkyd base) by dip coat. PS4 - Synthetic Enamel (long oil alkyd) to IS2932. PS5 - Red Oxide Zinc Phosphate primer (Alkyd base) to IS 12744 PS9 - Aluminum paint to IS 2339. PS9* - Heat resistant Aluminum paint to IS-13183 Gr.-I (for temperature 400 degC – 600 degC), IS-13183 Gr.-II (for temperature 200 degC- 400 degC and IS-13183 Gr.-III (for temperature upto 200 degC) PS13 - Rust preventive fluid by spray, dip or brush. PS14 - Weldable primer-Deoxaluminate or equivalent. PS16 - High Build Epoxy CDC mastic `15'. PS17 - Aliphatic Acrylic Polyurethane CDE134, %V=40.0(min.) PS18 - Epoxy based TiO2 pigmented coat PS19 - Epoxy Zinc rich primer (92% zinc in dry film (min.), %VS=35.0(min.) PS-20 - Epoxy based finish paint			
1.06.06	All weld edge preparation for site welding shall be applied with one coat of wieldable primer.			
1.06.07	For internal protection of pipes/tubes, VCI pellets shall be used at both ends after sponge testing and ends capped. VCI pellets shall not be used for SS components and composite assemblies.			
1.06.08	SG membrane walls and other Flue gas swept pressure part surfaces shall be applied with appropriate primer for protection of surfaces during transit, storage and erection.			
1.06.09	a) all un-insulated equipments, pipes, valves etc. covered in sub-section A-06 (Steam Turbine & Auxiliary system) shall be painted with paint not inferior to Epoxy resin based paints with minimum DFT of 150 microns. The paint shall be applied in three stages i.e. primer, intermediate and finish coats in following manner: ▪ Primer coat – Epoxy based zinc phosphate ▪ Intermediate - Epoxy based TiO2 pigmented coat ▪ Finish coat - Epoxy based finish coat b) Equipment, pipes etc. with high temperature shall be painted with heat resistant aluminum paint (to be selected based on the service condition of component as per IS-13183). Two coats of paint shall be applied with total DFT 40 micron. c) Surface preparation before painting shall be carried out according to requirement indicated in this sub-section and international standard.			
1.06.10	A) Specification for the application of Epoxy coating for internal protection of DM tank & other vessels/tanks (as applicable) shall be as follows: Primer : One coat of unmodified epoxy resin along with polyimide hardener. Paint : Two (2) coats unmodified epoxy resin along with Aromatic adduct hardener. Total thickness of primer and paint should not be less than 400 microns.			
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS- 2600-001-9	SUB-SECTION - A- 10 SURFACE PREPARATION & PAINTING	Page 2 of 7

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	B) Specification for application of chlorinated Rubber paint for external protection vessel, tanks, piping, valves & other equipments shall be as follows: i) For Indoor vessel, tanks, piping, valves & other equipments: (a) Surface preparation shall be done either manually or by any other approved method. (b) Primer coat shall consist of one coat of chlorinated rubber based zinc phosphate primer having minimum DFT of 50 microns. (c) Intermediate coat (or under coat) shall consist of one coat of chlorinated rubber based paint pigmented with Titanium dioxide with minimum DFT of 50 microns. (d) Top coat shall consist of one coat of chlorinated rubber paint of approved shade and colour with glossy finish and DFT of 50 microns. Total DFT of paint system shall not be less than 150 microns. ii) For Outdoor vessel, tanks, piping, valves & other equipments: (a) Surface preparation shall be blast cleared using non-siliceous abrasive after usual wire brushing, which shall conform to Sa 2-1/2 Swiss Standard. (b) Primer coat shall consist of one coat of epoxy resin based zinc phosphate primer having minimum DFT of 100 microns. (c) Intermediate coat (or under coat) shall consist of epoxy resin based paint pigmented with Titanium dioxide with minimum DFT of 100 microns. (d) Top coat shall consist of one coat of epoxy paint suitable pigmented of approved shade and colour with glossy finish and DFT of 75 microns. Additionally finishing coat of polyurethane of minimum DFT of 25 microns shall be provided. The paint may be applied in one coat, in case high built paint is used, otherwise two coats shall be applied. Total DFT shall not be less than 300 microns.			
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS- 2600-001-9	SUB-SECTION - A- 10 SURFACE PREPARATION & PAINTING	Page 3 of 7

1.06.10 Primer/Painting Schedule

Sl. No	Description		Surface Preparation	Primer Coat			Intermediate Coat			Finish Coats			Total Min. Painting DFT (Microns)	Colour Shade
				Type of Primer	No. of Coats	Min. DFT / coat (Microns)	Type of coating	No. Coats	Min. DFT/ Coat (Microns)	Type of coating	No. Coats	Min. DFT/ Coat (Microns)		
A) Power Cycle Piping														
1.	All insulated Pippings, fittings/ components, Pipe clamps, Vessels/Tanks, Equipments etc.		SP3/SP4	PS9*	1	20	-	-	-	PS9*	1	20	40	As per NTPC Colour shade/ coding scheme
2.	All un-insulated Pippings, fittings/ components, Pipe clamps, Vessels/Tanks, Equipments etc.	Design temperature < or equal to 60°C	SP3/SP4	PS 5	2	25	-	-	-	PS 4	3 \$	35 \$	155 \$	
		Design temperature above 60°C- 200°C	SP3/SP4	PS 9*	1	20	-	-	-	PS9*	1	20	40	
		Design temperature > 200°C	SP3/SP4	PS9*	1	20	-	-	-	PS9*	1	20	40	
3	Constant Load Hanger (CLH) and Variable Load Hanger (VLH)		SP4*	PS19	1	40	-	-	-	PS17	1	30	70	
4	Piping hangers/ supports (other than (3) above. (un-insulated)		SP3/SP4 (SP6 - for cleaning of weld joints after erection,)	PS19	1	40	-	-	-	PS17	1	30	70	

Valves													
5.	Cast/Forged	Design temperature < or equal to 60 degC	SP1/SP2 /SP3	PS4/PS9	1	40	Polyamide Epoxy	1	100	PS17	1	40	180
		Design temperature above 60 degC and up to 200 degC	SP1/SP2 /SP3	PS 9*	1	20	-	-	-	PS9*	1	20	40
		Design temperature above 200 degC	SP1/SP2 /SP3	PS9*	1	20	-	-	-	PS9*	1	20	40
6.	All auxiliary Structural Steel components for pipe supports	Outside TG building and in SG envelope	SP4*	Inorganic Ethyl Zinc Silicate	1	75	PS18	1	75	a) Epoxy coat b) Final coat of paint PS17	2 1	35 30	250
		Within building TG	SP4*	-do-	1	35	PS18	1	35	a) Epoxy coat b) Final coat of paint PS17	2 1	25 30	150
7.	Weld Edges		SP6 (Hand cleaning by wire brushing)	PS13 (Weldable primer)	1	25	-	-	-	-	-	-	25

1. \$ - The first 2 finished coats (total min.DFT of 70 microns) shall be done at shop and the 3rd finish coat (min.DFT 35 Microns) shall be applied at site.
2. For valves below 65NB and temperature upto and including 540 DegC, Parkerizing/zinc phosphate corrosion resistant coating as per ASTM F1137 is also acceptable in lieu of Aluminum paint.
3. For corrosion protection of threaded hanger rods and variable spring cages, electro galvanizing in full compliance to minimum Corrosion category C3 as per EN ISO12944 is also acceptable.
4. For spring cages, 2 coats of 30 µm (min) zinc-rich epoxy resin primer with zinc content> 80 weight% in dry film followed by 2 coats of 30 µm (min) top coat of Acrylic resin Co-polymerisate with a total combined minimum DFT of 120µm is also acceptable in lieu of above specified paint scheme.
5. For corrosion protection, all inner parts of the hangers shall be at least in full compliance to Corrosion category C3 as per EN ISO12944.

B) Steam Generator & Auxiliaries:

1	All surfaces with temperature 95°C or less and which are insulated	SP3/SP4	PS 5	2	30	-	-	-	PS 4	2 \$	20 \$	100 \$
2	All surfaces with temperature above 95°C and which are insulated	SP3/SP4	PS9*	1	20	-	-	-	PS9*	1	20	40

Note: 1) SG membrane walls and other Flue gas swept pressure part surfaces shall be applied with appropriate primer for protection of surfaces during transit, storage and erection.

2) Painting specification for all other exposed steel surfaces not covered above shall be same as that given in Civil Sub-section, Part-B, Section VI for corrosion protection of steel structures.

C) LOW PRESSURE PIPING

1	All Piping, fittings / components, valves, Equipments etc.	SP3/SP5	PS3/ PS5	2	25	PS 4	1	30	PS 4	2	35	150	As per NTPC Color shade/ coding scheme.
2	Stainless steel surface, Galvanized steel surface and gun metal surface.	No Painting											
3	On the internal surface for pipes 1000 Nb and above	A coat of primer followed by hot coal-tar enamel or coal tar epoxy painting (cold) shall be applied.											

D) Fire Detection & Protection System, Compressed air system, Hydrogen generation plant and Air-conditioning & Ventilation System

For Fire Detection & Protection System, Surface preparation and painting of Fire Water Storage Tanks, all Steel Surfaces (external) exposed to atmosphere (outdoor & indoor installation), Deluge Valves, Alarm Valves, Foam monitors, Water monitors, Foam Proportioning equipments, Foam makers, etc. should be as per the Part-B, Sub Section-A-16, Fire Detection & Protection System

For Air Conditioning System, Surface preparation and painting of all the steel surfaces (external) exposed to atmosphere (outdoor & indoor installation), centrifugal fans – Casing etc. should be as per the Part-B, Sub Section-A-15, Air Conditioning System.

For Ventilation System, Surface preparation and painting of all the steel surfaces (external) exposed to atmosphere (outdoor & indoor installation), centrifugal fans – Casing etc. should be as per the Part-B, Sub Section-A-23, Ventilation System.

For compressed air system, Surface preparation and painting of all the steel surfaces should be as per the Part-B, Sub Section--A-14 compressed air system.

For hydrogen generation plant, Surface preparation and painting should be as per the Part-B, Sub-Section-A-17 hydrogen generation plant.

E) BAG FILTER

1	All surfaces with surface temperature 95°C or less (with or without insulation)	SP3/SP4	PS3/PS3*	1	25	-	-	-	PS 4	1	30	55
2	All surfaces with surface temperature above 95°C (with or without insulation)	SP3/SP4	PS5	2	30	-	-	-	-	-	-	60

SUB-SECTION–A-11

THERMAL INSULATION

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
1.00.0	THERMAL INSULATION			
	a) For all Piping / SG / TG systems and the equipment with surface operating temperature of 60 deg.C and above, thermal insulation shall be applied for heat conservation and/or personnel protection such that the temperature of protective cladding shall not exceed 60 deg.C. Insulation thickness shall be calculated based on the following design data & methodology:			
	Design ambient temperature	40 Deg.C for inside and 45 Deg.C for outside the Main plant building.		
	Maximum cladding temperature	60 Deg.C		
	Wind speed	0.5m/sec. for inside and 0.25m/sec for outside the Main plant building		
	Emissivity of cladding	0.2		
	Pipe/Equipment wall temp.	Maximum operating temperature.		
	Thickness calculation	As per ASTM C-680 (Latest edition) or equivalent		
	Thermal insulation shall also be provided for piping systems where it is expected that occasional rise in fluid temperature during operation exceeds 60 deg.C,			
	Upstream of all drain lines and the lines connected to steam traps, shall be insulated up to and including isolating valve for heat conservation. Rest of such lines drain lines and other lines such as safety valve discharges, vents, etc. shall be insulated for personnel protection.			
b) Insulating materials should conform to the following requirements:				
i) The minimum insulation thickness, however, shall not be less than 75 mm for Steam Generator surfaces and 25 mm for other surfaces. Also refer as specified at clause no 1.00.00 b (ii) of this chapter. Material and application of insulation material, protective cladding, wire mesh etc. shall also be conforming to latest edition of following Codes: IS: 8183, IS: 3677, IS: 3144, IS: 14164, IS: 280, ASTM-B 209.				
Physical requirements — Following shall be met by testing as per relevant clauses of IS: 3144.				
a) Shot content	5% by weight (maxm.), size of any shot not to exceed 5 mm in diameter			
b) Bulk density	To comply with Table 2.01.00 below.			
c) Weight gain by moisture absorption	2% (maxm.)			
d) Sulphur Content	Not exceeding 0.6%			
e) Alkalinity as percentage of Na2O	Not exceeding 0.6%			
f) Maximum oil content	Not exceeding 0.3% by weight			
g) Total carbon content	Not exceeding 0.3% by weight			
h) Settlement	Nil (When tested as per Cl. 21.1 & 21.2 of IS:3144)			
i) Handability	Fully handable, without any lump formation and disintegration of material			
j) Loss of weight after combustibility test	Not exceeding 5% by weight			
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub-Section – A 11 THERMAL INSULATION	Page 1 of 8

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	In addition to requirements of as specified above, the Mineral wool shall: (a) Pass standard combustibility test both immediately after application and after subjected to maximum operating temperature for not less than 100 hrs. (b) Not suffer permanent deterioration as a result of contact with moisture due to condensation and shall be free from objectionable odor. (c) Not cause corrosion of the surface being insulated or of cladding on it under normal site conditions. (d) Not suffer any quality deterioration under specified service conditions (both cold/hot face temp.) of use. (e) Not contain asbestos in finishing materials of insulation in any form (ii) Insulation mattress/section shall be supplied in thickness of 25, 40, 50, 60 and 75 mm. Insulation of higher thickness shall be made up in multiple layers using mattress/slabs of thickness specified above. However, if the required thickness is such that by using above mattress/slabs the calculated thickness is not achieved, the mattress/slabs in increment of 5 mm shall be acceptable for outer layers. The min. thickness however, shall not be less than 25 mm and number of layers shall be minimum and innermost layer shall be thickest. c) INSULATION (STEAM TURBINE AND BFP) (a) The HP cylinder, IP cylinder, steam chest and interconnection piping, crossover / cross-around piping, such parts of LP cylinder as considered necessary, and all associated piping and valves shall be efficiently insulated with inner thermal insulating materials. The insulated portion of the steam turbines shall be covered with fabricated steel cover, provided with suitable anti-drumming and sound pressure attenuating material inside. The insulation and steel covering should be so designed and erected as to provide easy accessibility to parts requiring frequent inspection. (b) The thermal insulation for the turbine casing shall preferably be insulated by preformed ceramic mattress blankets conforming to IS15402 or equivalent. These mattresses are fixed over the casing and held in position by metallic washers fastened to the MS rod welded to the casing. To meet the thickness requirements, multiple layers of mattresses may be applied. Alternatively, bidder may apply turbine insulation as per their standard practice i.e. sprayed insulation produced by projecting specially prepared mineral wool along with a fine liquid spray. This should be covered with prefabricated 'blanket' type insulation. The bidder may apply complete spray type or complete blanket type or combination of both of above as per their standard practice. These blankets shall consist of high temperature felted mineral insulation fully enclosed in wire inserted asbestos free cloth for temperature exposure to 445°C to 595°C. A single layer of blanket shall not be more than 75 mm thick. Voids around the blankets should be avoided. However, unavoidable voids shall be filled with loose mineral wool.			
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub-Section – A 11 THERMAL INSULATION	Page 2 of 8

CLAUSE NO.	TECHNICAL REQUIREMENTS																					
	(c) Nuts and other exposed portions of the casing and valve flanges shall be suitably insulated for minimum heat loss. (d) Suitable stainless steel lugs shall be tack welded on turbine casing to support the insulation. In places where welding is not permitted, suitable alternative arrangement shall be provided by the Contractor. The design of the support shall be so as to involve minimum number of lugs. (e) The thermal insulation designed, furnished and installed by the Contractor shall be such that the following items of performance shall be guaranteed, and the specific design and application features adopted shall be so as not to exceed the stipulated limits in temperature differentials. The Employer shall have the option to have any random check of specimen as per his choice, to establish conformity to guaranteed particulars: (1) The difference in temperature between upper and lower metallic parts of HP and IP casings in the zone of governing stage/ steam admission shall not be more the 40 °C during cooling of the casing. (2) The difference in metallic temperatures of upper and lower halves of both H.P. and I.P. casings, during normal operating conditions shall not be more than 15 °C. (f) Applicable Standards: <table><tr><td>1.</td><td>IS15402</td><td>Ceramic mattress insulation</td></tr><tr><td>2.</td><td>IS - 9742</td><td>Sprayed mineral wool thermal insulation.</td></tr><tr><td>3.</td><td>IS - 5696</td><td>Loose mineral wool.</td></tr><tr><td>4.</td><td>IS - 3677</td><td>Unbonded rock and slag wool for thermal insulation.</td></tr><tr><td>5.</td><td>IS - 8183</td><td>Lightly bonded mineral wool for thermal insulation.</td></tr><tr><td>6.</td><td colspan="2">IS - 7413, IS - 3144, IS - 9482</td></tr></table> (g) The use of asbestos in any form for insulation and elsewhere is not permitted. The insulating material and cladding material shall be as per the tables of material given below:				1.	IS15402	Ceramic mattress insulation	2.	IS - 9742	Sprayed mineral wool thermal insulation.	3.	IS - 5696	Loose mineral wool.	4.	IS - 3677	Unbonded rock and slag wool for thermal insulation.	5.	IS - 8183	Lightly bonded mineral wool for thermal insulation.	6.	IS - 7413, IS - 3144, IS - 9482	
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KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub-Section – A 11 THERMAL INSULATION	Page 3 of 8																		

2.01.00 Insulation Materials

	Type # 1	Type # 2	Type # 3	Type # 4	Type # 5
Type	Lightly resin bonded mineral (rock) wool	Lightly resin bonded mineral (rock) wool	Resin bonded mineral (rock) wool preformed pipe section	Resin bonded glass wool preformed pipe section	Calcium silicate preformed block type
Apparent Density	120-150 Kg/M ³	100 Kg/M ³	140-150 kg/M ³	60-80Kg/M ³	200-250Kg/m ³
Mtl. Standard	IS:8183	IS:8183	IS:9842	IS:9842	IS:8154
Applicable Service	Piping system & equipment with operating temp. in range of 400-500 deg.C	Piping system & equipment with operating temp. in range of 60-400 deg.C	Piping system of 350 NB and below with temp. in range of 60 – 500 deg. C	Piping system of 350 NB and below with operating temp. in range of 60-400 deg.C	Piping system & equipment with operating temp. in range of 400 – 500 deg. C
Testing Requirement	As per IS:8183	8183	IS:9842	IS:9842	IS:8154

2.02.00 Cladding Material & Accessories shall be as specified here under.

S.No.	Item	Basic Specification	Description
1.	Cladding	Aluminum ASTM B-209-1060 temper H14 or IS:737 Gr.19000/H2	Thickness of sheathing (a) 18SWG (1.219mm) for diameter for insulated surface 450 mm and above and for flat surfaces (b) 20 SWG (0.91 mm) for diameter of insulated surface 150 mm and above up to 450 mm. (c) 22 SWG (0.71 mm) for diameter of insulated surface 150 mm and below. (d) 16 SWG ribbed Aluminum for Steam Generator outer casing
2.	Binding & lacing wire	Galvanized Steel wire to IS: 280 for temp. below 400°C and stainless to IS:6528 for temp above 400°C	20 SWG for all insulation interface temperature
3.	Straps & Bands	(i) Aluminum where interface temperature are below 400 deg. C (ii) Stainless steel where temperatures are above 400 deg. C	Band shall be 20 mm wide and 0.6 mm thick for securing Aluminum Sheathing anodized aluminum bends shall be used.
4.	Screws	Stainless steel	Self-tapping, cheese headed
5.	Hexagonal wire mesh	(i) Galvanized steel wire to IS: 280 mesh for interface temperature up to 400 deg. C. (ii) Stainless steel wire for temperature above 400 deg. C	Wire mesh netting shall be 10 to 13 mm aperture at least 0.56mm diameter wire.

CLAUSE NO.	TECHNICAL REQUIREMENTS	एनटीपीसी NTPC					
2.03.00	SPECIFIC REQUIREMENTS FOR APPLICATION OF THERMAL INSULATION 1) All vertical pipes shall be provided with the suitable insulation supports to prevent collapsing/crushing of insulation due to its self-weight. Support rings shall be provided on all vertical piping with a difference in elevation of 4 meter or above, and there shall not be more than 3-meter straight length between support rings. 2) Where insulation is applied in two or more layers each layer of mattress shall be backed with hexagonal wire mesh. For pipe sections, the sections shall be held in place by binding wires without any wire mesh. 3) The insulation shall be held in place by fastening over with binding wire for insulation surface with diameter unto and including 550 mm and with metal bends for insulation surfaces with diameter over 550 mm. The fastening shall be done at intervals of 250 mm except where specified otherwise. The ends of the binding wires shall be hooked and embedded in the insulation. The straps shall be mechanically stretched and fastened with metallic clamping seals of the same materials as the strap. 4) Weather hoods shall be provided for insulated piping passing through floors/walls. 5) All pipe attachments exposed to weather shall be provided with weather proof. 6) All valves and flanges shall be provided with removable box type of insulation covered with box fabricated from aluminum sheets of thickness same as the connected pipe cladding. The portion of the valve which cannot be covered by box type insulation shall be filled by loose insulating material of packing density at least equal to that of the insulating material of adjoining pipe. Expansion joints, metallic or rubber shall not be insulated unless otherwise specifically indicated. 7) All insulation shall be protected by means of an outer covering of aluminum sheathing. All insulation / cladding joints shall be sealed and made effectively weather and waterproof. All flat surfaces shall be given suitable slope to prevent collection of pools of water on the cladding surface. 8) Removable box type cladding for valves and flanges shall be fitted on the connected pipe cladding, with bands. The insulation applied to the equipment shall be reinforced with hexagonal wire mesh. One layer of wire mesh shall be provided on the equipment surface prior to application of insulation. All vertical vessels/tanks shall be provided with support rings/ribs with other necessary frame work to take up the weight of the insulation prior to HT. Where vessel/tank outer diameter exceeds 1500 mm, binding wire passing through insulation clips provided both longitudinally and circumferentially at 500 mm centers shall be used 9) Application of insulation on Steam Generator and other flat surfaces and equipments Insulation to various areas shall be applied as under. <table><tr><td>Insulation Area</td><td>Form of Insulation</td></tr><tr><td>(a) SG surfaces, hot air & gas ducts</td><td>Mineral wool block Mineral wool blankets</td></tr></table>	Insulation Area	Form of Insulation	(a) SG surfaces, hot air & gas ducts	Mineral wool block Mineral wool blankets		
Insulation Area	Form of Insulation						
(a) SG surfaces, hot air & gas ducts	Mineral wool block Mineral wool blankets						
WTE PROJECT (1 X 500 TPD) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-XXXX-001-1	Sub-Section – A 11 THERMAL INSULATION	Page 6 of 8				

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	(b) All other surfaces/not enclosed Calcium silicate block or as per (a) above by SG casing I. For the Steam Generator furnace, if provided with skin casing and the super heater, re-heater and economizer casings where water cooled walls are involved, a first covering of refractory material shall be applied to the external tube surfaces before the application of any further heat resistant insulating material. II. The access doors and inspection doors in the Steam Generator shall be lined with refractory material. The access doors in other portions of the Steam Generator shall be insulated in a similar manner corresponding to any casing, flue-ducts or air, ducts where such openings and access doors occur. III. While applying mineral wool blanket insulation: (a) Provide expended metal or hexagonal wire mesh on both sides for single layer mattress and on first layer in case of multilayer insulation. Subsequent layers of multilayer insulation to have only one side wire netting. (b) The edges of adjacent blankets to be leased together, by appropriate lacing wire as per as specified at clause no 2.02.00 of this chapter. (c) Any gap between joints between insulation layers shall be filled by loose mineral wool confirming to IS 3677. (d) All insulation to be secured by 1.63 mm diameter wire netting over blankets with ends of wire tightly twisted, and pressed in to insulation surface. (e) Impelling pins shall be placed on centers not exceeding 300 mm. IV. Air & Flue Gas ducts with external stiffeners shall have first layer of insulation between the stiffeners and a second layer of insulation over stiffeners so that stiffeners are also insulated and a level surface is achieved. Other requirements are same as given in as specified at clause no 21.10.00 of this chapter. 10) Testing and Guarantee for insulation: 1. All tests, as per the applicable material standards and as specified shall be carried out in accordance with the methods prescribed. Employer shall have the right to witness any or all of the tests conducted by the contractor at the shop or laboratory. 2. The Contractor shall guarantee that if on actual measurement the specified maximum insulation surface temperatures are exceeded, the contractor shall either replace the insulation with a superior material or provide additional insulation thickness at no extra cost. 2.04.00 Refractories 2.04.01 The refractory material shall comply with relevant Indian Standards. The refractory selected shall ensure perfect sealing, and shall have good thermal cycling properties allowing quick startup/shut down of Steam Generators. 2.04.02 The refractory material shall			
WTE PROJECT (1 X 500 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-XXXX-001-1	Sub-Section – A 11 THERMAL INSULATION	Page 7 of 8

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
2.04.03	(a) Have high bulk density and minimum moisture content, (b) Be capable of withstanding service temperature of 1700 degree Celsius. (c) Be resistant to slagging products due to coal, and to impurities of oil like V_2O_5, Fe_2O_3, K_2O_2, Na_2O etc. and to erosion due to fly ash. (d) Be chemically inactive towards alkalis, iron, silica etc. shall pose no health hazard to working personnel, and shall not have any explosive properties. (e) Have sufficient strength to withstand forces generated in Steam Generator, without any rupture or damage.			
	Application of refractory shall be such that: (a) To ensure perfect sealing, easy maintenance, minimum time for application. (b) To ensure minimum number of joints, all the joints to be filled and tightly packed with loose powder of same material. (c) Selection of Refractory shall consider the applied stress, stress distribution and expansion allowance. (d) Refractories shall have good thermal cycling properties to ensure quick start up and shut down of Steam Generators.			
WTE PROJECT (1 X 500 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-XXXX-001-1	Sub-Section – A 11 THERMAL INSULATION	Page 8 of 8

SUB-SECTION–A-12

WATER SYSTEM

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	WATER SYSTEM			
1.00.00	This Chapter describes the System description, Basic Design Criteria and Minimum Technical Requirements of Water System for waste to energy and associated equipments.			
2.00.00	TECHNICAL REQUIREMENTS OF WATER SYSTEM AND ASSOCIATED EQUIPMENTS: The minimum technical requirements related to the design, manufacturing, testing etc. of the following equipment are furnished below. 1) Part-I : DM plant 2) Part-II : Pre-Treatment plant 3) Part-III: Pumps a). Horizontal centrifugal pumps. b). Vertical Pumps. c). Submersible pumps. 2) Part - IV: Auxiliary cooling water system 3) Part - V: Leachate Treatment system 4). Part- VI : Effluent treatment system 5) Piping, valves and Rubber expansion joint – As per LP Piping Sub Section 5) Painting –As per ‘Painting’ Subsection 6) AC and Ventilation - As per AC and ventilation sub section.			
3.00.00	Total make-up water available for the entire WTE plant is 20cum/hr. Make-up water shall be drawn from existing raw water reservoir through 2x100% raw water booster pumps.			
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI BID DOC. NO.: CS-2600-001-9	PART-B SUB-SECTION-A-12 WATER SYSTEM	PAGE 1 OF 35

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	PART-I DM PLANT			
1.00.00	TECHNICAL SPECIFICATION -GENERAL			
	i) Bidder to quote for only one (1) option i.e. either UF+RO+EDI or UF+RO+MB. The UF+RO+EDI OR UF+RO+MB system shall be capable of treating filter water to produce demineralized water. ii) The Plant shall consist of a Pre-treatment section, Reverse osmosis (RO) section and a Post-treatment section. The pre-treatment section will condition the water before it goes into the RO section. The pretreatment section shall include filtration and dechlorination. iii) The RO section shall be divided into 1x100% capacity train. The train shall have two-passes in which permeate water from the first pass feeds the second pass. iv) The post-treatment system will remove the remaining dissolved solids. It will consist of one Electro de-ionization (EDI) unit or Mixed bed (MB) unit which will treat the water to make it suitable as boiler make-up water.			
1.02.00	Design net capacity			
	The plant (UF+RO+EDI or UF+RO+MB) shall operate at an overall recovery rate 75% (Minimum).			
1.03.00	TECHNICAL SPECIFICATION			
1.04.00	PRESSURE FILTER			
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI BID DOC. NO.: CS-2600-001-9	PART-B SUB-SECTION-A-12 WATER SYSTEM	PAGE 2 OF 35

CLAUSE NO.	TECHNICAL REQUIREMENTS			
1.05.00	a)	Pressure Filter shall be sized for the flow rate of the basket filter at UF inlet. Air blower shall be used for air scouring of filter bed. Backwashing for the filter shall be done in 20-24 hours.		
	b)	The filter shall have sufficient freeboard height to permit bed expansion of 50%. Freeboard provided shall be based on total volume of media.		
	c)	The filtering medium shall be washed, screened and hydraulically graded anthracite coal or sand with graded gravel as supporting medium.		
	d)	All piping downstream of the filters shall be CPVC Schedule 80.		
	e)	Material of construction for Pressure filters shall be MSEP/FRP/GRP.		
1.05.00	BASKET FILTER			
1.06.00	a)	Basket Filter shall be sized for the flow rate of the UF. The vessel shall be made of SS-316. The filters shall be designed as automatic type. The basket filter shall be designed and operated in such ways that it also goes for back wash every time the UF is going for backwash. This will ensure that basket filter is clean and is working effectively.		
	ULTRA-FILTRATION (UF) SYSTEM			
	a)	The Ultra-Filtration (UF) Skid should be designed for suitable capacity to match the RO Flow. UF shall be pressurized type.		
	b)	Membranes shall be of reinforced hollow fiber type, chlorine tolerant PVDF/Polyether Sulphone/Polysulphone material. Gross flux of membranes shall be less than 60 LMH. Pore size of the membrane shall not be more than 0.04 microns. Make: Norrit-Pentair/Hydranautics/Dow/GE/Toray/Koch/Inge		
	c)	These membranes should take free chlorine up to 200 ppm in operation cycles.		
	d)	The pressure tube shall be side port type and of FRP material.		
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI BID DOC. NO.: CS-2600-001-9	PART-B SUB-SECTION-A-12 WATER SYSTEM	PAGE 3 OF 35

CLAUSE NO.	TECHNICAL REQUIREMENTS			
1.07.00	e)	The hollow fiber membranes should have out-to-in or inside-out configuration as per manufacturer's standard.		
	f)	The Ultra Filtration System should have air-scouring feature for back wash for effectively doing the backwashing.		
	g)	Chemically Enhanced backwash (CEB) shall have Sodium Hypo Chlorite Dosing Tank and Pump, Hydrochloric Acid Dosing tank and Pumps, Alkali Dosing Tanks, Pumps and agitator. Dosing Pump and dosing tanks should integrate as a single system.		
	h)	One (1) number of UF backwash pump shall be provided. UF permeate water shall be used for backwashing.		
	i)	The Permeate water from Ultra Filtration should go into the UF permeate tank of suitable capacity designed as per system requirement. The material of construction of tank shall be HDPE.		
1.08.00	RO SYSTEM (2 PASS)			
1.08.00	a)	RO System shall be two pass and include Pre-filtration system, reverse osmosis membrane, pressure vessels, high pressure pump and all required piping, wiring and controls for a fully operational system.		
	MICRON CARTRIDGE FILTER (MCF)			
	a)	Micron Cartridge Filter (5 microns) shall be provided at the up-stream of R.O to protect the membranes from larger size impurities.		
	b)	The Cartridges shall be removable polypropylene Spiral Wound type. Required no. of cartridges shall be provided.		
1.09.00	c)	MCF casing and internals shall be SS-316.		
		Make: GE/CUNO Filtration/Godani/MMP filtration/Approved Equiv.		
	RO BLOCK			
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI BID DOC. NO.: CS-2600-001-9	PART-B SUB-SECTION-A-12 WATER SYSTEM	PAGE 4 OF 35

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	a) Reverse Osmosis system: Reverse Osmosis system shall be of two (2) pass, designed for suitable capacity for EDI/MB flow producing RO permeate water suitable for EDI/MB inlet. b) RO Membrane Elements: The membrane elements shall be spiral wound composite polyamide membrane elements. In order to have a leak-tight connection between adjacent element RO membranes should have interlocking facility. c) RO Element Housings: RO train shall be an integrated assembly of high-strength thermally cured Fiber reinforced epoxy pressure tubes housing RO membrane elements. The pressure tubes for RO Plants should be ASME Section X compliant design. In order to monitor the product water at each pressure tube sampling valves and probe test point shall be provided at each pressure tube. Make: NORRIT-PENTAIR/Approved Equiv. d) It should have facility for the auto monitoring of Feed Conductivity, DP across RO, SDI, pH of CIP Solutions, Product Conductivity. e) High Pressure Pumps and Motors: Vertical high efficiency centrifugal multistage high pressure pumps (1W+1S) with VFD, of required flow and head shall be provided with pressure switches at the inlet and outlet of the pump. High pressure pumps housing shall be SS 316, mill finish. All internally wetted parts are SS 316 to eliminate corrosion problems. The pumps shall be powered by a HP Totally Enclosed Fan Cooled (TEFC) motor. The motor selected shall be non-overloading on the entire performance curve. Make: GRUNDFOSS/EBARA/Approved Equiv. f) The RO system shall be sized to produce the rated output and quality for the entire life of the membrane. There shall be provision of Auto raw water flushing, Permeate soaking cycle at each start and stop so as to prevent the			
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI BID DOC. NO.: CS-2600-001-9	PART-B SUB-SECTION-A-12 WATER SYSTEM	PAGE 5 OF 35

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनडीपीसी NTPC
1.09.01	precipitation of the sparingly soluble materials on the membrane surface during the periods of shut down. g) The RO system should be so designed that there is auto sensing on variation in raw water quality and product water quality. h) In order to ensure that the RO membranes are safe there should be auto reminder facility for chemical cleaning, calibration, dosing chemicals and replacement of cartridge. i) Alarms/trips should be provided on variation in the feed pH, tampering with recovery, recycling.			
	RO CHEMICAL CLEANING SYSTEM			
	a) The RO Chemical cleaning system consist of one (1) no. of tank, one (1) no. of pump with motor and Micron Cartridge Filter. b) There shall be provision in the RO system to monitor the pH of the Cleaning solution. c) An alarm system shall be provided for alerting the operators when fault conditions will occur and the plant shall be shut down automatically in the event of critical failure conditions.			
	ELECTRO DE-IONIZATION UNIT			
1.10.00	a) The Electro de-ionization process should be a Combination of Ion exchange membranes, Ion exchange resins and DC electric potential System must be designed with the minimum numbers of module with quality commitment & one frame construction along with control panel. b) The Electro de-ionization system shall be designed in such as way that there is no concentrate recirculation. c) The EDI system should be fully automatic. The complete deionization process should be a Chemical Free Process.			
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI BID DOC. NO.: CS-2600-001-9	PART-B SUB-SECTION-A-12 WATER SYSTEM	PAGE 6 OF 35

CLAUSE NO.	TECHNICAL REQUIREMENTS																					
	d) The system configuration should be Plate and frame type. The modules should be arranged vertically or as per EDI manufacturer's standard. e) The Design of the EDI system should not involve any brine injection and/or product recirculation. To improve the system recovery, the reject of EDI can be directly recirculated to RO feed, hence the reject of EDI should be free from free Chlorine, Hydrogen and Oxygen gas. f) There shall not be any salt bridging. The Complete EDI Module shall be leak proof. g) Flow rate through the EDI units will be controlled by varying the RO flow rate using the VFDs. Any adjustments on the concentrate flow or pressure will take place automatically. h) System must have a capability of 24 X 7 operations. i) The following minimum feed water requirements shall be met at the feed of EDI unit: <table><tr><td>Feed water source</td><td>RO permeate</td></tr><tr><td>Feed water conductivity</td><td>< 25 micro S/cm</td></tr><tr><td>Silica (SiO₂)</td><td>< 1 ppm</td></tr><tr><td>Iron, Mn, Sulfite</td><td>< 0.01 ppm</td></tr><tr><td>Free Chlorine</td><td>< 0.02 ppm</td></tr><tr><td>Hardness</td><td>< 1.0 ppm</td></tr><tr><td>Dissolved Organics</td><td>< 0.5 ppm</td></tr><tr><td>Operating pH range</td><td>5 – 9</td></tr><tr><td>Operating Temperature</td><td>40 – 113 deg F (5 – 45 deg C)</td></tr></table>				Feed water source	RO permeate	Feed water conductivity	< 25 micro S/cm	Silica (SiO ₂)	< 1 ppm	Iron, Mn, Sulfite	< 0.01 ppm	Free Chlorine	< 0.02 ppm	Hardness	< 1.0 ppm	Dissolved Organics	< 0.5 ppm	Operating pH range	5 – 9	Operating Temperature	40 – 113 deg F (5 – 45 deg C)
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Feed water conductivity	< 25 micro S/cm																					
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Operating pH range	5 – 9																					
Operating Temperature	40 – 113 deg F (5 – 45 deg C)																					
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI BID DOC. NO.: CS-2600-001-9	PART-B SUB-SECTION-A-12 WATER SYSTEM	PAGE 7 OF 35																		

CLAUSE NO.	एनडीपीसी NTPC TECHNICAL REQUIREMENTS
1.11.00 1.11.01 1.11.02	j) The EDI system shall be supplied with a 4 hrs Factory performance test, before dispatch. The testing of the system shall be done controlled atmospheric conditions considering the sensitivity of the System. k) To protect the system during transportation, vacuum packing shall be done. The complete Continuous Electro Deionisation system should be Factory assembled and FAT (Factory acceptance Test) conducted for Minimum 6 Hrs before dispatch from factory. l) The Electrodeionisers shall polish the water to meet the guaranteed parameters specified. EDI Make: GE/SIEMENS/SNOWPURE/QUA MIXED BED ION EXCHANGER GENERAL REQUIREMENT a) Material of construction for MB vessels shall be FRP/MSRL construction. The vessel internals such as inlet distributor, regenerant distributor, under drain system etc. shall be of proven design. b) In case strainer-on-plate design is used for under drain system, an additional manhole shall be provided to give access below the bed plate for all units of filters, Ion Exchange Units etc. c) All valves used with vessels shall be suitably arranged in the front in accessible position, for manual operation in case of emergency. d) MB stream shall be designed to run continuously at its rated capacity. e) Suitable permanent flushing connections shall be provided for all pipelines carrying acid and alkali. f) The period between two successive regenerations and net output between two regenerations for MB units shall be as specified. DESIGN AND CONSTRUCTION FEATURES
	KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE TECHNICAL SPECIFICATION SECTION-VI BID DOC. NO.: CS-2600-001-9 PART-B SUB-SECTION-A-12 WATER SYSTEM PAGE 8 OF 35

CLAUSE NO.	TECHNICAL REQUIREMENTS			
1.11.03	a) Design and Fabrication of the vessels should be as specified. b) The inlet distribution, under drain collecting systems and regenerant inlet distribution system / middle collector shall be so designed as to give uniform distribution and flow without channeling and obstruction. The under drain collector system shall be header lateral or strainer-on-plate type and shall be adequately designed to ensure uniform distribution of flow. The interface collector & distributor shall be of suitable acid/alkali resistant material. All internal studs/nuts/washers shall be of suitable material for acid/alkali service. c) At least 100% free board shall be provided over resin bed below the backwash outlet nozzle and in straight portion of vessel to allow for expansion during backwashing and for addition of extra resin, if required. d) The exchanger unit shall be provided with resin traps on treated water outlet line. Resin traps shall also be provided both on the backwash and regenerant outlet lines. Flow measuring instrument shall also be provided at the regenerate outlet. e) Suitable sample connection shall be provided.			
	Regeneration System a) The ion exchange resin shall be regenerated by employing optimum regeneration level to prevent leakage of ions. Cation resins shall be regenerated by hydrochloric acid (30-33% w/v technical grade IS: 265) and anion resins by sodium hydroxide (48% w/v rayon grade in flakes or lye form as per IS: 252). The strength of acid regenerant and alkali regenerant at the cation and anion bed inlet shall be selected accordingly. b) Type of Bidder's regeneration technique (co-current or counter-current) shall be as per the proven practice of the Contractor/Supplier. c) The process calculation shall be furnished by the bidder during detailed engineering indicating the various steps of regeneration, regeneration level			
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI BID DOC. NO.: CS-2600-001-9	PART-B SUB-SECTION-A-12 WATER SYSTEM	PAGE 9 OF 35

CLAUSE NO.	 TECHNICAL REQUIREMENTS		
1.11.04	employed, total and used exchange capacity of resins, resin quantity provided etc. The bidder shall also furnish relevant resin literature & curves indicating various parameters and exchange capacity & regeneration levels selected along with the process calculations. d) Regeneration facilities offered shall be complete with acid/alkali measuring tanks, ejectors for dosing of chemicals as applicable. Acid or alkali from the measuring tank shall be injected to exchangers by means of hydraulically operated ejector or metering pumps at suitable strength. e) Automatic block and bleed valves shall be provided at the regenerant inlet line(s) to each exchanger of Mixed (MB) Bed. f) Suitable sampling connection shall be provided for acid/alkali storage, preparation & handling equipments.		
	Exchange Resin a) Cation and anion resin shall be of reputed make and must have been in use capable of producing water of quality as specified or better, for a period of not less than three (3) years. b) Cation and anion resin charge shall consist of material properly selected washed, processed and graded to provide the guaranteed capacity and life and shall have adequate abrasion resistance during its guaranteed life. c) The cation exchanger resin used in the mixed bed exchanger shall be strongly acidic, high capacity polystyrene resin in the bead form to the satisfaction of the Engineer. d) The anion exchanger resin used mixed bed shall be strongly basic, high capacity resin (Type-I) in bead form to the satisfaction of the Engineer. The anion resin shall be able to withstand a temperature of 60 deg. C (minimum) continuously. Type-II anion resin shall not be accepted. Strong Base Anion resin (or weak base Anion in case of hookup) shall be MACROPOROUS type only.		
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI BID DOC. NO.: CS-2600-001-9	PART-B SUB-SECTION-A-12 WATER SYSTEM PAGE 10 OF 35

CLAUSE NO.	TECHNICAL REQUIREMENTS			
1.11.05	e) Degasser System (as applicable) shall be designed to reduce dissolved CO₂ in treated water. Waste Water Neutralizing Arrangement a) Bidder shall design the plant in such a way that the regenerant effluent from the mixed bed unit is self neutralising. Provision shall however be made to dose acid, alkali and lime to neutralise the effluent, whenever required Bidder shall furnish the calculations in support of his claim that the resultant effluent is self neutralizing or furnish the amount of chemical required for neutralizing the same during detailed engineering. Suitable waste effluent collection system and disposal system (hose) shall be provided.			
1.11.06	General Requirements for FRP Vessels and Tanks a) Design of all FRP pressure vessels shall conform to ASME Section X standard. Design pressure shall be the maximum expected pressure to which the vessels may be subjected to plus 5% additional margin. Maximum expected pressure for vessels placed in the discharge line of pumps shall be based on the shut-off head of the pumps plus static head at pumps suction if any. However, design pressure shall be at least 8 Kg/cm²(g). b) Resins used for the tanks shall be a commercial grade corrosion-resistant thermoset, fully tested and accepted for the service conditions. Resins shall not contain fillers, pigments, dyes or colorants. Clear UV absorbers shall be used in final resin coat. Tanks shall be covered top with suitable reinforcing and bracing. c) Regardless of the theoretical design requirements, the minimum total laminate thickness of the filament wound tank shall not be less than 12 mm. d) All surfacing shall be finished as so to obtain complete cure of the resin without air inhibition. Acetone sensitivity on any surface shall be considered evidence of unsatisfactory cure. e) Unless otherwise specified, the inner surface shall consist of a resin-			
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI BID DOC. NO.: CS-2600-001-9	PART-B SUB-SECTION-A-12 WATER SYSTEM	PAGE 11 OF 35

CLAUSE NO.	TECHNICAL REQUIREMENTS			
1.12.00	saturated layer of 0.25 to 0.50 mm thick Type C glass surfacing mat. No resin gelcoat shall be used.			
	f) The longitudinal strength of the cylindrical shell shall be at least 25% of the hoop strength No paints or pigmented, coloured, or dyed resins shall be used the outside surface of the tank.			
	g) Unless otherwise specified, nozzles shall have a flanged faces perpendicular to the vertical centerline of the tank/to radial centerlines as the case may be.			
	h) There shall be no vertical joints (in axial direction) in the cylindrical shell. The entire thickness of the cylindrical shell shall be built up prior to removal of the shell from the mandrel. Heads may be fabricated integrally with the shell or may be fabricated separately; heads fabricated separately shall be moulded with an integral skirt. The minimum skirt length shall be 100 mm. The entire head including knuckle radius and skirt shall be fabricated in one piece. Teflon gaskets shall be provided.			
	i) All linings and coatings shall extend through all tank openings and nozzles and around to flange faces. Flanges shall be meeting the requirements AWWAC202. The vessels shall be equipped with lifting lugs, nozzles etc.			
	DOZING SYSTEM			
	a) All dosing tanks shall be of molded Fiber Reinforced Plastic (FRP) material or moulded UV stabilized semitransparent high density poly-ethylene material and shall be shop manufactured.			
	b) Dosing Pump and dosing tanks should integrate as a single system.			
	c) Enclosure of dosing pump shall be IP-65 There should be facility of Air purge at pump top.			
	d) It should have double balled NRV to eliminate chances of reverse flow. There should be molded connections for agitator, dosing line, level switch & indicator, service water.			
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI BID DOC. NO.: CS-2600-001-9	PART-B SUB-SECTION-A-12 WATER SYSTEM	PAGE 12 OF 35

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	e) The dosing pump should have 150 strokes/min for precise control of chemicals. Dosing tanks should have corrosive free FRP tanks. f) Necessary level switches and level gauges etc. shall be provided. g) Supply of all types of operating and cleaning and lab chemicals shall be in the scope of the bidder for the initial and trial operations and up to six (6) months from the commissioning of UF+RO+EDI OR UF+RO+MB units.			
	PART-II PRE-TREATMENT PLANT			
1.00.00	This specification defines the basic guidelines to design, manufacture and supply the pre-treatment plant.			
1.01.00	MBBR System			
1.01.01	The process design for MBBR system shall be suitable to reduce BOD and total nitrogen to the acceptable level. The MBBR process shall include the following:			
1.01.02	The process train shall comprise of MBBR reactors (if required) followed by membrane filtration. Total hydraulic residence time (HRT) in MBBR system shall not be less than 1.2 hours and not more than 2 hours. Anoxic reactor alongwith submersible mixers shall be provided, if required.			
1.01.03	For aeration, a bubble diffusers aeration system shall be provided. The aeration system with drilled holes in pipes shall not be acceptable. Anoxic reactor (if required) shall be provided with suitable size submersible mixers. The aeration system diffusers shall be arranged to provide a mixing pattern that causes the media to be thoroughly mixed through the whole depth, width, and length of the aerobic volume and prevents media from floating at the tank surface or in the corners of the basin. This will be achieved by spacing the diffusers with gaps between groups of diffusers in order to create a rolling action.			
1.01.04	The aeration system shall be provided for sufficient oxygen supply for the effective biodegradation in aerobic reactors. The level of dissolved oxygen in the Aerobic reactors shall be maintained at 2.0 mg/l or above to facilitate the required biodegradation.			
1.01.05	The blowers to supply air to the bioreactor shall have 100% standby capacity. Wedge wire screens made from SS-316 or superior material shall be provided to ensure that media does not escape to the downstream unit.			
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI BID DOC. NO.: CS-2600-001-9	PART-B SUB-SECTION-A-12 WATER SYSTEM	PAGE 13 OF 35

CLAUSE NO.	TECHNICAL REQUIREMENTS			
1.01.06	The MBBR reactors shall contain special engineered biofilm carriers made of HDPE to provide extended surface area for attached micro-organism growth. Biofilm carriers or media will occupy not more than 60 % of the reactor volume. To allow the biofilm carriers to move freely inside the reactors, mixers will be installed in each reactor. The carriers in the anoxic reactors will be mixed by mechanical mixer while the carriers in the aerobic reactors will be mixed by airlift hydraulics using the process supplied through diffusers arranged on the reactor basin floor.			
1.01.07	To allow the raw water to be transferred to the next reactor within each MBBR train without any transfer of bio-carriers, stainless steel (SS-316) wedge wire screens will be installed between MBBR reactors. The size of the screens will be governed by the size of the bio-carriers.			
1.01.08	Turbidity, ammonia nitrate and pH analyzers shall be installed at the upstream of biological treatment to on-line record the parameters and control the chemical injection. The dose rate control of methanol and phosphoric acid (if required) will be based on the concentration of the above parameters in raw water.			
1.01.09	Blowers, piping, valves and other equipment to maintain air flow to the aerobic reactors shall suit the needs of the media circulation and aeration of MBBR system. A standby blower unit shall be provided. The blower room should be design to accommodate all blowers required for the full capacity plant with acoustic enclose.			
1.01.10	All pumping stations, pipes, valves, instruments etc as required to recirculate feed mixed liquor with reactors for nitrogen removal. All systems and process equipment as necessary to meet the performance requirements will be provided. As a minimum, a standby unit must be provided for the mixed liquor pumping station.			
1.01.11	At least two mechanical mixers will be required to maintain solids in suspension in the anoxic zone (in case if anoxic reactor is required). The mixers will be fitted with lifting system for operational and maintenance convenience.			
1.01.12	Each compartment of the reactors shall have adequate walkways all around the units with hand railing, platforms and staircase for installation of the equipment and maintenance.			
1.01.13	Suitable bypass line shall be provided rated at the maximum hydraulic capacity to bypass the biological treatment system and to connect directly to the membrane system. Bypass line shall be provided to each process train.			
1.01.14	Hydraulics of the Complete Sewage treatment Plant shall be designed to take an occasional over loading of 20% over the design flow.			
1.02.00	Membrane Biological reactor (MBR) Process			
1.02.01	Data regarding number of MBR trains, capacity of each Stream/train, Number of working & standby Streams/Trains, etc shall be as per system requirement.. Further, in case of MBR system, the reactor clarifier at the outlet is not required to			
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI BID DOC. NO.: CS-2600-001-9	PART-B SUB-SECTION-A-12 WATER SYSTEM	PAGE 14 OF 35

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनडीपीसी NTPC
	be provided and the treated effluent from MBR system will be led directly to the Clarifier water storage tank. The MBR process shall include the following:			
1.02.02	Membrane bioreactor reactors (MBR) shall be complete with the anoxic zones (if required) for denitrification. The number of membrane cassettes (modules) to be supplied and installed all match the loading requirements. The bidder may consider staging the membranes infrastructure (tanks, blowers, cleaning equipment etc.) where it suits proprietary systems			
1.02.03	The MBR system shall include a fully automatic “Clean-In-Place/cleaning system” to maintain performance of the membranes. The CIP sequence should be operator initiated.			
1.02.04	Blowers, pumps, valves and other equipment to deliver membrane agitation air to the membrane modules shall suit the needs of the MBR system. A standby blower unit shall be provided. The equipment sizing shall be sufficient to meet the required capacity.			
1.02.05	The waste activated sludge will be transported to the existing sludge sump. The bidder shall provide a solution to contain the odour release from the balance tank.			
1.02.06	All pumping station's pipes valves, instruments etc as required to feed mixed liquor to the membrane zone (and / or draw out of membrane zone), produce filtrate, backwash, perform CIP and all other anticipated operations and sequences shall be provided. All systems and process equipment as necessary to meet the performance requirement for MBR process will be provided by the bidder. As a minimum, a standby unit must be provided for the mixed liquor priming station.			
1.02.07	Mixers will be required to maintain solids in suspension in the anoxic zone (as applicable).			
1.02.08	Facilities to withdraw waster activated sludge and deliver it to the existing sludge sump.			
1.02.09	Suitable bypass line shall be provided rated at the maximum hydraulic capacity to bypass the biological treatment system and to connect directly to Clarified water tank. Bypass line shall be provided to each process train.			
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI BID DOC. NO.: CS-2600-001-9	PART-B SUB-SECTION-A-12 WATER SYSTEM	PAGE 15 OF 35

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	PART-III PUMPS (A).HORIZONTAL CENTRIFUGAL PUMPS 1.00.00SCOPE 1.01.00The specification covers general requirements in respect of design, material, constructional features, manufacture, inspection, testing the performance at the Vendor's/ Sub-Vendor's works and delivery to site erection, field testing and commissioning of Horizontal Centrifugal Pumps. 2.00.00CODES AND STANDARDS 2.01.00The design, material, construction manufacture inspection and performance testing of Horizontal Centrifugal Pumps shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. The equipment supplied shall comply with the latest applicable Indian standards listed below. Other National Standards are acceptable, if they are established to be equal or superior to the Indian Standards. 2.02.00List of Applicable Standards i) IS : 1520 - Horizontal Centrifugal Pumps for clear cold fresh water. ii) IS : 5120 - Technical requirements of rotodynamic special purpose pumps			
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI BID DOC. NO.: CS-2600-001-9	PART-B SUB-SECTION-A-12 WATER SYSTEM	PAGE 16 OF 35

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC									
	iii) API – 610 - Centrifugal pumps for general refinery service. iv) IS : 5639 - Pumps Handling Chemicals & corrosion liquids. v) IS : 5659 - Pumps for process water vi) HIS - Hydraulic Institute Standards ; USA vii) ASTM-I-165-65 - Standards Methods for Liquid Penetration Inspection.												
2.03.00	In case of any contradiction with aforesaid standards and the stipulations as per the technical specifications as specified hereinafter the stipulations of the technical specifications shall prevail.												
3.00.00	DESIGN REQUIREMENTS												
3.01.00	The maximum efficiency of pumps shall be preferably be within $\pm$ 10% of the rated design flow indicated in data sheets.												
3.02.00	The total head capacity curve shall be continuously rising from the operating point towards shut–off without any zone of instability and with a minimum shut off head of 15% more than design head.												
3.03.00	Pumps of a particular category shall be identical and shall be suitable for parallel operation with equal load division. The head Vs capacity and BHP Vs capacity characteristics should match to ensure even load sharing and trouble free operation throughout the range. Components of identical pumps shall be interchangeable.												
3.04.00	Pumps shall run smoothly without undue noise and vibration. Peak to peak vibration limits shall be restricted to the following values during operation. <table><tr><th>Speed</th><th>Antifriction Bearing</th><th>Sleeve Bearing</th></tr><tr><td>1500 rpm and below</td><td>75.0 micron</td><td>75.0 micron</td></tr><tr><td>3000 rpm</td><td>50.0 micron</td><td>65.0 micron</td></tr></table> The noise level shall not exceed 85 dBA. Overall sound pressure level reference 0.0002 microbar (the standard pressure reference for air sound measurement) at a distance of 1M from the equipment surface.				Speed	Antifriction Bearing	Sleeve Bearing	1500 rpm and below	75.0 micron	75.0 micron	3000 rpm	50.0 micron	65.0 micron
Speed	Antifriction Bearing	Sleeve Bearing											
1500 rpm and below	75.0 micron	75.0 micron											
3000 rpm	50.0 micron	65.0 micron											
3.05.00	The pumps shall be capable of starting with discharge valve fully open and close condition.												
4.00.00	DESIGN CONSTRUCTION												
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI BID DOC. NO.: CS-2600-001-9	PART-B SUB-SECTION-A-12 WATER SYSTEM	PAGE 17 OF 35									

CLAUSE NO.	TECHNICAL REQUIREMENTS	एनटीपीसी NTPC	
4.01.00	Pump casing shall have radially split type construction. The casing shall be designed to withstand the maximum shut – off pressure developed by the pump at the pumping temperature.		
4.01.01	Pump casing shall be provided with a vent connection and piping with fittings & valves Casing drain as required shall be provided complete with drain valves, piping and plugs. It shall be provided with a connection for suction and discharge pr. Gauge as standard feature.		
4.02.00	Impeller		
4.02.01	Impeller shall be closed or semi-closed as specified elsewhere and designed in conformance with the detailed analysis of the liquid being handled. The impeller shall be secured to the shaft, and shall be retained against circumferential movement by keying pinning or lock rings.		
4.03.00	Impeller/ Casing Wearing Rings		
4.03.01	Replaceable type wearing rings shall be provided at suitable locations pumps. Suitable method of locking the wearing ring shall be used.		
4.04.00	Shaft		
4.04.01	The critical speed shall be well away from the operating speed and in no case less than 130% of the rated speed.		
4.05.00	Shaft Sleeves		
4.05.01	Shaft sleeves shall be fastened to the shaft to prevent any leakage or loosening. Shaft and shaft sleeve assembly should ensure concentric rotation.		
4.06.00	Bearings		
4.06.01	Heavy duty bearings, adequately designed for the type of service specified in the enclosed pump data sheet and for long, trouble - free operation shall be furnished.		
4.06.02	The bearings offered shall be capable of tanking both the radial and axial thrust coming into play during operation. In case, sleeve bearings are offered additional thrust bearings are offered additional thrust bearings shall be provided. Anti-friction bearings of standard type, if provided, shall be selected for a minimum life 16,000 hrs. of continuous operation at maximum axial and a radial loads and rated speed.		
4.06.03	Proper lubricating arrangement for the bearings shall be provided such that lubricating element does not contaminate the liquid pumped. Where there is a possibility of liquid entering the bearings suitable arrangement in the form of		
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI BID DOC. NO.: CS-2600-001-9	PART-B SUB-SECTION-A-12 WATER SYSTEM
PAGE 18 OF 35			

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	deflectors or any other suitable arrangement must be provided ahead of bearing assembly.			
4.06.04	Bearings shall be easily accessible without disturbing the pump assembly. A drain plug shall be provided at the bottom of each bearing housing.			
4.07.00	Stuffing Boxes Stuffing boxes of packed ring construction type shall be provided wherever specified. Packed ring stuffing boxes shall be properly lubricated and sealed as per service requirements and manufacturer’s standard. If external gland sealing is required, it shall be done from the pump discharge. The Bidder shall provide the necessary piping, valves, fitting etc. for the sealing connection.			
4.08.00	Mechanical Seals			
4.08.01	Wherever specified in pump data sheet, mechanical seals shall be provided. The sealing face should be highly lapped surfaces of material known for their low fractional co-efficient & resistance to corrosion against the liquid being pumped.			
4.09.00	Pump Shaft Motor Shaft Coupling			
4.09.01	The Pump and motor shaft shall be connected with a adequately sized flexible coupling of proven design with a spacer to facilitate dismantling of the pump without disturbing the motor. Necessary coupling guards.			
4.10.00	Base Plate			
4.10.01	A common base plate mounting both for the pump and motor shall be furnished. The base plate shall be of fabricated steel and of rigid construction, suitable ribbed and reinforced.			
4.11.00	Assembly and Dismantling			
4.11.01	Assembly and dismantling of each pump with drive motor shall be possible without disturbing the grouting base plate or alignment.			
4.12.00	Drive Motor (Prime Mover)			
4.12.01	The KW rating of the drive shall be based on continuously driving the connected equipment for the conditions specified. In case, where parallel operation of the pumps are specified, the actual motor rating is to be selected considering overloading of the pump in the event of tripping of operating pumps. Continuous motor rating (at 50 deg. ambient) for pump shall be at least 10% above the maximum load demand of the driven equipment in the complete range.			
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI BID DOC. NO.: CS-2600-001-9	PART-B SUB-SECTION-A-12 WATER SYSTEM	PAGE 19 OF 35

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC																																										
	Appendix-I TECHNICAL DATA SHEET <table border="1"> <thead> <tr> <th colspan="3">a). PUMPS - DM WATER APPLICATION</th> </tr> </thead> <tbody> <tr> <td>1)</td> <td>Working Fluid</td> <td>----- DM Water -----</td> </tr> <tr> <td>2)</td> <td>Operating Speed</td> <td>1500 rpm (nominal)</td> </tr> <tr> <td>3)</td> <td>Pumps and drives to be designed for</td> <td>Outdoor duty</td> </tr> <tr> <td>4)</td> <td>Service of duty</td> <td>Continuous</td> </tr> <tr> <td>5)</td> <td>Type of pump casing</td> <td>Preferably Radially Split type</td> </tr> <tr> <td>6)</td> <td>Type of impeller</td> <td>Closed / Semi Open</td> </tr> <tr> <td>7)</td> <td>Type of lubrication</td> <td>Grease</td> </tr> <tr> <td>8)</td> <td>Suction condition</td> <td>Flooded suction</td> </tr> <tr> <td>9)</td> <td>Type of Shaft Sealing</td> <td>Mechanical Seal</td> </tr> <tr> <td>10)</td> <td colspan="2"><u>Material of Construction :</u></td> </tr> <tr> <td>i)</td> <td>Casing</td> <td>ASTM A CF 8M</td> </tr> <tr> <td>ii)</td> <td>Impeller</td> <td>ASTM A CF 8M</td> </tr> <tr> <td>iii)</td> <td>Wearing rings</td> <td>SS -316</td> </tr> </tbody> </table>				a). PUMPS - DM WATER APPLICATION			1)	Working Fluid	----- DM Water -----	2)	Operating Speed	1500 rpm (nominal)	3)	Pumps and drives to be designed for	Outdoor duty	4)	Service of duty	Continuous	5)	Type of pump casing	Preferably Radially Split type	6)	Type of impeller	Closed / Semi Open	7)	Type of lubrication	Grease	8)	Suction condition	Flooded suction	9)	Type of Shaft Sealing	Mechanical Seal	10)	<u>Material of Construction :</u>		i)	Casing	ASTM A CF 8M	ii)	Impeller	ASTM A CF 8M	iii)	Wearing rings	SS -316
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KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI BID DOC. NO.: CS-2600-001-9	PART-B SUB-SECTION-A-12 WATER SYSTEM	PAGE 20 OF 35																																										

CLAUSE NO.	TECHNICAL REQUIREMENTS		
		(if applicable)	
	iv)	Shaft	SS -410
	v)	Shaft sleeves	SS – 410
	vi)	Mechanical Seal	As per manufacturer's standard suiting to the liquid being pumped
	vii)	Bolts & nuts	Stainless steel for those coming in contact with water and for others, material shall be high tension carbon steel.
	viii)	Base plate	Carbon steel (Epoxy painted)

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	b). PUMPS - CLARIFIED WATER APPLICATION			
	NO	DESCRIPTION	PARAMETERS	
	1.	Operating Speed (Max)	1500 rpm (Nominal)	
	2.	Location of pumps	Outdoor duty	
	3.	Service of duty	Continuous	
	4.	Type of pump	Horizontal	
	5.	Type of Working Fluid	Clarified water /Treated water	
	6.	Type of impeller	Closed/Semi open	
	7.	Type of lubrication	Grease	
	8.	Suction condition	Flooded suction	
	9.	Material of Construction :		
	I.	Casing	2.5% Ni Cl IS210 Gr FG 260	
	II.	Impeller	SS -316	
	III.	Wearing rings (if applicable)	SS -316	
	IV.	Shaft	SS-410	
	V.	Shaft sleeves	SS-410	
	VI.	Stuffing box	2.5% Ni Cl IS210 Gr FG 260	
	VII.	Gland	2.5% Ni Cl IS210 Gr FG 260	
	VIII.	Gland packing	As per Manufacturers standard	
	IX.	Gaskets	As per Manufacturers standard	
	a)	Bolts & nuts	Stainless steel for those coming in contact with water and for others, material shall be high tension carbon steel.	
	b)	Base plate	Carbon steel (Minimum 10 mm thick)	

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	(B). VERTICAL PUMPS			
1.00.00	SCOPE			
1.01.00	This specification covers general requirements in respect of design, construction features, manufacture, inspection and performance at Vendor's / sub-vendor's works delivery to site, erection field testing and commissioning of vertical Pumps.			
2.00.00	CODES AND STANDARDS			
2.01.00	The design, material, construction, manufacture, inspection, testing and performance of Vertical Pumps shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. The equipment supplied shall comply with the latest applicable Standards listed below. Other national standards are acceptable, if they are established to be equal or superior to the listed standards.			
2.02.00	List of Applicable Standards IS: 1710 : Vertical Turbine Pumps for clear cold fresh water. IS: 5120 : Technical requirement of rotor dynamic special purpose pumps. HIS : Hydraulic Institute Standards U.S.A. PTC 82 : Centrifugal pumps-power test code API 610 : Centrifugal pumps for general refinery purposes. In case of any contradiction with aforesaid standards and the specifications requirements as specified hereinafter the stipulations of the technical specifications shall prevail.			
3.00.00	DESIGN AND PERFORMANCE REQUIREMENTS			
3.01.00	The maximum efficiency point of the pumps shall preferably lie within 10% of the rated design flow.			
3.02.00	Pumps of a particular category shall be identical, suitable for parallel operation and provided with interchangeable components. Head vs. capacity and BHP vs. Capacity characteristic should match to ensure even load sharing and trouble free operation throughout the range.			
3.03.00	The pumps shall have stable Head vs. Capacity characteristic continuously rising towards shut-off with the highest at shut-off and with an approximate shut-off head of 15% or more than the design head for radial flow pumps and 25% more than the design head for mixed flow/ turbine type pumps.			
3.04.00	The operating range of operation of pumps shall generally be 40% to 120% of rated flow for sustained period of operation.			
3.05.00	The power requirement of the pump shall be non-over loading type for mixed flow/ turbine type pumps.			
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI BID DOC. NO.: CS-2600-001-9	PART-B SUB-SECTION-A-12 WATER SYSTEM	PAGE 23 OF 35

CLAUSE NO.	TECHNICAL REQUIREMENTS			
3.06.00	The critical speed of the pump shall be less than 80% of the rated speed or more than 130% of the rated speed. Also, the critical speed of the pump-motor assembly shall be more than the maximum reverse run-away speed.			
3.07.00	Pump shall run smoothly without undue noise and vibration. The vibration limit measured at motor end shall not exceed the limit specified in Hydraulic Institute Standards. The noise level shall not exceed 85 dBA overall sound pressure level reference 0.0002 microbar (the standard pressure reference for air sound measurement) at a distance of 1M from the equipment surface.			
3.08.00	The base plate, foundation bolts, motor stool and other components shall be designed to take the full force coming on the discharge elbow under shut-off condition due to provision of expansion joint (untied condition prevailing)) on the discharge pipe.			
3.09.00	Water for motor cooling and thrust bearing cooling, if required, shall be tapped from the discharge of the pumps and/or fed from an over-head tank. All piping, valves, strainer, instruments etc. required for this purpose and line shaft bearing lubrication (if required) shall be provided by the Contractor. Hence the coolers shall be designed to operate satisfactorily with the cooling water discharge pressure available. Cooling water if required during starting of the pumps shall be arranged by the bidder by provision of water supply tank, valves piping etc.			
3.10.00	Reverse Rotation a) The pump shall be provided with an approved mechanical device to protect reverse rotation on loss of drive motor power and failure of discharge valve to close. b) It is possible that the pump may rotate in the reverse direction in case the discharge butterfly valve is not fully closed or is passing. Hence to prevent starting of the pump, a reverse rotation detection switch shall be provided to prevent starting of motor while rotating in reverse direction.			
3.11.00	Motor Rating The pumps shall be capable of starting with discharge valve fully closed as well as fully open conditions. Motors shall be selected to suit to the above requirements. Continuous motor rating (at 50 ^o C ambient) for all pumps shall be at least ten per cent (10%) above the maximum load demand of the driven equipment in the complete operating range (including run out condition) to take care of the system frequency/voltage variation. Drive motors shall be connected directly to the line shaft of the pump.			
4.00.00	DESIGN AND CONSTRUCTION			
4.01.00	Pump Type Pumps shall be of vertical shaft, single stage/multi-stage, submerged suction, complete with bowl, column & head assembly and drive assembly. The pump design shall be of pullout/non-pull-out type as specified			
4.02.00	Discharge head			
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI BID DOC. NO.: CS-2600-001-9	PART-B SUB-SECTION-A-12 WATER SYSTEM	PAGE 24 OF 35

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	The pump discharge shall be of above-floor type/sub- floor type as indicated. In certain cases of pump installation where expansion joint is located immediately at the pump discharge, the pump assembly will be subjected to the unbalanced hydraulic thrust. A thrust pad will be built in with the discharge head for transmitting the hydraulic thrust to external structures such that this hydraulic thrust is not transmitted to the foundation bolts for which they may not be designed.			
4.03.00	Column Pipe			
	Column pipes shall be flanged and bolted and shall be complete with gaskets, nuts and bolts.			
4.04.00	Impeller			
	The impeller shall be closed, or semi-open or open as specified elsewhere.			
4.05.00	Wearing Rings			
	Replaceable type wearing rings shall be provided for both casing and the impeller. For open impellers replaceable casing liners shall also be provided. The difference in hardness of the casing & impeller wearing rings shall be minimum 50 BHN.			
4.06.00	Impeller & Line Shaft			
	Shaft size selected on the basis of maximum combined shear stress must take into consideration the critical speed as per API - 610.			
4.07.00	Pump & Shaft Bearings - lubrication			
4.07.01	Adequate number of properly designed bearings shall be furnished. All interconnected piping, valves, instruments and fittings for bearing lubrication shall be provided. The type of lubrication i.e. self water lubrication or forced water lubrication shall be provided as per the data specified elsewhere in this Sub-section.			
4.07.02	Self water Lubrication System			
	The line shaft bearings shall be lubricated by the water being pumped. The main pump and line shaft bearings which are above minimum water level shall be of 'Thordon' type/ equivalent. For other line shaft bearings located below minimum water level, cutless rubber bearings can be used.			
4.07.03	Forced water lubrication system			
	The line shaft shall be provided with shaft enclosing tube to exclude pumped water from shaft and bearings. Lubricating water pumps (type, nos. & capacity as indicated in data sheet enclosed) shall be provided to supply lubricating water for bearings. These lubricating water pumps shall get supply from the overhead water storage tank. This tank shall be fed water from the pump discharge header as indicated in tender drawings. Strainers downstream of each lubrication			
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI BID DOC. NO.: CS-2600-001-9	PART-B SUB-SECTION-A-12 WATER SYSTEM	PAGE 25 OF 35

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनडीपीसी NTPC																												
4.08.00	water pumps shall be provided to ensure clean water for the bearings. The lubrication water pumps shall conform to Specification titled "Horizontal Centrifugal Pumps" Complete instrumentation, piping, valves to ensure reliable operation of lubrication system shall be provided. During initial filling and normal operation the lubricating water shall be tapped from water filling line/potable/nearest source and fed to overhead tank.																															
	Thrust Bearings																															
	Single thrust bearing at motor top or separate thrust bearings at pump and motor shall be provided to take care of hydraulic thrust and weight of the rotating assembly.																															
	Thrust bearing shall be spherical roller type or superior, capable of absorbing axial thrust in both directions of rotation. Water required for cooling of thrust bearing shall be taken from pump discharge, wherever applicable.																															
4.09.00	The thrust bearing shall be rated for continuous operation with thrust as developed in shut-off condition with clearance between the wearing rings in worn out condition to be at least four (4) times the clearance between the wearing rings in new condition.																															
	Pump Motor Supports, Base plate etc.																															
4.10.00	The pump and motor shall have a common support. The necessary supporting frame, base plates, mounting plates etc. as required shall be supplied under this specification.																															
	Stuffing Box																															
4.11.00	Gland packing shall be provided at the top of the line shaft. Shaft sleeves shall be provided at the stuffing box. The stuffing box shall be of sufficient depth to provide ample packing. The packing glands shall be split type to facilitate repackaging of the stuffing boxes. The space between motor and the stuffing box shall be sufficient to permit removal of gland packing and insertion of new gland packing without dismantling of pump.																															
	Assembly and Dismantling																															
5.00.00	Assembly and dismantling of each pump with drive motor shall be possible without disturbing the grouted base/sole plate or alignment.																															
	MATERIALS OF CONSTRUCTION																															
Materials of construction of the pumps shall not be inferior to those specified in this sub-section.																																
<table><tr><td>1)</td><td>Material of Construction :</td><td></td><td></td></tr><tr><td>c)</td><td>Suction Bell</td><td>:</td><td>2% Nickel Cast Iron, IS:210 Grade FG 260; S-0.1% max. P-0.15% max.</td></tr><tr><td>d)</td><td>Casing</td><td>:</td><td>-do-</td></tr><tr><td>e)</td><td>Impeller</td><td>:</td><td>ASTM A351 CF8M Grade</td></tr><tr><td>f)</td><td>Wearing rings</td><td>:</td><td>SS-316</td></tr><tr><td>g)</td><td>Impeller Shaft, Pump & line shaft</td><td>:</td><td>SS - ASTM A 276 Gr. 410.</td></tr><tr><td>h)</td><td>Shaft sleeves</td><td>:</td><td>SS - ASTM -A 276 – 410</td></tr></table>					1)	Material of Construction :			c)	Suction Bell	:	2% Nickel Cast Iron, IS:210 Grade FG 260; S-0.1% max. P-0.15% max.	d)	Casing	:	-do-	e)	Impeller	:	ASTM A351 CF8M Grade	f)	Wearing rings	:	SS-316	g)	Impeller Shaft, Pump & line shaft	:	SS - ASTM A 276 Gr. 410.	h)	Shaft sleeves	:	SS - ASTM -A 276 – 410
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KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI BID DOC. NO.: CS-2600-001-9		PART-B SUB-SECTION-A-12 WATER SYSTEM																												
PAGE 26 OF 35																																

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	i)	Column pipe	:	Fabricated steel as per IS:2062/IS 3589 (minimum thickness shall not be less than 8 mm) with 300micron of epoxy coating inside & outside.
	j)	Discharge Head	:	Fabricated steel as per IS:2062 (minimum thickness shall not be less than 8 mm) with 300 micron of epoxy coating inside.
	k)	Matching flanges	:	Fabricated steel as per IS:2062
	l)	Stuffing box	:	2.5% NI-CI to IS:210 FG-260
	m)	Gland	:	2.5% NI-CI to IS:210 FG-260
	n)	Gland packing	:	Impregnated Teflon
	o)	Gaskets	:	Neoprene rubber
	p)	Ladder, platform and related accessories.	:	Fabricated steel as per IS : 2062
	q)	Bolts, nuts and lock washers / fasteners	:	SS AISI 316
	r)	Base plate	:	Fabricated steel to IS : 2062
6.00.00	OPERATION PHILOSOPHY			
6.01.00	The Pumps shall be controlled from the Central Control Room (CCR). The start/stop commands of these pumps, all associated auxiliaries/drives including all the motor operated discharge valves, shall be routed through control system where all interlocks & permissive shall be implemented and start/stop signals shall be issued to MCC/Switchgear. The operation of interconnecting valve and any other common drive shall be possible from pump house as well as DDCMIS. The exact details of the same shall be finalised during detailed engineering.			
6.02.00	A local pushbutton switch shall be used for emergency tripping of the motor.			
6.03.00	The pump can be started either with pump discharge valve partially open or in closed position depending upon contractor's standard practice.			
6.04.00	An interlock shall prevent the starting of pump unless bearing lubricating water flow and motor bearing cooling water flow has been established over a period of time. Low flow of either pump or motor bearing cooling water when the pump is running will give alarm(s) and trip the pump with alarm in case of sustained low value over a preset time.			
6.05.00	In case of high pressure at pump discharge due to accidental closure of any of the butterfly valves, an alarm shall be generated.			
6.06.00	In case of normal stopping, when a pump control switch is turned 'OFF', the butterfly valve at its discharge first closes (25-30) % before the respective pump motor is de-energised.			
6.07.00	On tripping of motor due to any reason, the butterfly valve at the discharge shall close fully automatically.			
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI BID DOC. NO.: CS-2600-001-9		PART-B SUB-SECTION-A-12 WATER SYSTEM
PAGE 27 OF 35				

CLAUSE NO.	TECHNICAL REQUIREMENTS	एनटीपीसी NTPC	
6.08.00	If water level in pump sump is low, an alarm shall be initiated. Pump shall be tripped in case of very low level of water in the intake sumps and very high discharge header pressure. Ultrasonic type Level transmitters to be provided for sump level measurement.		
6.09.00	Pump shall be tripped from very high winding temperature of motor and very high metal temperature of thrust bearings. Alarm shall be provided for high motor winding temperature and high motor/ pump bearing temperature.		
6.10.00	The operation philosophy as detailed above is suggestive only. .The control and interlock scheme to be adopted shall be finalised in consultation with the successful bidder after award of contract and shall be subject to Employer's approval.		
7.00.00	INSTRUMENTATION		
7.01.00	Vibration monitoring system if necessary shall be provided. The alarm and trip signals from vibration system shall be connected to the Control system.		
7.02.00	Bidder shall provide Duplex temperature elements for bearing & winding temperature monitoring points if specified. The excessive bearing/winding temperature shall be used for alarm and tripping of pumps/ motors.		
7.03.00	Further, Bidder shall provide required level & pressure sensing instruments as specified elsewhere in relevant Subsections of Control & Instrumentation and/or tender drawings.		
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI BID DOC. NO.: CS-2600-001-9	PART-B SUB-SECTION-A-12 WATER SYSTEM
			PAGE 28 OF 35

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	(C). SUBMERSIBLE PUMPS			
1.00.00	SCOPE			
1.01.00	This specification covers general requirements in respect of design, material, manufacture, construction, testing & inspection at Vendor's / sub-vendor's delivery to side, of submersible pumps.			
2.00.00	CODES AND STANDARD			
	The design manufacture and performance of submersible pumps shall be comply with all currently applicable statues, regulation, and safely codes in the locality where the Equipment will be installed. The Equipment shall also conform to the latest applicable Indian standards listed below/equivalent standards.			
2.01.00	List of Applicable Indian Standards			
	IS: 8034 - Submersible pumps for clear cold fresh water			
	IS: 5120 - Technical requirement of Rotodynamic Special Purpose pumps.			
	In case of any contradiction with aforesaid standards and the technical specification requirements, the stipulation of the technical specification shall prevail.			
3.00.00	DESIGN AND PERFORMANCE REQUIREMENTS			
	a) The pump shall be of single stage mono - block type with non-clog design.			
	b) Components of Identical pumps shall be interchangeable.			
	c) Pumps shall have continuously rising head characteristics.			
4.00.00	MOTOR RATING			
	Continuous motor rating (at 50 deg. C ambient) for pumps shall be at least ten percent (10%) above the maximum load demand of the driven equipment in the complete operating range to take care of the system frequency variations.			
5.00.00	FEATURES OF CONSTRUCTION			
	a) Pumps shall be of Submersible, wet pit type.			
	b) Pumps shall be able to pass through solids upto 100 mm and capable of handling waste water which may contain, sludge, plastic solids etc.			
	c) Coupling device shall ensure leak proof joint between the pump and discharge elbow. This shall also enable pump to be removed from the sumps without the necessity of dismantling any nuts, bolts etc.			
	d) Pumps shall be portable type and capable of using in any sump as and when required. Pump shall be provided with required stool, flexible, hose chain connection etc. for easy installation, removal and maintenance. Adequate length of chain required for lowering the pump into the sump and flexible type discharge pipe shall be provided.			
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI BID DOC. NO.: CS-2600-001-9	PART-B SUB-SECTION-A-12 WATER SYSTEM	PAGE 29 OF 35

CLAUSE NO.	TECHNICAL REQUIREMENTS			
6.00.00	e) Impeller			
	The Impeller shall be as indicated in Data Sheets in this Sub-section. Enclosed impellers shall be equipped with seal rings on their hubs. In case of open impeller, the pump shall be design to take care of the additional thrust produced.			
	Equipment Data Sheet			
	Type of pump	:	Submersible type fixed inside pits/ sump with guides /lifting chains	
	Type of Working Fluid	:	Drains with particle size upto 40 mm	
	Type of impeller	:	Open	
	Type of lubrication	:	Self / Grease / Oil	
	Speed	:	Preferrably 1500 rpm (maximum)	
	Material of Construction			
	a) Casing	:	2% Nickel Cast Iron, IS:210 Grade FG 260;	
b) Impeller	:	SS-316 / CF8M		
c) Shaft	:	SS- 410		
d) Bolts & nuts	:	SS-316		
e) Accessories	:	Suction Strainer, Pump stand, Adaptors for discharge flange, Level measuring devices/ Controllers, Lifting hook & chain Handle to agitate debris etc, Discharge hose connected with piping upto the drains etc.		
f)	The discharge, suction /column pipes shall be heavy grade Carbon steel externally lined with epoxy or galvanised.			
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI BID DOC. NO.: CS-2600-001-9	PART-B SUB-SECTION-A-12 WATER SYSTEM	PAGE 30 OF 35

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनडीपीसी NTPC
	PART-IV COOLING WATER SYSTEM			
1.00.00	Auxiliary Cooling Water System			
1.01.01	The auxiliary cooling water system shall be provided as closed cooling system with auxiliary cooling towers. Makeup to the auxiliary cooling water system shall be provided by clarified water transfer pumps.			
1.01.02	The general design and construction features of Auxiliary cooling water pump shall be as per the general Specification for “Horizontal centrifugal Pumps”.			
1.01.03	Specific features of Auxiliary cooling water pumps shall be as follows:			
	NO	DESCRIPTION	PARAMETERS	
	10.	Total Number of Pumps	Two (2)	
	11.	Number of operating pumps	One (1)	
	12.	Number of stand by pump	One (1)	
	13.	Design Flow	As required	
	14.	Total head	As required	
	15.	Operating Speed (Max)	1500 rpm (Nominal)	
	16.	Service of duty	Continuous	
	17.	Type of pump	Horizontal	
	18.	Type of Working Fluid	Clarified water /Treated water	
	19.	Type of impeller	Closed/Semi open	
	20.	Type of lubrication	Grease	
	21.	Suction condition	Flooded suction	
	22.	Material of Construction :		
	X.	Casing	2.5% Ni CI IS210 Gr FG 260	
	XI.	Impeller	SS -316	
	XII.	Wearing rings (if applicable)	SS -316	
	XIII.	Shaft	SS-410	
	XIV.	Shaft sleeves	SS-410	
	XV.	Stuffing box	2.5% Ni CI IS210 Gr FG 260	
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI BID DOC. NO.: CS-2600-001-9		PART-B SUB-SECTION-A-12 WATER SYSTEM
PAGE 31 OF 35				

CLAUSE NO.	TECHNICAL REQUIREMENTS			
2.00.00	XVI.	Gland	2.5% Ni Cl IS210 Gr FG 260	
	XVII.	Gland packing	As per Manufacturers standard	
	XVIII.	Gaskets	As per Manufacturers standard	
	s)	Bolts & nuts	Stainless steel for those coming in contact with water and for others, material shall be high tension carbon steel.	
	t)	Base plate	Carbon steel (Minimum 10 mm thick)	
	Cooling Tower			
	Type		Induced draft, cross or counter flow.	
	Design Parameters		- Capacity: As required - Ambient Wet bulb temperature: 27 Deg C - Cold water temperature: As per WtE bidder's design - Hot water temperature: As per WtE bidder's design	
	Casing & Sump tank		F.R.P/G.R.P	
	Fan		FRP Propeller type and multi-blade aerofoil construction with adjustable pitch.	
	Fill		Non combustible PVC or Equivalent (of light colour).	
	Louvers		F.R.P. /PVC/ Aluminum	
	Nozzles		Polypropylene	
	Eliminators		In removable sections to reduce the drift loss to 0.2% of water flow.	
	Supporting structure		Mild steel with spray galvanization or epoxy painting.	
	Strainer at water outlet		Plate strainer made of GI/SS wire mesh of 16 gauge.	
	Bird screen on top of tower		25 mm square made of GI/SS wire mesh of 16 gauge.	
	Ladder		Hot dip galvanized steel ladder for each tower.	
	Distribution Pipe (if any)		Galvanised MS pipe.	
	Accessories		a) Drain connection with isolation valve.	
			b) Make up connection with ball – float valve, back up gate valve and a bypass with a gate valve for manual operation.	
			c) Overflow connection	
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI BID DOC. NO.: CS-2600-001-9		PART-B SUB-SECTION-A-12 WATER SYSTEM
PAGE 32 OF 35				

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
3.00.00		d) Equalizing connection to connect sump of all the towers wherever applicable.		
		e) Access door in louvers / fan deck.		
	Chemical Treatment System Suitable chemical treatment system shall be provided as per bidder's standard practice.			
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI BID DOC. NO.: CS-2600-001-9	PART-B SUB-SECTION-A-12 WATER SYSTEM	PAGE 33 OF 35

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	PART-V LEACHATE TREATMENT SYSTEM			
1.00.00	The Leachate treatment system shall be based on Evaporation & drying technology only. The process flow diagram of suggested Evaporation & drying technology has been attached herewith as Appendix-A. The scheme is elaborated as follows: a). Triple effect falling film evaporator with Thermal Vapour Recompression (TVR) System for concentrating effluent. b). Single effect forced circulation evaporator for further concentrating the concentrated effluent to required concentration. This concentrate will be directly pumped to boiler feed hoppers and will be incinerated in the boiler. c). In case of shut down of boilers, the leachate will be converted into solid powder using Spray Dryer. For dryer, the effluent concentrated in triple effect evaporator will be directly sent to the spray dryer bypassing the single effect forced circulation evaporator. The powder output from spray dryer will be stored and fed to boiler when boiler will be operated. The spray dryer will be used with steam air heater to dry concentrated effluent.			
2.00.00	The leachate treatment process scheme mentioned above is indicative only. However, bidder may go for any other alternative proven evaporative and drying technology for leachate treatment. The same shall be finalized during detail engineering.			
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI BID DOC. NO.: CS-2600-001-9	PART-B SUB-SECTION-A-12 WATER SYSTEM	PAGE 34 OF 35

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	PART-VI EFFLUENT TREATMENT SYSTEM 1.00.00 The effluent generated from various sources of waste to energy plant shall be collected in an underground RCC sump through channel/pipes. Proper mixing of effluent in sump shall be ensured by bidder. Storm water collection and disposal shall be separated from effluent system. 2.00.00 Suitable Effluent treatment process shall be adopted by the bidder to ensure recycle/ reuse of treated effluent water inside Waste to energy plant itself. Total capacity of effluent treatment plant shall be minimum 1.67 m3/h (or 40 KLD). Hydraulics of effluent treatment plant shall be such as to take an occasional overloading of 20% of the design flow rate. 3.00.00 Bidder to ensure that no effluent/water to be discharged out from the Waste to Energy plant.			
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI BID DOC. NO.: CS-2600-001-9	PART-B SUB-SECTION-A-12 WATER SYSTEM	PAGE 35 OF 35

SUB-SECTION–A-13

NOT USED

SUB-SECTION–A-14

COMPRESSED AIR SYSTEM

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	COMPRESSED AIR SYSTEM			
1.00.00	SYSTEM DESCRIPTION			
1.01.00	The compressed air system shall consist of Instrument Air compressors & their motor drives, Air Drying (ADPs) Plants, Service Air compressors & their motor drives, air receivers for each Air compressors, instrumentation and control, control panels, interconnecting compressed air piping in the compressor house, Instrument Air Piping network, service air piping network and Unit Instrument Air receivers (One for each unit).			
1.02.00	The Air compressors & Drives, instruments, control panels and ADPs shall be located indoor inside the compressor house and the air receivers shall be located outside the compressor house. The compressor house shall be provided with an electrically operated Monorail Hoist.			
1.05.00	Air from Instrument air compressors shall be dried in respective Air Drying Plants in compressor house and delivered to the Air receivers. From the Compressed air piping header at the downstream of Air receivers, one instrument air piping header shall be provided. Distribution of instrument air network shall be provided as per requirement finalized during detailed engineering.			
1.06.00	A separate service air header shall be tapped off from the pipe header at Service Air receiver outlet and distributed as per requirement finalized during detailed engineering.			
2.00.00	EQUIPMENT DESCRIPTION:			
2.01.00	The minimum requirements of design and construction features of various components of Compressed air system (screw type air compressor, air dryer, air receiver, etc.) are described below.			
3.00.00	SCREW AIR COMPRESSORS			
3.01.00	CODES AND STANDARDS			
3.01.01	The design, manufacture, testing and performance of the various components of the Rotary Screw type Air Compressors shall comply with the requirements of relevant codes (IS-5456, IS-10431 [part -1], ASME PTC-9, IS-6206, IS-5727 and CAGI).			
3.01.02	Other International Standards like American/BS/DIN etc. equivalent or superior to above mentioned standards are acceptable. Where IS specification is not available, the equipment shall conform to one such International Standard, which shall be indicated in the proposal.			
3.01.03	The materials of the various components shall conform to the applicable IS/BS/ASTM/DIN Standards.			
3.02.00	DESIGN AND CONSTRUCTION			
3.02.01	The compressor shall be oil free multistage, horizontal, water cooled, rotary screw type, heavy duty, rugged construction. Their speed shall be so selected as to result in low maintenance and trouble-free operation under specified conditions.			
3.02.02	The rotor and shaft shall be of single piece construction, made of forged steel (AISI C1141 or equivalent). The stator (casing) shall be of Cast-Iron (IS-210 grade) Construction with integral jacket cooling. The rotors shall be dynamically balanced to reduce vibration. Any Superior material as per manufacturer standard and of proven design may be acceptable.			
3.02.03	The seal rings and retainers shall be of stainless steel construction and be free for radial self adjustment along the rotor shafts.			
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-14 COMPRESSED AIR SYSTEM	PAGE 1 OF 9

CLAUSE NO.	TECHNICAL REQUIREMENTS		
3.02.04	Bearings shall be high precision antifriction type IS- 25 Grade 84). The axial thrust load shall be minimized by dividing the axial load of compression on the main and auxiliary bearings through suitable balancing arrangement.		
3.02.05	Lubrication system shall be as per manufacturer standard practices		
3.03.00	Gear Box		
3.03.01	Gears shall have a rating of AGMA-12 or equivalent. Speed increasing gears between the motor and compressor stages shall consist of a common helical gear driving the pinion of each stage. Helical timing gears shall be mounted on the rotor shafts to maintain accurate relative rotor position.		
4.00.00	PERFORMANCE REQUIREMENT		
4.00.01	Air Compressors (screw type) shall be designed for continuous operation with high efficiency to satisfy the performance requirement as specified in the Data Specification Sheet.		
4.00.02	The power rating of the driver shall be selected such that a minimum margin of 10% is available over the power required to deliver rated capacity against rated pressure.		
4.00.03	As more than one compressor with drive is specified, satisfactory operation in parallel shall be ensured without any uneven load sharing, undue vibration, keeping noise level within permissible limits for a number of compressors working simultaneously in the same room.		
5.00.00	INTERCOOLER, AFTERCOOLER & OIL COOLERS (FOR SCREW)		
5.01.00	Intercoolers, After coolers and Oil coolers shall be of water cooled & shell-and-tube type with water on the tube side. Intercoolers & after coolers shall be designed in accordance with Section VIII, Division 1 of ASME Code or equivalent.		
5.02.00	Outlet temperature of air from intercooler shall be suitable to suit the equipment and outlet temperature of air from the compressor house outlet header shall be limited to 45 deg.C. However, the instruments or the pneumatic devices requires air temperature less than 45 deg.C., the same shall be achieved at the outlet header.		
5.03.00	Coolers shall be provided with removable tube bundle design in accordance with design code TEMA Class C and shall be constructed with removable shell cover.		
5.04.00	Oil Coolers shall be equipped with vent & drain connections on oil and water sides. Oil temperature control valve with manual override feature or bypass construction shall be provided to maintain constant temperature. Vent & drain connections for intercoolers and aftercoolers shall be provided.		
5.05.00	Design pressure shall be 8 Kg/cm2 (g) or based on shut-off head of cooling water pumps.		
5.06.00	The coolers shall be designed for maximum heat load and atleast 10 percent design margin shall be provided in the number of tubes.		
5.07.00	Adequately sized safety valves shall be provided for both intercoolers and after coolers.		
5.08.00	Each intercooler and aftercooler shall be provided with moisture separator units with suitable baffling. Moisture separator units shall be equipped with a level gauge glass with isolating cock.		
5.09.00	Electrically operated automatic drain trap stations with bypass and isolating valves shall be provided for moisture separators for automatically draining of condensed moisture. The drain trap may be of full bore ball valve operated by capacitance type level switch. Manual draining facility shall also be provided in the drain trap.		
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-14 COMPRESSED AIR SYSTEM
PAGE 2 OF 9			

CLAUSE NO.	TECHNICAL REQUIREMENTS		
5.10.00	Cooler shells, channels and covers shall be of carbon steel (SA 285 Gr C / SA 516 Gr 70 / equivalent).Tube sheet shall be of Brass or SS and the tubes shall be of Admiralty brass or Aluminium brass or Copper or SS 304.		
5.11.00	For the instrument air compressors offered with "Heat of compression" type air drying plants, the after coolers shall be provided at downstream of Air Drying Plant.		
6.00.00	AIR RECEIVERS		
6.01.00	The design pressure and temperature shall be minimum 10 Kg/cm ² (g) and 50 deg.C respectively. Receivers shall be designed in accordance with Section VIII, Division 1 of ASME Code or equivalent.		
6.02.00	Air receivers are to be provided with gasketted inspection manhole of minimum 500 mm diameter with cover plate, lifting handle, davit cap etc.		
6.03.00	Receivers shall be of welded construction with minimum number of joints. Longitudinal seam in adjacent sections shall not be in same line. Welding shall be as per relevant codes. Filler material to have composition & structure as that of material welded. Welding electrodes to be approved by Employer. Electrodes to be dried before use.		
6.04.00	Relief valves shall be provided to suit compressor capacity and set pressure of the same shall be atleast 10% above working pressure. The spring in relief valve shall not reset for any pressure more than 10% above or below the design set pressure.		
6.05.00	Each receiver shall be provided with drain connection with electrically operated automatic drain trap arrangement with isolation and bypass valves.		
6.06.00	The material of construction of shell, dished ends, flanges, etc of the air receivers shall be of carbon steel as per IS:2062 or equivalent.		
7.00.00	INTAKE AIR FILTER AND SILENCER		
7.01.00	Filters with multiple elements quick removal type for easy cleaning shall be provided at suction of each air compressor and also be of heavy-duty dry type.		
7.02.00	The filters shall be complete with integral silencers. Separate silencers, if specified, shall be provided. The filtering elements shall be easily removable for cleaning.		
7.03.00	The filters shall be designed for an efficiency of not less than 99% for particles 2 microns and larger.		
8.00.00	AIR DRYING PLANTS		
8.01.00	One number Air drying plant shall be provided for each Instrument air compressor. Drying shall be by adsorption process through a desiccant medium.		
8.02.00	Air Drying (ADP) Plant may be of "Open Through type (Blower reactivated)" OR "Heat of (HOC) Compression type".		
8.03.00	Regeneration of desiccant shall be achieved by "open through" or "Heat of compression" method without any air purge loss.		
8.04.00	Hot unsaturated compressed air shall be used for regeneration of exhausted desiccant in case of "Heat of compression type ADP" and air from blower shall be used for regeneration after heating by electrical heater in case of "Open through type ADP".		
8.05.00	Each ADP shall be provided with two adsorber towers each sized for design drying cycle of minimum 8 hours. After this period, the adsorber tower which was under drying mode shall be put under regeneration/reactivation mode while the other tower will take over the drying duty. The change of drying mode to reactivation mode or vice-versa shall be automatic with		
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-14 COMPRESSED AIR SYSTEM
PAGE 3 OF 9			

CLAUSE NO.	TECHNICAL REQUIREMENTS	एनटीपीसी NTPC		
8.06.00	provision for manual operation also. The change over from one mode to another shall be through automatic solenoid operated valves. In "Open Through" type ADP, for regeneration of desiccant, atmospheric air shall be filtered, heated through an electric heater and passed through the desiccant before exhausted to atmosphere. The reactivated desiccant shall be cooled through same atmospheric air without heater in operation. In case of HOC type drier, the reactivation shall be achieved by the heat of the compressed air itself. The hot unsaturated compressed air from the outlet of last stage of compressor shall be passed through the adsorber tower. The moist air shall be cooled in dehumidifier and passed through the second adsorber for final drying. The design reactivation cycle/period of the tower shall be less than 8 hours including cooling period for desiccant for both the types of ADP.			
8.07.00	Each ADP shall be provided with two (2) numbers of 100 percent capacity pre-filters and two (2) numbers of 100 percent capacity after-filters at the upstream & downstream of towers. The filtering media shall be of ceramic candle type elements designed to withstand atleast 50% of static pressure as differential pressure. The pre-filters shall be provided with automatic electrically operated drain trap arrangement with isolation and bypass valves.			
8.08.00	The electric heaters (if required) (2x100% capacity for each ADP) shall be provided with thermostatic control for heater and relief valve for safety and shall be flanged type to facilitate easy replacement of element.			
8.09.00	Each electric motor driven blower (2x100% capacity for each ADP) shall be provided with individual dry type filters at inlet.			
8.10.00	The adsorber tower shall be designed with sufficient cross sectional area resulting low air velocity and pressure drop. Minimum 20% of desiccant depth shall be provided as free board in adsorber vessels. Adsorber vessels to be provided with suitable number of inspection/sight windows of "Persplex" for observation of adsorbent condition. Desiccant filling and removal connections shall be provided for the adsorber vessels.			
8.11.00	The coolers/heat exchangers/ dehumidifiers of ADP shall be designed & constructed as per the requirements specified for "Intercoolers, After coolers & Oil coolers" above.			
8.12.00	All pressure vessels such as pre-filters, after-filters, adsorber vessels, heaters, heat exchangers/de-humidifiers / coolers etc associated with ADP shall be designed in accordance with Section VIII, Division 1, of ASME Code or equivalent. The pressure vessels shall be provided with air tight gasketed manholes/handholes and relief valves.			
8.13.00	Quantity of desiccant to be calculated shall take into account residual moisture content at the end of regeneration cycle.			
8.14.00	Adsorption capacity and density to be considered for silica gel shall not be more than 10% and 550 kg/m³ respectively. In case of activated alumina the same shall be 8% (max) and 900 kg/m³ (max.) respectively.			
8.15.00	In case of Heat of compression type, adsorbers shall be sized so that even when the compressor is operating at part load, complete regeneration shall be achieved within the cycle time and quality of air (dew point) shall be maintained throughout the design cycle period.			
8.16.00	Complete ADP equipments shall preferably be mounted on a skid.			
8.17.00	Required sample connections in piping be provided for sampling of air at desired locations.			
8.18.00	Non-lubricated two way / three way / four way valves ball valves with pneumatic actuators be provided.			
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-14 COMPRESSED AIR SYSTEM	PAGE 4 OF 9

CLAUSE NO.	TECHNICAL REQUIREMENTS		
8.19.00	The material of Construction for various components of ADP shall be as as per manufacturer's proven standard.		
8.20.00	HOC dryers of single rotating drum type design using packed dessicant with in-built regeneration and adsorption compartments are also acceptable in place of specified twin-tower type dryers, if the design ensures specified performance guarantee. In case, the Contractor offers such a type, the same shall be of proven design.		
9.00.00	INTERCONNECTING PIPING, FITTING AND VALVES The interconnecting piping & valves within compressor house for compressed air & cooling water etc shall be designed in line with the specification furnished as per low pressure piping.		
10.00.00	Not Used		
11.00.00	CONTROL PHILOSPHY		
11.01.00	GENERAL		
11.01.01	The minimum requirements are specified herein and the same shall be elaborated by contractor. The Contractor shall include controls & instrumentation to facilitate safe, reliable and efficient operation for the system. The controls, protection, interlock and instrumentation system offered by the contractor shall be subjected to approval of the Employer during post award engineering stage.		
11.01.02	Any of the compressor and Air drying Plant may be selectable for "shutdown", "working" or "standby" duty.		
11.01.03	On tripping of working equipment, the standby equipment shall come into operation automatically in case of very low air pressure in the system.		
11.01.04	All abnormal conditions used for tripping the compressor or any other equipment shall be provided with pre-trip audio-visual indication/annunciation in the control panel.		
11.01.05	An electrically operated automatic valve shall be provided on cooling water supply line of each compressor & dryer (if applicable) which will automatically shut off the cooling water supply, in case any of the compressor/dryer is not running for more than set time duration. Suitable interlock shall also be provided for opening the valve before starting of any of the compressor.		
11.01.06	The following indications shall be made available in the control panels for repeating the same in main plant Control System / Panels. (a) Status of each compressor (b) Instrument air pressure low/high (c) Service air pressure low/high (d) Dew point of instrument air (e) Status of each ADP		
11.01.07	Lube oil pressure and temperature in the oil circuit of compressor shall be automatically controlled.		
11.01.08	Unless otherwise mentioned in the relevant electrical sub-section, automatic motor overload control system shall be included to permit continuous operation of compressors at minimum ambient air without exceeding the name plate rating of the motor.		
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-14 COMPRESSED AIR SYSTEM
			PAGE 5 OF 9

CLAUSE NO.	TECHNICAL REQUIREMENTS			
11.02.00	Screw compressor			
11.02.01	Each compressor shall be in the control panel to operate either in Base duty (Auto Load-Unload) or Standby duty (Auto On-Off) mode in case of Screw and unload/module/energy optimization (Auto Dual Mode) in case of centrifugal			
11.02.02	In "Base duty" mode, whenever air supply from compressors exceeds the demand, control system shall operate the load-unload circuit at a predetermined set pressure, throttle the inlet valve and open the blow off valve. The compressor shall run in unloaded condition. When system pressure drops due to more demand, the load-unload circuit shall operate again to bring the compressor to 100% load after closing the blow -off valve.			
11.02.03	In "Stand-by" mode the compressor shall automatically assist base load compressors during periods of peak air demand. When air pressure in the system reaches a pre-set lower limit, compressor should start in unloaded condition and the compressor shall be fully loaded. When the pressure in the system rises to pre-set high value, the compressor shall be unloaded and shall run in idling mode for a specific period (set by a timer). The compressor may be loaded to full load in case of drop in system pressure or compressor may be stopped in case the system pressure does not drop and compressor continues to idle for more than a pre-set time.			
11.02.04	The control system shall provide warning to the operator that a hot-start condition exists for the motor driver and adequate cool-down period has not occurred after the motor was shut down.			
11.02.05	The alarms and shutdown scheme mentioned below are suggestive and shall be provided as per manufacturer's standard practice meeting the safe operational requirement of the equipment/system each compressor:-			
	(a)	"Air temperature high" at inlet to last stage	Alarm & trip	
	(b)	"Low lube oil pressure"	Alarm & trip	
	(c)	"High Lube oil supply temperature"	Alarm & trip	
	(d)	"High oil filter differential pressure"	Alarm	
	(e)	"Low lube oil level in lube oil sump"	Alarm	
	(f)	"High inlet air filter differential pressure"	Alarm & trip	
	(g)	"Low cooling water flow to air compressor"	Alarm	
11.03.00	Air Drying Plant			
11.03.01	Sequential operation of the adsorber towers & air compressors shall be controlled automatically with a provision for manual take over.			
11.03.02	Change over of tower from drying mode to regeneration mode shall happen automatically if the dew point is high at the outlet of ADP sensed by the dew point (using aluminium oxide probe) meter/sensor. Automatic operation during regeneration, starting and stopping of blowers, starting and stopping of heaters, etc shall be timer controlled. During the process, in case, operation is taken over manually from the panel through push button or selector switch, the sequential operation shall start with the manual initiation for each of the steps.			
11.02.03	The control system shall provide the (as minimum) alarms, "High Reactivation air temperature", "Low Reactivation air temperature", "Low cooling water flow", "Low air pressure at the outlet of ADP" and "High dew point at the outlet of ADP". Adequate number of temperature elements etc. shall be provided for measurement and monitoring of the same.			
11.02.04	For rotary drum type Air drying plant, control philosophy as per manufacture's standard and proven practice is also acceptable.			
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-14 COMPRESSED AIR SYSTEM	PAGE 6 OF 9

CLAUSE NO.	TECHNICAL REQUIREMENTS																					
12.00.00	PAINTING All the equipments shall be protected against external corrosion by providing suitable painting. The surface of SS, galvanized steel, Gun metal, Brass, Bronze and non-metallic components shall not be applied with any painting. The steel surface to be applied with painting shall be thoroughly cleaned before applying painting by brushing, shot blasting etc as per standard procedure.																					
13.00.00	EQUIPMENT SIZING CRITERIA																					
13.01.00	DESIGN CRITERIA / BASIS AND PERFORMANCE GUARANTEE 1. All the equipments shall be designed for continuous duty and as well as for intermittent operation. Frequent start/stop of the system shall not result deterioration in performance nor damage to the equipment. 2. The compressors and Air Drying plants shall operate under the following ambient conditions. i. Minimum temperature : 10 deg.C ii. Maximum temperature : 50 deg. C iii. Design condition (temperature & Relative humidity) : 45 deg.C& 75% RH iv. Height above MSL (m) : Refer Chapter “Project Information” 3. The design ambient conditions for the motors shall be as mentioned in relevant Electrical sub-sections.																					
13.02.00	Selection of Capacity of Air Compressor																					
13.02.01	Instrument Air Compressor																					
a)	Instrument Air Compressor 4. Instrument air Compressor shall be designed to meet the Instrument air requirement of all the equipments/plant/systems to be supplied by the Contractor as follows:- <table><thead><tr><th>Sl. No.</th><th>Continuous Requirement</th><th>Quantity (in NM³/min)</th></tr></thead><tbody><tr><td>1.</td><td>For each Unit of Steam Generator & its auxiliaries (Continuous)</td><td>A</td></tr><tr><td>2.</td><td>For each Unit of TG & its auxiliaries (Continuous)</td><td>B</td></tr><tr><td>3.</td><td>For Water Treatment Plant and other facilities (Continuous)</td><td>C</td></tr><tr><td>4.</td><td>For Station C&I System (Continuous)</td><td>D</td></tr><tr><td>5.</td><td>Instrument air requirement for 2 unit (Z)</td><td>= [1.5x{2x(A+B)+(C+D)}]</td></tr></tbody></table>				Sl. No.	Continuous Requirement	Quantity (in NM ³ /min)	1.	For each Unit of Steam Generator & its auxiliaries (Continuous)	A	2.	For each Unit of TG & its auxiliaries (Continuous)	B	3.	For Water Treatment Plant and other facilities (Continuous)	C	4.	For Station C&I System (Continuous)	D	5.	Instrument air requirement for 2 unit (Z)	= [1.5x{2x(A+B)+(C+D)}]
Sl. No.	Continuous Requirement	Quantity (in NM ³ /min)																				
1.	For each Unit of Steam Generator & its auxiliaries (Continuous)	A																				
2.	For each Unit of TG & its auxiliaries (Continuous)	B																				
3.	For Water Treatment Plant and other facilities (Continuous)	C																				
4.	For Station C&I System (Continuous)	D																				
5.	Instrument air requirement for 2 unit (Z)	= [1.5x{2x(A+B)+(C+D)}]																				
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-14 COMPRESSED AIR SYSTEM	PAGE 7 OF 9																		

CLAUSE NO.	TECHNICAL REQUIREMENTS																					
13.02.02	6. Minimum Capacity of instrument air = Z/N compressor Where N=nos. of instrument air compressor (working) as specified																					
	Notes: While calculating the air requirement of Bidder's equipments/plant/systems, for continuous requirements of instrument air, no diversity factor shall be considered and they are to be assumed to be of "Simultaneous Requirements". The intermittent requirement of instrument air, if any shall be converted into continuous requirement by considering frequency of such requirements or selecting an appropriate diversity factor and such diversity factor shall not be less than 0.4.																					
	Service Air Compressor																					
	a) Service air Compressor shall be designed to meet the Service air requirement of all the equipments/plant/systems to be supplied by the Contractor as follows:-																					
	<table><tr><th>Sl. No.</th><th>Continuous Requirement</th><th>Quantity (in NM³/min)</th></tr><tr><td>1.</td><td>For each Unit Steam Generator & its auxiliaries (Continuous)</td><td>E</td></tr><tr><td>2.</td><td>For each unit of TG & its auxiliaries (Continuous)</td><td>F</td></tr><tr><td>3.</td><td>For Water Treatment Plant (Continuous) and other facilities</td><td>G</td></tr><tr><td>4.</td><td>Service air requirement for 2 unit (Y)</td><td>= [1.5x{2x(E+F)+G}]</td></tr><tr><td>5.</td><td>Minimum Capacity of service air compressor</td><td>= Y/N</td></tr></table>				Sl. No.	Continuous Requirement	Quantity (in NM ³ /min)	1.	For each Unit Steam Generator & its auxiliaries (Continuous)	E	2.	For each unit of TG & its auxiliaries (Continuous)	F	3.	For Water Treatment Plant (Continuous) and other facilities	G	4.	Service air requirement for 2 unit (Y)	= [1.5x{2x(E+F)+G}]	5.	Minimum Capacity of service air compressor	= Y/N
	Sl. No.	Continuous Requirement	Quantity (in NM ³ /min)																			
	1.	For each Unit Steam Generator & its auxiliaries (Continuous)	E																			
	2.	For each unit of TG & its auxiliaries (Continuous)	F																			
	3.	For Water Treatment Plant (Continuous) and other facilities	G																			
	4.	Service air requirement for 2 unit (Y)	= [1.5x{2x(E+F)+G}]																			
5.	Minimum Capacity of service air compressor	= Y/N																				
Where N=nos. of service air compressor (working) as specified																						
Note:																						
1. While calculating the air requirement of Bidder's equipments/plant/systems, for continuous requirement of service air, no diversity factor shall be considered and they are to be assumed to be of "Simultaneous Requirements". The intermittent requirement of service air if any shall be converted into continuous requirement by considering frequency of such requirements or selecting an appropriate diversity factor and such diversity factor shall not be less than 0.4. The Service air requirement of mill reject shall not be included while sizing the compressor capacity, as separate & dedicated compressors are to be provided for the same.																						
2. The compressor capacity & discharge pressure of instrument air system and service air system identified at Clause no. 13.02.01 & 13.02.02 shall be identical.																						
3. The capacity of air drying plant shall be equal to the capacity of the individual air compressors. The Air drying plant, at its rated capacity, shall be designed to deliver continuously air at dew point of minus (-) 40 deg C at atmospheric pressure and the																						
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-14 COMPRESSED AIR SYSTEM	PAGE 8 OF 9																		

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	Quality of dry outlet air to conform to Instrument Society of American Standard S7.3 "Quality Standard for Instrument Air". 4. Discharge pressure available at the outlet of Air drying Plant shall be minimum 7.5 Kg/cm² (g) or more as per the requirement of Contractor. 5. The discharge pressure of compressor shall be minimum 8.5 Kg/cm² (g). 6. The heat exchangers are DMCW cooled and the maximum cooling water temperature at compressor coolers inlet to be considered same as that of PHE outlet cooled DMCW temperature. 7. The temperature rise of cooling water in the heat exchangers of the Compressed air system shall be limited to 5-7 deg C. 8. Noise level shall not exceed 85 dBA to a reference level of 0.0002 microbar when measured at a distance of 1.5 meter above the floor. Required acoustic enclosures may be provided to meet the above condition. The discharge blow-off silencer and intake silencers shall be designed to meet the above noise limitation level. 9. Parallel operation of compressors shall be possible without any undue vibration and noise. 10. The flow in compressed air piping shall be designed for the design capacity of each compressor and the flow in header and ring mains to be designed for the total capacity of working compressors. 11. The maximum velocity to be considered in compressed air and cooling water piping shall be as mentioned elsewhere in Subsection titled "Low Pressure Piping" in Part-B of this Technical Specification. 12. All hot vessels/pipelines/ valves shall be insulated to restrict the outside temperature within 60 deg.C or less with mineral wool (or equivalent), GI wire netting and aluminum cladding/cover.			
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	SUB SECTION-A-14 COMPRESSED AIR SYSTEM	PAGE 9 OF 9

SUB-SECTION–A-15

AIR CONDITIONING

CLAUSE NO.	TECHNICAL REQUIREMENTS			
1.00.00	GENERAL			
1.01.00	This section of specification covers details of system specifications, detailing the areas to be air conditioned, basis of design, brief description of the system, equipment and services to be furnished by bidder. The supply, delivery and erection of the entire equipment listed here shall be in bidder's scope of work.			
2.00.00	AREAS TO BE COVERED UNDER AIR CONDITIONING SYSTEM			
2.01.00	The areas to be air-conditioned shall be as follows: a) Central Control rooms, Control Equipment Rooms, UPS & battery charger room, etc. b) CEMS room and SWAS room c) Water system control room (as Applicable). d) Switchyard building (as Applicable). f) Administrative building g) Canteen building (as Applicable). h) Fire water pump house control room. i) CPU Regeneration control room v) Any other building not mentioned above but require air conditioning.			
3.00.00	REDUNDANCY OF EQUIPMENTS			
3.01.00	Redundancy of various A/C system equipments shall be as follows: a) For Central control room i) Vapour compression type chilling units: 2X100% ii) Chilled water pumps: 2X100% iii) AHUs: At least one (1) no. unit, capacity same as each working unit shall be provided as common standby. b) 100% standby shall be provided for area served by Cassette / Hi-wall Split type Air conditioners for all other offsite control rooms. c) Fresh air fans shall be 1 x 100 % Capacity for each AHU room.			
4.00.00	EQUIPMENT DESCRIPTION – AIR CONDITIONING SYSTEM			
4.01.00	Vapour compression type machines			
4.01.01	Each chilling unit shall comprise of compressor with drive motor, Condenser, Chiller/evaporator, Chilled water pumps, other accessories such as supporting structure, vibration isolators, insulation, piping, valves, instrumentation, microprocessor / PLC based Control panel, etc. Chilling unit shall have stepless capacity control. The screw/scroll compressor based chilling unit to be supplied shall be ARI /Eurovent/Equivalent standard certified (if applicable).			
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-15 Air Conditioning System	Page 1 of 31

CLAUSE NO.	TECHNICAL REQUIREMENTS		एनटीपीसी NTPC
4.02.00	Chilling Unit: Air-cooled type		
	Type		Air-cooled type chilling unit.
	Vibration isolators	:	Steel spring/ Neoprene rubber cushy foot/ neoprene serrated rubber pad type with isolation efficiency not less than 85%.
	Casing /frame material		: GI sheet (3.15 mm thickness minimum)
	Design ambient :		: Air cooled chiller shall be designed for minimum 50deg.C ambient temperature.
	Noise level		: Max 85 dba under free field condition at horizontal 1m distance and 1.5m height
	Compressor		
	Type	:	Compressor shall be Scroll/Screw type (open/semi-hermetic/multiple hermetic)
	Type of drive	:	Motor driven, through direct/V-belt along with Star delta/Double delta Starter.
	Capacity	:	Minimum capacity shall be suitable for the identified/selected evaporating temperature and condensing temperature.
	Refrigerant	:	The refrigerant shall be R-134a/R-410A/R-407C or any other environment friendly refrigerant.
	Capacity control	:	Automatic (stepless).
	Air cooled Condenser		
	Type	:	Shall be as per manufacturer standard and proven practice. However design ambient temperature for air cooled condenser shall be minimum 50 deg.C
	Evaporator		
	Type	:	Shell and tube type
	Superheating of	:	At least 2 deg.C
	Design Fouling Factor	:	Minimum 0.0001 (MKS units)
	Fluid	:	Shell side - Refrigerant
		:	Tube side - Water
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-15 Air Conditioning System Page 2 of 31

CLAUSE NO.	TECHNICAL REQUIREMENTS			
4.03.00	Leaving/entering water temperature		6.7 dec.C / 12.2 deg.C	
	Capacity	:	To match with respective plant capacity.	
	Shell material	:	Mild steel (IS : 2062) / SA 106 Gr. B	
	Tube material		Plain tube internally /externally finned copper as per the manufacturer's standard practice.	
	Fin material	:	Integral	
	Accessories	:	Purge and drain connections, Isolating valves, flow switches, Pressure & temperature indicators at inlet and outlet, Anti-freeze thermostats, electronic expansion valve or float assembly as applicable, pilot solenoid valve, Relief valves, Operating thermostats for capacity control, supporting frame, etc.	
	Steel Structure	:	The complete condensing/ chilling unit shall be mounted on steel structure and shall be provided with necessary vibration isolators.	
	Condensing Unit (Air-Cooled/Water cooled D-X type-If applicable))			
	Condensing unit			
	Type	:	Air cooled type / Water cooled type (if applicable)	
Vibration isolators	:	Steel spring / Neoprene rubber cushy foot type with isolation efficiency not less than 85%.		
Compressor				
Type	:	The Compressor shall be Screw/scroll, serviceable, either open type or hermatic type or semi-hermetic type with load, unload and automatic capacity control (minimum 3 steps).		
Type of drive	:	Motor driven, direct or through V-belt.		
Refrigerant	:	The refrigerant shall be R-134a/ R-410A/R-407C or any other environment friendly refrigerant.		
Accessories	:	High/Low pressure cutouts, oil pressure switches, relief valves, pressure gauges at each stage, lube oil and control oil pressure gauges, suction & discharge stop valves, Muffler, Crank case heaters, oil filters, magnetic oil separators, temperature indicators for lube oil/heaters, oil level indicators, safety thermostat		
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9		Sub Section-A-15 Air Conditioning System
Page 3 of 31				

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	for crank case heater, vibration isolators, etc. Motor Rating : 10% more than the power required by the compressor at 50 deg C design ambient temperature. Capacity : Minimum capacity shall be suitable for the identified/selected at evaporating temperature and condensing temperature and shall be indicated. NOTE: Up to 50TR cap. Chilling/Condensing unit can be of air/water cooled type however, beyond this cap. unit shall be water cooled type only.			
4.04.00	Air Handling Unit (AHU)			
4.04.01	Each AHU shall consist of casing, fan impeller section, cooling coil section, damper section, steel frame with anti vibration mountings (AVMs) having minimum 85% vibration dampening efficiency and flame retardant, water proof neoprene impregnated flexible connection on fan discharge. Isolation dampers at the suction and discharge of each AHU shall be provided, in case return air duct is directly connected to AHU. However, in case AHU room is used for return air, isolation dampers are required to be provided only at AHU discharge of each AHU. Pre-filter at the suction and fine (micro-vee type) and absolute (HEPA type) filters (wherever applicable) at the discharge of each individual AHU, and heater section in the common discharge of AHUs.			
4.04.02	The casing of AHUs shall be of double skin construction. Double skin sandwich panels (inside and outside) shall be fabricated using minimum 0.63 mm (24g) galvanized steel sheet (thickness of galvanization as per manufacturer's standard) , with 25mm thick polyurethane foam insulation of minimum 38 Kg/Cum density in between. Suitable reinforcements shall be provided to give structural strength to prevent any deformation/buckling.			
4.04.03	Sloping condensate drain pan shall be made of minimum 1.2 mm thick Stainless Sheet Steel. It shall be isolated from bottom floor panel through 25mm thick heavy duty treated for Fire (TF) quality expanded polystyrene or polyurethane foam. Drain pan shall extend beyond the coil.			
4.04.04	Cooling coil (min. 4 row deep) shall be made of seamless copper tubes with aluminium fins firmly bonded to copper tubes and shall be provided with suitable drains and vents connections.			
4.04.05	All filter plenum shall be provided with a walking platform inside the plenum chamber for filter cleaning purpose. Inspection door shall be provided at the plenum chamber and a removable type ladder shall be attached to plenum.			
4.04.06	Centrifugal fan for AHU			
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-15 Air Conditioning System	Page 4 of 31

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	a) Fan Type : Double Width Double Inlet (DWDI) Centrifugal Type b) Fan impeller : Backward curved blades c) Casing material : GI /Mild steel with minimum thickness of 3 mm. d) Impeller material : Carbon steel e) Shaft : EN 8 Steel f) Fan bearings : Self aligning type, permanently lubricated, heavy duty with a design life of 10,000 operating hours. g) Critical speed : First critical speed of rotating assembly shall be at least 25% above the operating speed. h) Drive : Motor driven with removable belt guard.			
4.04.07	Mixing Box: Mixing box shall be complete with fresh and return air dampers. Mixing box shall be provided whenever the return air is ducted back to the AHU.			
4.04.08	Pan Humidifier: Pan humidifier shall be made of 22 gauge SS 304 tank, duly insulated with 25 mm thick resin bonded fiber glass insulation (min. 24 Kg/m3 density) with 0.5 mm GSS cladding. The humidifier shall be complete with stainless steel immersion heaters, safety thermostat, float valve with stainless steel ball, sight glass, overflow and drain connections, steam outlet nozzle and float switch. Step controller shall be provided for switching on / off heater banks as per system requirement.			
4.05.00	HI-WALL SPLIT/CASSETTE/PRECISION AIR-CONDITIONERS			
4.05.01	Hi-wall Split/cassette air conditioners shall in general consist of the following: i) Casing ii) Hermetically sealed rotary/scroll Compressor iii) Condenser iv) Evaporator and condenser cooling fan			
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-15 Air Conditioning System	Page 5 of 31

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
4.05.02	v) Cooling coil vi) Filters vii) Piping, valves, refrigerant strainer, etc. viii) Controls, instruments, control panel/starter panels. ix) Vibration isolator pads, etc as required. Indoor unit of Ceiling Mounted Cassette Type Unit (Multi Flow Type): The housing of the unit shall be powder coated galvanized steel. All the indoor units regardless of their difference in capacity should have same decorative panel size for harmonious aesthetic point of view. Unit shall have four way supply air grills on sides and return air grill in center. Each unit shall have high lift drain pump and very low operating sound.			
5.00.00	BALANCE EQUIPMENT SPECIFICATION			
5.01.00	Centrifugal Pumps a) Type : Horizontal Centrifugal, Axially split type casing pump b) Impeller : Closed type c) Material of Construction i) Casing : 2% Ni Cast Iron : IS:210 Gr. FG-260 ii) Impeller : Bronze IS:318 Gr-2 iii) Wearing rings : Bronze iv) Shaft : SS 316 v) Shaft sleeve : SS 316 vi) Lantern ring : Brass / Bronze vii) Packing : Asbestos free viii) Base Plate : Carbon steel as per IS:2062			
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-15 Air Conditioning System	Page 6 of 31

CLAUSE NO.	TECHNICAL REQUIREMENTS			
5.02.00	ix) Speed : Maximum 1500 rpm			
	x) Other requirements : To refer to Annexure-I titled “Horizontal Pumps” of this sub section.			
	Material of Construction for Piping & Fittings			
	a) Piping for Chilled and Condenser water lines : Heavy grade-IS:1239 or Equivalent upto150 NB and IS:3589 or Equivalent for pipes beyond 200 NB with thickness as indicated in Annexure-II			
	b) Refrigerant piping : Seamless steel tubes conforming heavy grade IS:1239 or copper tubes as per IS:2501 (copper material as per IS:191 hard copper grade).			
	c) Drain piping : Same as (a) above & galvanized as per IS:4736.			
	d) Fittings : 1) The steel fittings shall conform to ASTM A234 Gr. WPB and dimensional standard to ANSI B 16.9/ANSI B16.11 / equivalent for sizes 65 NB and above.			
	2) For sizes 50 NB and below, the material shall conform to ASTM A-105.			
	3) All steel flanges shall be of slip on type and shall conform to ANSI B 16.5			
	4) For pipe sizes above 350 NB, fabricated fittings from sheets of adequate thickness may be used. The bend radius in case of mitre bends shall be minimum 1.5 times the nominal pipe diameter and angle between two adjacent sections shall not be more than 22.5 deg and shall be as per BS:2633/BS:534.			
	5) Fittings, flanges and pipe joints of refrigerant piping shall conform to ANSI B31.5			
5.03.00	VALVES			
5.03.01	Valves shall have full sizes port and suitable for horizontal and as well as vertical installation.			
5.03.02	Valves for regulating duty shall be of globe type suitable for controlling throughout its lift.			
5.03.03	All safety /relief valves shall be so constructed that the failure of any part does not obstruct the free discharge.			
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-15 Air Conditioning System	Page 7 of 31

CLAUSE NO.	TECHNICAL REQUIREMENTS	एनटीपीसी NTPC		
5.03.04	Valves shall be furnished with back seating arrangement for repacking while working under full working pressure.			
5.03.05	Manual gear operators be provided for valves of size 200 NB and above.			
5.03.06	All valves shall be supplied with companion flanges, nut, bolts & washers, etc.			
5.03.07	The refrigerant line valves shall have steel or brass body with TEFLON gland packing. The construction of disc shall be either globe or angle type. The valve seat shall have white metal lining or equivalent.			
5.03.08	All water line valves shall be of Cast Iron body for sizes 65 NB and above conforming to IS :14846 and Gun Metal construction for sizes less than 65NB conforming to IS:778. Cast Iron parts shall conform to IS:210 Gr FG 220. Butterfly valves shall confirm to latest revision of BS:5155 or equivalent standard of required class/rating.			
5.03.09	Balancing / Controller Valves: The valves of sizes 32 mm to 65 mm dia shall be of gun metal / cast iron construction with screwed ends. Whereas valves of sizes 75 mm and above shall be of cast iron construction with internal parts of SS 410 and EPDM / nitrile seat with flanged ends.			
5.04.00	AIR FILTERS			
5.04.01	Pre Filter 1) Type : Flange / Cassette 2) Pre-filter shall contain washable non-woven synthetic fiber or High density Polyethylene (HDPE) media having 18G GSS / 16G Al alloy frame. The filter media shall be supported with HDPE mesh on air inlet side & Aluminium expanded metal on exit side or G.I. wire mesh on both sides. 3) Other requirements : (as applicable) a) Suitable aluminium spacers be provided for uniform air flow; b) Casing shall be provided with neoprene sponge rubber sealing. c) Capable of being cleaned by water flushing. d) Density of filter medium shall increase in the direction of air flow in case of metallic filter. e) Filter media shall be fire retardant and resistant to moisture, fungi, bacteria & frost. 4) Efficiency : Average arresstance of 65 - 80 % when tested in accordance with BS:6540/ASHRAE – 52 – 76 / EN-779.			
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-15 Air Conditioning System	Page 8 of 31

CLAUSE NO.	TECHNICAL REQUIREMENTS				
5.04.02	5)	Minimum thickness	:	50 mm	
	6)	Face Velocity	:	Not more than 2.5 m/sec.	
	7)	Pressure drop	:	Initial pressure drop - Not to exceed 5.0 mm WC at rated flow. Final pressure drop - Upto 7.5 mm WC.	
	8)	Location	:	a) At the suction of each AHUs b) At the suction of each Fresh air fan c) At the suction of each Supply air fan d) At the suction of each Air washer and UAF (water repellent nylon type).	
	Fine Filters (Microvee type)				
	1)	Type	:	Flange / Cassette	
	2)	Fine filter shall contain washable non-woven synthetic fibre or High density Polyethylene (HDPE) media having 18G GSS / 16G Al alloy frame. The filter media shall be supported with HDPE mesh on air inlet side & Aluminium expanded metal on exit side or G.I. wire mesh on both sides.			
	3)	Other requirements	:	a) A neoprene sponge rubber sealing shall be provided on either face of the filter frame. b) Capable of being cleaned by air or water flushing. c) Filter media shall be fire retardant and resistant to moisture, fungi, bacteria & frost.	
	4)	Efficiency	:	Average arrestance > 90% when tested in accordance with BS:6540/ASHRAE-52-76 / EN-779.	
	5)	Minimum thickness	:	150 mm or 300 mm.	
6)	Face Velocity	:	Not more than 1.2 m/sec for 150 mm and not more than 2.4 m/sec. for 300 mm.		
7)	Pressure drop	:	Initial pressure drop - Not to exceed 10 mm WC at rated flow ; Final pressure drop-Upto 25 mm WC.		
8)	Location	:	i) At the discharge of each individual AHU. ii) At the discharge of each Fresh air fan. iii) At the discharge of each supply air fan having		
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9		Sub Section-A-15 Air Conditioning System	Page 9 of 31

CLAUSE NO.	TECHNICAL REQUIREMENTS			
5.04.03	static pressure 30mm wc or more.			
	Absolute Filter / Hepa Filter			
	1)	Media	:	100% sub-microscopic glass fibers.
	2)	Frame	:	Aluminium alloy of (minimum 16 gauge conforming to IS: 737) with handles.
	3)	Other requirements	:	A neoprene sponge rubber sealing shall be provided on either face of the filter frame.
	4)	Efficiency	:	99.97 % down to 0.3 micron when tested in accordance with BS: 3928 (Sodium flame test)/FED-209B.
	5)	Minimum thickness	:	300 mm
	6)	Face Velocity	:	Not more than 1.2 m/sec.
	7)	Pressure drop	:	Initial pressure drop - Not to exceed 25 mm WC at rated flow; Final pressure drop - Up to 75 mm WC.
	8)	Location	:	At the discharge of each individual AHUs for Control Equipment room / Control room areas.
6.05.00	LOW PRESSURE AIR DISTRIBUTION SYSTEM			
6.05.01	Material of air distribution system shall be through galvanized steel sheet (Conforming to Class 275 of IS: 277) or Aluminium alloy (grade 19000 / SIC or 3100 / NS3 of IS: 737)			
6.05.02	Thickness of rectangular ducts shall be as follows:			
	Larger Dimension of duct (mm)	Thickness of GI sheet(mm)	Thickness of Aluminium sheet (mm)	
	up to 750 mm	0.63 (24 G)	0.80	
	751 to 1500	0.80 (22 G)	1.00	
	1501 to 2250	1.00 (20 G)	1.50	
	2251 & above	1.25 (18 G)	1.80	
6.05.03	Thickness of round ducts shall be as follows :			
	Diameter of Round duct (mm)	Thickness of GI sheet(mm)	Thickness of Aluminium sheet (mm)	
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9		Sub Section-A-15 Air Conditioning System
Page 10 of 31				

CLAUSE NO.	TECHNICAL REQUIREMENTS 		
6.05.04	150 to 500	0.63	0.80
	501 to 750	0.80	1.00
	751 to 1000		
		0.80	1.00
	1001 to 1250	1.00	1.50
	1251 & above	1.25	1.80
	Duct Fabrication and Supports: a) Duct fabrication shall be as per the latest relevant BIS/SMACNA standard. b) Ducts for A/C system may be site fabricated or factory fabricated and installed at site. However, in case of partly used factory fabricated ducts, vendor shall take back the unused ducts. c) The ducts routed inside the buildings with larger side greater than 2250 mm shall be supported by 16mm MS rods and 50x50x3 mm MS double Angles while those below 2250 mm shall be supported by 10mm MS Rods and 40x40x3 MS angles. The duct supports shall be at a distance of not more than 2000 mm for A/C system. The MS rods for these ducts routed inside the building shall be hung from the existing floor beams/wall beams/roof beams/columns as provided by the Employer with provision of necessary auxiliary or special steel members or by hooks or can be provided by contractor by dash fasteners fixed to the ceiling slab. No supports shall be taken from horizontal/vertical bracings of the structures. All items of duct support including MS rods, MS angles and double angles, auxiliary or special steel members, hooks, dash fasteners coach screws and all other supporting material required shall be provided by the bidder. d) Where the sheet metal duct connects to the intake or discharge of fan units a flexible connection of fire retarding, at least 150 mm width shall be provided of closely woven, rubber impregnated double layer asbestos/canvas or neoprene coated fibre glass. e) All curves, bends, off-sets and other transformations shall be made for easy and noiseless flow of air. The throat of every branch duct shall be sized to have the same velocity as in the main duct to which the branch duct is connected. f) Wherever duct passes through a wall, the opening between masonry and duct work shall be neatly caulked or sealed to prevent movement of air from one space to the adjoining space. g) Wherever pipe hangers or rods pass through the ducts, light and streamline easement around the same shall be provided to maintain smooth flow of air. h) Access doors shall be provided in the duct work or casing on the both sides		
	KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		
	TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9		
	Sub Section-A-15 Air Conditioning System		
	Page 11 of 31		

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	of the equipment to be serviced. All access doors shall be of adequate size and shall be lined with substantial felt edging to prevent air leakage. Access doors shall be of built up construction, structurally strong and each shall have at least two hinges. Access doors shall have two rust proof window sash of approved type. All doors shall be set so as to flush with insulation or plaster finish on the duct.			
6.05.05	Splitters and dampers shall be provided for equipment/area isolation and for proportional volume control of system. The same shall be minimum 16 gauge GS sheet of quadrant type with suitable locking device, mounted outside of duct in accessible position.			
6.06.00	Factory fabricated ducts: i) All ducting shall be fabricated of LFQ (Lock Forming Quality) grade prime G.I. ii) Unless otherwise specified here, the construction, erection, testing and performance of the ducting system shall conform to the SMACNA-1995 standards (“HVAC Duct Construction Standards-Metal and Flexible-Second Edition-1995” SMACNA) iii) All ductwork including straight sections, tapers, elbows, branches, show pieces, collars, terminal boxes and other transformation pieces must be factory fabricated by utilizing the machines and processes as specified in SMACNA or by equivalent technology. In equivalent method, the fabrication shall be done by utilizing the following machines and process to provide the requisite quality of ducts and speed of supply: a. Coil lines to ensure location of longitudinal seams at corners/folded edges only to obtain the required duct rigidity and low leakage characteristics. No longitudinal seams permitted along any face side of the duct. b. All ducts, transformation pieces and fittings to be made on CNC profile cutters for required accuracy of dimensions, location and dimensions of notches at the folding lines. c. All edges to be machine treated using lock formers, flangers and roll-bending for turning up edges. d. Sealant dispensing equipment should be used for applying built-in sealant in Pittsburgh lock where sealing of longitudinal joints are specified. Sealing of longitudinal joint is compulsory for the ducts over 2” w.g. static pressure iv) All transverse connectors shall be 4-bolt slip-on flange system with built-in sealant, if any. To avoid any leakage additional sealant shall be used. v) For each drawing, all supply of ductwork must be accompanied by computer-generated detailed bill of material indicating all relevant duct sizes, dimensions and quantities. In addition, summary sheets are also to be provided showing duct areas by gauge and duct size range as applicable.			
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-15 Air Conditioning System	Page 12 of 31

CLAUSE NO.	TECHNICAL REQUIREMENTS	एनटीपीसी NTPC	
6.07.00	Diffusers, Grills & Dampers :		
6.07.01	Supply air diffusers/grills with factory fitted volume control dampers be provided for all air-conditioned areas.		
6.07.02	Return air diffusers of air conditioned areas shall be without volume control dampers.		
6.07.03	The diffusers/grills shall be of extruded Aluminum of minimum 1.2 mm thick with powder coating. The colour of power coating shall be as per the interior Décor.		
6.07.04	Supply air grills shall be of double deflection type and return air grills shall be of single deflection type.		
6.07.05	The nozzle type diffusers shall be fabricated from minimum 1.5mm aluminium sheet. The base shall be fixed type. The nozzle shall be of volute design with the spout diameter being half the base dia. and designed for low noise and long throw. The nozzle shall be able to rotate to any angle within the base. The whole assembly shall be powder coated as per interior decor.		
6.07.06	All volume control (VC) damper shall be operated by a key from the front of the grills/diffusers and shall be of GI sheet.		
6.07.07	The thickness of VC dampers shall be of minimum 20 gauge and thickness of louvers shall be of minimum 22 gauge.		
6.07.08	Suitable vanes shall be provided in the duct collar to have uniform and proper air distribution. Bank of Baffles wherever required shall also be provided.		
6.07.09	Fire dampers shall be motor operated type and shall have fire rating of minimum 90 minutes.		
6.07.10	All plenum chambers of connections to fans, dampers etc shall be constructed in 18 gauge GS sheet and supported on MS angle frames,		
6.07.11	All ducting surfaces coming in contact with corrosive fumes or gases shall be painted with three coats of epoxy paint over a coat of suitable primer.		
6.08.00	Thermal and Acoustic Insulation		
6.08.01	A) Application with Glass Wool (a.) All surfaces to be insulated both thermally and acoustically shall be thoroughly cleaned, dried and an adhesive (CPRX compound of Shalimar Tar Products or Equivalent) be applied @ 1.5 Kg /Sqm on the surface. (b.) Insulation material (either expanded polystyrene foam or Glass Wool/ Glass fiber or Equivalent) shall be struck to the surface. All the joints shall be sealed with bitumen. (c.) Insulation mass to be covered with 500 gauge polythene sheet with 50 mm overlaps and sealing all joints on hot side.		
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-15 Air Conditioning System
			Page 13 of 31

CLAUSE NO.	TECHNICAL REQUIREMENTS																
6.08.02	(d.) Insulation Finish of types specified under shall be provided thereafter.																
	B) Application with Nitrile Rubber:																
	(a) All surfaces to be insulated shall be properly cleaned.																
	(b) A suitable adhesive such as SR 998 or equivalent shall be applied over the surfaces to be insulated and insulation material surfaces.																
	(c) Insulating material shall than be pasted onto the surfaces in a manner to avoid stretching and any air entrapment within.																
	(d) Two layers of Glass Cloth with a suitable adhesive as SR 998 or equivalent shall be then applied over the insulating material to avoid surface weathering.																
	C) Application with FR Closed Cell Chemically Cross Linked Polyethylene Material (XLPE)																
	(a) All surfaces to be insulated shall be properly cleaned of any dust, grease and moisture.																
	(b) A suitable adhesive, normally, a pressure sensitive acrylic base, such as SR 998/STAR Glue R242 or Neosole AA 900 or equivalent shall be used to paste the insulating material over the cleaned surface.																
	(c) XLPE cut to size for each surface, with overlaps provided for two faces shall be stuck to the surfaces in a manner to avoid air entrapment. The extent of overlap shall be equivalent to the thickness of the material to be applied. The adhesive is applied on both the surfaces to be insulated and the insulation foam material.																
(d) Application of the insulating material to surfaces should preferably be carried out at ground level, in a clean dust free area.																	
(e) All joints- lateral & longitudinal, shall be taped with self adhesive aluminium foil tape 75 mm wide. The insulation over the surface shall be then held in position with 12mm wide PVC straps at every 600mm, to provide a neat & clean finish.																	
Type of Insulation & Finish																	
<table><tr><th>Sl. No.</th><th>Surface</th><th>Insulation Material</th><th>Insulation Form</th><th>Thick (mm)</th><th>Finish (mm)</th></tr><tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr></table>						Sl. No.	Surface	Insulation Material	Insulation Form	Thick (mm)	Finish (mm)						
Sl. No.	Surface	Insulation Material	Insulation Form	Thick (mm)	Finish (mm)												
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9		Sub Section-A-15 Air Conditioning System													
Page 14 of 31																	

CLAUSE NO.	TECHNICAL REQUIREMENTS एनटीपीसी NTPC					
	Sl. No.	Surface	Insulation Material	Insulation Form	Thick (mm)	Finish (mm)
	1.	Supply & return air duct of A/C System	Resin bonded glass wool	Roll /Slab	50	F-3
			or Closed Cell Elastomeric Nitrile Rubber	sheet	19	As per manufacturer std.
			Or FR Closed Cell Chemically Cross Linked Polyethylene (XLPE) with Al foil face	Roll	19	F-3(a)
	2.	Refrigerant (Suction and liquid lines)	Closed Cell Elastomeric Nitrile Rubber	Tube	19	As per manufacturer std.
			Or FR Closed Cell Chemically Cross Linked Polyethylene (XLPE)	Pre-formed tube/roll	19	F-1(a)
	3.	AHU drain pipe	Closed Cell Elastomeric Nitrile Rubber	Tube	19	As per manufacturer std.
			Or FR Closed Cell Chemically Cross Linked Polyethylene (XLPE)	Pre-formed tube	19	F-1(a)
	4.	AHU condensate pan (insulation if required)	Mineral wool or resin bonded glass wool Or	Slab	25	As per manufacturer std.
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE			TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9		Sub Section-A-15 Air Conditioning System	Page 15 of 31

CLAUSE NO.	TECHNICAL REQUIREMENTS						एनटीपीसी NTPC
	Sl. No.	Surface	Insulation Material	Insulation Form	Thick (mm)	Finish (mm)	
			FR Closed Cell Chemically Cross Linked Polyethylene (XLPE) with Al foil face	Sheet	15	F-1(a)	
	5.	Chilled water piping, valves & specialties	Resin bonded Mineral wool or resin bonded glass wool	Pipe section	75	F-1	
			Or FR Closed Cell Chemically Cross Linked Polyethylene (XLPE)	Pre-formed tube/roll	19	F-1(a)	
	6.	Chiller (insulation if required)	----- As per manufacturer std.-----				
	7.	Chilled water pumps	Resin bonded Mineral wool or resin bonded glass wool	Slab	50	F-1	
			Or FR Closed Cell Chemically Cross Linked Polyethylene (XLPE)	Plain Roll	19	F-1(a)	
	8.	Expansion tank with associated piping	Resin bonded Mineral wool or resin bonded glass wool	Slab/ Pipe section	50	F-1	
Or FR Closed Cell Chemically Cross Linked Polyethylene (XLPE)			Roll	19	F-1(a)		
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE			TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9		Sub Section-A-15 Air Conditioning System	Page 16 of 31	

CLAUSE NO.	TECHNICAL REQUIREMENTS						एनटीपीसी NTPC
6.08.03	Sl. No.	Surface	Insulation Material	Insulation Form	Thick (mm)	Finish (mm)	
	9.	Acoustic insulation of duct	Resin bonded Glass wool	Slab	25	As per specifications	
	10.	Exposed air duct	Resin bonded Glass wool	Roll	50	F-4	
			Or FR Closed Cell Chemically Cross Linked Polyethylene (XLPE) with Al foil face	Roll	19	F-4(a)	
	Specification for insulation shall be as follows: -						
	Insulation Material		Code	Thermal conductivity (w/m ⁰ C)	Density Kg/m ³		
	Resin bonded glass wool		IS:8183	0.049 at 50 ⁰ C	i) 24 (For thermal insulation) ii) 48(For acoustic insulation)		
	Mineral wool pipe section Min.Gr.2		IS:9842	0.043 at 50 ⁰ C	144		
	Closed Cell Elastomeric Nitrile Rubber			0.036 at 20 ⁰ c	60-70		
	FR Closed Cell Chemically Cross Linked Polyethylene (XLPE)			0.033 at 23° C	33 ± 3		
Note : Insulation used for HVAC application shall be CFC/HCFC free							
6.08.04	The specification for various finishes shall be as follows						
	a)	Finish F-1 <u>Step-1</u> Wrapping of Poly-Bonded Hessain (PBH – to act as vapour seal) on outer surface of insulation with 50 mm overlap stitching and sealing of overlap with synthetic adhesive like CPRX or Equivalent					
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE			TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9		Sub Section-A-15 Air Conditioning System		Page 17 of 31

CLAUSE NO.	TECHNICAL REQUIREMENTS एनटीपीसी NTPC			
		compound. <u>Step-2</u> The surface then shall be wrapped with 19 mm mesh 24 SWG GI wire netting, butting all the joints and laced down with 22 SWG lacing wire. <u>Step-3</u> Sand cement (4:1) plaster shall be applied in two layers totalling to 12.5 mm thick, the second layer being brought to a smooth finish. A water proofing compound shall be added to the cement before its application. b) Finish F-1(a) (With FR Closed Cell Chemically Cross Linked Polyethylene Material) Wrapping of two layers of 7 mil 10x10 mesh glass cloth dipped in suitable adhesive such as SR 998 or equivalent. c) Finish F-2 <u>Step-1</u> Insulation shall be covered with 500g polythene with 50mm overlap and sealing of overlap with synthetic adhesive like CPRX or Equivalent compound. <u>Step-2</u> Same as Step-2 of Finish F-1 above. <u>Step-3</u> Same as Step-3 of Finish F-1 above. d) Finish F-3 <u>Step-1</u> Same as Step-1 of Finish F-2 above <u>Step-2</u> The polythene shall be covered with 30 gauge Aluminium sheet and locking of joints with self-locking screws at a pitch of minimum 100 mm. e) Finish F-3(a) (With FR Closed Cell Chemically Cross Linked Polyethylene Material) Al foil faced XLPE material applied over duct surfaces, shall be covered with 30 gauge aluminium sheet, having tongue-in-groove joints and these are held in position with self drilling self tapping screws (SDST) at a distance of 150mm. f) Finish F-4 <u>Step-1</u> Same as Step-1 of Finish F-1 above. <u>Step-2</u> Same as Step-2 of Finish F-1 above. <u>Step-3</u> Same as Step-3 of Finish F-1 above. <u>Step-4</u> Application of 3 mm thick coat of water proofing compound and wrapped with fibre glass RP tissue followed by final coat of 3 mm thick water proofing compound "SHALIKOTE 30" or Equivalent over		
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-15 Air Conditioning System	Page 18 of 31

CLAUSE NO.	TECHNICAL REQUIREMENTS		
		the RP tissue. <u>Step-5</u> After the above treatment, 22G Aluminium sheet cladding, properly stitched at all joints shall be provided over the external surface.	
	g)	Finish F-4(a) (With FR Closed Cell Chemically Cross Linked Polyethylene Material)	
		Application of aluminium sheet 22G cladding to be provided over the XLPE insulating material. Cladding sheet is held in position with SDST screws @ 150 mm C/C over tounge-in-groove joints applied with afelt for sealing joint against water ingress. Al sheet joints to be done in a manner to shed water.	
6.08.05	For all inspection covers and hatches on equipment, pump casing, valve bodies and flanges (100 mm and above), insulation shall be applied so as to facilitate removal without minimum damage to the insulation by encasing the insulation in 24 gauge GI box or 22 gauge Aluminium sheet metal boxes which are bolted together around the equipment. However continuity of the vapour seal between the static and removable portions of the insulation is to be maintained.		
6.08.06	ACOUSTIC INSULATION a) All ducts up to a distance of 5 meters from AHU shall be acoustically lined from inside with 25 mm thick resin bonded glass wool of 48 Kg/Cu.M. density and 30 gauge perforated aluminium sheet having 5 mm dia perforation at 8 to 10 mm centre-to-centre distance. Insulation shall be fixed on wooden frame of 600 x 600 mm dimension. b) Fibre glass tissue sheet shall be applied over the outer surface of insulation before applying perforated aluminium sheet. Application of acoustic insulation shall be inline with the requirements specified above.		
7.00.00	PLANT CONTROL		
7.01.00	Brief scheme of controlling the operation is described below. Detailed description of the control system for safe and efficient operation of the plant shall be elaborated, got approved from employer. The descriptions in the sub-sections of the control & instrument sections shall also be referred to		
7.02.00	<i>Control Scheme for Air-Conditioning System</i>		
7.02.01	<i>All the functional requirements specified below and general control logic specified under this section shall be implemented in the respective control system.</i>		
7.02.02	The basic function of the system shall be to closely control and monitor temperature and humidity conditions inside the air-conditioned spaces, to optimize / minimize energy consumption by automated operation, to provide remote centralized monitoring & control for various mechanical facilities including sequential start/stop of the whole HVAC System, automatically calculate record and cooling load for		
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-15 Air Conditioning System
Page 19 of 31			

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	each hour /day/season, to generate maintenance data & alarms, to maintain records of plant operation & energy consumption for varying loads, duty cycling to operate all the equipment including standby equipment for equal duration, automatic startup of standby equipment in case of failure of operating unit and displaying fault alarm status of the tripped unit, activating /deactivating water valves to startup/stop water flow through chiller/condenser circuit. For sequential operation /duty cycling, Programmed startup/stop of individual AHU as per operating requirements and inside room temperature and humidity of CR, CER, , UPS and Battery Charger room shall be maintained by controlling the chilled water flow by means of motor operated three way modulating valve humidified system and duct heater.			
7.02.03	The operation of each Air Conditioning system shall be possible through Microprocessor based dedicated controllers to be provided by Contractor for each Screw /centrifugal Chiller units with local start / stop & indication for main plant A/C system in addition to Main DDCMIS based Control system of A/C plant (provided by contractor) for central control room.. Further these microprocessor based control panels of Chiller units shall be suitably interfaced with DDCMIS based Control panels.			
7.03.00	Water Chilling Plant Control			
7.03.01	Microprocessor based controls shall be provided as per manufacturer’s standard practice along with facilities to interface with control system and to meet the requirement of all system operations and controls. Water chilling unit control system shall be designed to have a constant chilled water outlet temperature from evaporator at all load condition by means of controlling ON-OFF thermostat (one for each compressor). The closure of liquid line solenoid valve and tripping of compressor at lower water temperature and opening of solenoid valve and starting of compressor at high water temperature set point shall be automatic through the thermostat. Between the above set points the compressor capacity shall be controlled automatically through cylinder “load-unload” mechanism activated through the suction pressure or return chilled water temperature.			
7.03.02	Water chilling unit shall be equipped with superheat control of water chilling unit through thermostatic expansion valve which gets its impulse from temperature element connected with suction line after chiller outlet.			
7.03.03	High discharge pressure cut-out and oil pressure (OP) differential cut-out shall be of manual reset type and low pressure cut-out shall be automatic reset type. The OP cut-out shall trip the compressor in case of low oil pressure.			
7.03.04	Facility toggle switch to close the liquid refrigerant line solenoid valve shall be provided to shut the compressor by the operation of low pressure cut-out (after the refrigerant has been pumped to the condenser).			
7.03.05	Switching of Crank case heaters shall be interlocked with starting and stopping/tripping of compressor motor. Further, the safety thermostat shall switch off the crank-case heater in the event temperature rises above safe limit.			
7.03.06	Provision shall also be made for the manual restarting of the compressor.			
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-15 Air Conditioning System	Page 20 of 31

CLAUSE NO.	TECHNICAL REQUIREMENTS	एनटीपीसी NTPC	
7.03.07	On-off type anti-freeze thermostats, one for each chiller shall be provided in addition to the controlling on-off thermostat for safety purpose and shall act in the event of failure of on-off thermostat to close the liquid line solenoid valve and also to simultaneously trip the compressor.		
7.03.08	Compressor starting/running shall be interlocked with the low / adequate flow at the outlet of each chiller and each condenser and as well as with pressure in the inlet of the condensers. In addition, closure or open status of various valves shall be used for interlock, alarm and control of Air Conditioning System.		
7.03.09	The standby chilled water pumps, standby fresh air fan & standby AHU shall be started automatically when the working equipments are stopped/ tripped. Auto/ Manual selecting and working/ standby selecting facility for the pumps/ AHU/ fresh air fan shall be provided.		
7.03.11	Closure of fire dampers shall raise an alarm in the system.		
7.03.12	There shall be provision for temperature and flow measurement in chilled water inlet and outlet line across AHUs to monitor the air conditioning load of each area.		
7.03.13	Operation of air conditioning system shall be interlocked with the required minimum pressure and temperature of cooling tower at inlet to the condenser. Status indication of condenser water pumps and associated cooling towers shall be provided in the control panel of air conditioning plant.		
7.04.00	Air Handling Unit a) Inside room temperature and humidity shall be maintained by controlling the chilled water flow by means of motor operated three way modulating valve . b) Humidity sensor and gyserstat located in the return air duct shall actuate the PAN humidifier to obtain the desired degree of humidification. c) Humidity and temp. sensor shall be provided and interlocked in steps with winter heater / re-heater / strip heaters for monsoon and winter re-heating or heating as the case may be. d) Heater banks shall be interlocked with the running of AHU, temperature of return air, humidity of return air and safety thermostat (airstat - located in front of the each heater in the supply air duct) e) AHU shall be started either locally or from the main control room of AC system by means of Remote / Manual selection facility. f) The closure of fire dampers, automatic tripping of AHU fans and fresh air fans shall be interlocked with Fire Detection System. g) Each AHU shall be provided with temperature indicators and flow indicator in the chilled water piping inlet and outlet to monitor the air-conditioning load of each area.		
7.05.00	D-X Air-Conditioning System		
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-15 Air Conditioning System
Page 21 of 31			

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	a) The control and interlocks described above for water chilling plants are applicable for this system also. b) Further the compressor starting/running shall be interlocked with the flow switches in condenser water circuit and as well as with AHU motors. c) The standby condenser water pumps, fresh air fan & standby AHU shall be started automatically when the working equipments are stopped / tripped. Auto/ Manual selector Switches and working / standby selector switches for the pumps, fresh air fans and AHU shall be provided in the panel.			
7.06.00	Cassette /Hi-wall Split Air Conditioners Control and interlocks for these type of units shall be as per manufacturer's standard practice.			
7.07.00	General a) Separate emergency local stop push button shall be provided for each pump, compressor, fans etc. of A/C system. b) Status shall be provided of each pump, compressor, fans etc. of AC system and Ventilation system on HMI system at control room. c) All the annunciations related to failure of equipments, tripping of equipments, source of failure / reason due to which the equipment is stopped / tripped, low & high limits of parameters such as level, temperature, pressure drop, pressure etc shall be provided for each pump, fan, compressor, AHU, PAC, AWU etc.. d) The fans (both supply and exhaust fans) associated with mechanical ventilation system shall be operated locally. e) Relative humidity and temperature measurement of all control rooms and CERs, ESP control room and all major air-conditioned areas shall be available in DDCMIS. Relative humidity and temp. measurement for main plant control room and CERs to be available in multiple numbers.			
8.00.00	PAINTING:			
8.01.00	All the Equipments shall be protected against external corrosion by providing suitable painting.			
8.02.00	The surfaces of stainless steel, Galvanized steel, Gunmetal, brass, bronze and non-metallic components shall not be applied with any painting. The Contractor shall clean the external surfaces and internal surfaces before Erection by wire brushing and air blowing. The steel surface to be applied with painting shall be thoroughly cleaned before applying painting by brushing, shot blasting, etc. as per the agreed procedure.			
8.03.00	For all the steel surfaces (external) exposed to atmosphere (outdoor installation), one(1) coat of red oxide primer of thickness 30 to 35 microns followed up with three (3) coats of synthetic enamel paint, with 25 microns as thickness of each coat, shall			
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-15 Air Conditioning System	Page 22 of 31

CLAUSE NO.	TECHNICAL REQUIREMENTS															
	be applied. For plant at coastal area, epoxy resin based zinc phosphate primer followed by epoxy resin based paint pigmented with titanium di-oxide shall be used in place of enamel paints.															
8.04.00	For all the steel surfaces inside the building (indoor installation), One (1) Coat of red oxide primer of thickness 30 to 35 microns followed up with two (2) coats synthetic enamel paint, with 25 microns as thickness of each coat shall be applied. For plant at coastal area, epoxy resin based zinc phosphate primer followed by epoxy resin based paint pigmented with titanium di-oxide shall be used in place of enamel paints.															
8.05.00	For centrifugal fans - Casing shall have hot dip/ spray galvanization (minimum 60 micron DFT).															
9.00.00	CODES & STANDARDS															
9.01.00	The design, manufacture and performance of equipment shall comply with all currently applicable statues, regulations and safety codes in the locality where the equipments are to be installed. Nothing in this specification shall be considered to relieve the bidder of this responsibility.															
9.02.00	Unless otherwise specified, equipment shall conform to the latest applicable Indian or IEC standard. Equipment complying with other authoritative standards such as British, USA, ASHRAE etc. will also be considered if it ensures performance equivalent or superior to Indian Standard.															
10.00.00	AIR CONDITIONING SYSTEM Equipment Sizing Criteria															
10.01.00	DESIGN PHILOSOPHY - Air conditioning system															
	1. Design ambient conditions for all air conditioning system shall be as indicated below:															
	2.															
	<table><tr><th>Season</th><th>Dry Bulb Temp. (Deg. C)</th><th>Wet Bulb Temp. (Deg. C)</th></tr><tr><td>Summer</td><td>43</td><td>25.6</td></tr><tr><td>Monsoon</td><td>32.2</td><td>28.3</td></tr><tr><td>Winter</td><td>10</td><td>6.1</td></tr></table>				Season	Dry Bulb Temp. (Deg. C)	Wet Bulb Temp. (Deg. C)	Summer	43	25.6	Monsoon	32.2	28.3	Winter	10	6.1
Season	Dry Bulb Temp. (Deg. C)	Wet Bulb Temp. (Deg. C)														
Summer	43	25.6														
Monsoon	32.2	28.3														
Winter	10	6.1														
	2. All equipment of Air Conditioning system shall be designed for continuous duty.															
	3. All air conditioned areas like control room, control equipment rooms, Service building, administrative building etc. shall be maintained at 24 deg. C ± (plus or minus) 1 deg. C and relative humidity of 50% ± (plus or minus) 5%.															
	4. The fresh air quantity for air-conditioned areas of Control Room / Control Equipment Room / UPS, etc. shall be 0.45 M³/minutes/person or 1.0 air change per hour whichever is greater. However, for areas like office building, administrative building, etc. quantity of fresh air shall be minimum 1.5 air changes per hour.															
	5. Lighting load shall be minimum 2 Watts/Sq.feet or actual whichever is higher.															
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-15 Air Conditioning System	Page 23 of 31												

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	6. The occupancy for general area shall be minimum one person per 10 Sq. M and for conference room the same shall be one per 3 Sq.M. In the control rooms, control, equipment rooms etc, the occupancy may be one person per 25 Sq.M (Minimum). 7. In Air conditioning system the return air shall be through ducts and use of plenum space for return air shall be avoided. Further, for service / administrative building where various floors are air-conditioned and no intermediate or intervening floor are left non air-conditioned, the space above false ceiling shall be used as return air plenum. 8. The supply and return air ducts shall be provided with automatic (motorised) fire dampers (of 90 minutes fire rating) at locations where ducts pass through walls & floors. Operation of these dampers shall be interlocked with the fire alarm system and shall also be possible to operate manually from the remote control panel. Required electrical contacts shall be provided in control panel of A/C plant by the Contractor for further wiring upto fire alarm panels. 9. Soft water make up (if required) for complete air conditioning and ventilation system shall be provided by the bidder. 10. Design Chilled water flow shall not be less than 0.7 Cu.M/hr per TR air-conditioning load. 11. Coil face area of Air Handling units shall be designed considering a face velocity of not more than 2.5 m/sec. Water piping shall be sized for a maximum velocity of 2.0 m/sec. However, gravity flow / pump suction line shall be sized for a maximum water velocity of 1.5 m/sec. Air distribution system shall be sized to have a constant frictional drop along its length and velocity through ducts shall not exceed 7.6 m/sec. 12. Requirement of Underdeck Insulation (for A/C area) 13. Underdeck insulation of 50 mm nominal thickness of glass wool (32 Kg/cu.m) or rock wool (48 Kg/cu.m) shall be provided if i) Non A/C area is located just above the A/C area. In this case, underdeck insulation shall be provided underneath of the ceiling of A/C area. ii) Non A/C area is located just below the A/C area. In this case, underdeck insulation shall be provided underneath of the ceiling of Non A/C area. 14. For air handling unit (AHU) serving main plant control area, where microprocessor based equipments are located, the dehumidified air shall be filtered at three different stages i.e. pre (coarse) filter followed by fine filter followed by HEPA filter before discharge it to conditioned space. For all other areas, AHU's shall be provided with two stage of filtration i.e. pre and fine filter. All fresh air supply shall also be filtered using pre and fine filter. 15. A minimum design margin of ten (10) % shall be considered in design of AC Plant Capacity for each area. Twenty (20) % design margin shall be considered for the cooling tower capacity over the selected A/C capacity provided.Head of the pumps shall take into account min. ten (10)% margin on friction head. For pumps, continuous motor rating (at 50°C ambient) shall be atleast 10% above the maximum load demand of the pump in the entire operating range. 16. For areas where A/C load is of the order of 25-60 TR, Direct Expansion (D-X) type Condensing unit shall be provided depending on the availability of space/ layout etc			
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-15 Air Conditioning System	Page 24 of 31	

CLAUSE NO.	TECHNICAL REQUIREMENTS												
	(however for centralized control room , air cooled chiller with AHU shall be provided in specified in Part-A of technical specification). For areas, where A/C load is of the order of 15-25TR, ductable split/package A/C shall be provided. Smaller areas which are away from the D-X type Condensing unit /central chilling units which may require air conditioning upto 15 TR rating shall be served with Hi-wall Split/Cassette air conditioner units as per requirement. 17. Valves at discharge of pumps, outlet of chillers and inlet of cooling towers or any other valve in the system shall be motor operated type for remote operation of the Air conditioning system. 18. As per ECBC codes minimum coefficient of performance (COP) for the chiller shall be as follows: A. Coefficient of Performance (COP) for air-cooled chillers: <table><tr><th>Sl.No</th><th>Chiller capacity</th><th>Min COP</th></tr><tr><td>01.</td><td>< 150 TR</td><td>2.9</td></tr><tr><td>02.</td><td>≥150 TR</td><td>3.05</td></tr></table> Refrigerant : Refrigerant should be CFC/HCFC free. - Insulation for supply and return air ducts: Supply and return ducts shall be insulated. - All types of Insulation used for HVAC application shall be CFC/HCFC free. 19. During normal operation period, all the working equipment shall run on A.C. power supply. However, in case of complete black-out condition, DG sets being provided are required to cater the load of some of the air-conditioning equipment so that Main Plant Control Rooms and CER remain air-conditioned. The equipment to run on DG set are: • 1 No. Air cooled chiller • 1 No. chilled water pump. • 1 no AHUs for CR & CER • 1 No. Fresh air fan.				Sl.No	Chiller capacity	Min COP	01.	< 150 TR	2.9	02.	≥150 TR	3.05
Sl.No	Chiller capacity	Min COP											
01.	< 150 TR	2.9											
02.	≥150 TR	3.05											
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-15 Air Conditioning System	Page 25 of 31									

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	Annexure –I GENERAL SPECIFICATION FOR HORIZONTAL PUMPS			
1)	SCOPE This specification covers the design, material, construction features, manufacture, inspection, testing the performance at the Vendor's/Sub-Vendor's Works and delivery to site of Horizontal Centrifugal Pumps.			
2)	CODES AND STANDARDS The design, material, construction, manufacture inspection and performance testing of Horizontal Centrifugal Pumps shall comply with all currently applicable statutes, regulations and safety codes in the locality where the Equipment will be installed. Nothing in these specifications shall be construed to relieve the Vendor of this responsibility. The Equipment supplied shall comply with the latest applicable Indian Standards listed below. Other National Standards are acceptable, if they are established to be equal or superior to the Indian Standards.			
3)	List of Applicable Standards. IS : 1520 : Horizontal Centrifugal Pumps for clear cold fresh water IS : 5120 : Technical requirements of rotodynamic special purpose pumps API : 610 : Centrifugal pumps for general refinery service. IS : 5639 : Pumps Handling Chemicals & corrosion liquids IS : 5659 : Pumps for process water HIS : Hydraulic Institute Standards, USA ASTM-1-165-65 Standards Methods for Liquid Penetration Inspection. In case of any contradiction with aforesaid standards and the stipulations as per the technical specifications as specified hereinafter the stipulations of the technical specifications shall prevail.			
4)	DESIGN REQUIREMENTS a) The Pump shall be capable of developing the required total head at rated capacity for continuous operation. Also the pumps shall be capable of being operated to give satisfactory performance at any point on the HQ characteristics curve. The operating range of the pump shall be 40% to 120% of the duty point unless otherwise mentioned elsewhere. The maximum efficiency of pump shall preferably be within ± 10% of the rated design flow as indicated in data sheets. b) The total head capacity curve shall be continuously rising from the operating point towards shut-off without any zone of instability and with a minimum shut-off head of about 15% more than the design head.			
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-15 Air Conditioning System	Page 26 of 31

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC									
	Annexure –I												
	c) Pumps of a particular category shall be identical and shall be suitable for parallel operation with equal load division. The head Vs capacity and BHP Vs capacity characteristics should match to ensure even load sharing and trouble free operation throughout the range. Components of identical pumps shall be interchangeable.												
	d) Pumps shall run smoothly without undue noise and vibration. Peak to peak vibration limits shall be restricted to the following values during operation: <table><tr><td>Speed</td><td>Antifriction Bearing</td><td>Sleeve Bearing</td></tr><tr><td>1500 rpm and below</td><td>75.0 micron</td><td>75.0 micron</td></tr><tr><td>3000 rpm</td><td>50.0 micron</td><td>65.0 micron</td></tr></table> The noise level shall not exceed 85 dBA overall sound pressure level reference 0.0002 microbar (the standard pressure reference for air sound measurement) at a distance of 1 M from the equipment surface.				Speed	Antifriction Bearing	Sleeve Bearing	1500 rpm and below	75.0 micron	75.0 micron	3000 rpm	50.0 micron	65.0 micron
Speed	Antifriction Bearing	Sleeve Bearing											
1500 rpm and below	75.0 micron	75.0 micron											
3000 rpm	50.0 micron	65.0 micron											
	e) The pumps shall be capable of starting with discharge valve fully open and close condition. Motors shall be selected to suit to the above requirements. Continuous Motor rating (at 50 deg.C ambient) shall be atleast ten percent (10%) above the maximum load demand of the pump in the entire operating range to take care of the system frequency variation and no case less than the maximum power requirement at any condition of the entire characteristic curve of the pump.												
	f) The kW rating of the drive unit shall be based on continuously driving the connected equipment for the conditions specified. However, in cases where parallel operation of the pumps are specified, the actual motor rating is to be selected by the Bidder considering overloading of the pumps in the event of tripping of operating pump(s).												
	g) Pumps shall be so designed that pump impellers and other accessories of the pumps are not damaged due to flow reversal.												
	h) The Contractor under this specification shall assume full responsibility in the operation of pump and motor as a unit.												
5)	DESIGN CONSTRUCTION												
	a) Design and construction of various components of the pumps shall conform to the following general specifications. For material of construction of the components, data sheets shall be referred to.												
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-15 Air Conditioning System	Page 27 of 31									

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	Annexure –I			
b)	Pump Casing	Pump casing shall have axially or radially split type construction as specified. The casing shall be designed to withstand the maximum shut-off pressure developed by the pump at the pumping temperature. Pump casing shall be provided with a vent connection and piping with fittings & valves. Casing drain as required shall be provided complete with drain valves, piping and plugs. It shall be provided with a connection for suction and discharge pressure gauge as standard feature. It shall be structurally sound to provide housing for the pump assembly and shall be designed hydraulically to minimum radial load at part load operation.		
c)	Impeller	Impeller shall be closed, semi-closed or open type as specified elsewhere and designed in conformance with the detailed analysis of the liquid being handled. The impeller shall be secured to the shaft, and shall be retained against circumferential movement by keying, pinning or lock rings. On pumps with overhung shaft, impellers shall be secured to the shaft by a lockout or cap screw which tightness in the direction of normal rotation.		
d)	Impeller/Casing Wearing Rings	Replaceable type wearing rings shall be provided at suitable locations of pumps. Suitable method of locking the wearing ring shall be used. Wearing rings shall be provided in pump casing and/or impeller as per manufacturer's standard practice.		
e)	Shaft	The critical speed shall be well away from the operating speed and in no case less than 130% of the rated speed. The shaft shall be ground and polished to final dimensions and shall be adequately sized to withstand all stresses from rotor weight, hydraulic loads, vibration and torques coming in during operation.		
f)	Shaft Sleeves	Renewable type fine finished shaft sleeves shall be provided at the stuffing boxes/mechanical seals. Length of the shaft sleeves must extend beyond the outer faces of gland packing of seal end plates so as to distinguish between the leakage between shaft and shaft sleeve and that past the seals/gland. Shaft sleeves shall be fastened to the shaft to prevent any leakage or loosening. Shaft and shaft sleeve assembly should ensure concentric rotation.		
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-15 Air Conditioning System	Page 28 of 31

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	Annexure –I			
g)	Bearings	Heavy duty bearings, adequately designed for the type of service specified in the enclosed pump data sheet and for long, trouble free operation shall be furnished. The bearings offered shall be capable of taking both the radial and axial thrust coming into play during operation. In case, sleeve bearings are offered additional thrust bearings shall be provided. Antifriction bearings of standard type, if provided, shall be selected for a minimum life 20,000 hrs. of continuous operation at maximum axial and radial loads and rated speed. Proper lubricating arrangement for the bearings shall be provided. The design shall be such that the bearing lubricating element does not contaminate the liquid pumped. Where there is a possibility of liquid entering the bearings suitable arrangement in the form of deflectors or any other suitable arrangement must be provided ahead of bearings assembly. Bearings shall be easily accessible without disturbing the pump assembly. A drain plug shall be provided at the bottom of each bearings housing.		
h)	Stuffing Boxes	Stuffing box design should permit replacement of packing without removing any part other than the gland. Stuffing boxes of packed ring construction type shall be provided wherever specified. Packed ring stuffing boxes shall be properly lubricated and sealed as per service requirements and manufacturer's standards. If external gland sealing is required, it shall be done from the pump discharge. The Bidder shall provide the necessary piping valves, fittings etc. for the gland sealing connection.		
i)	Mechanical Seals	Wherever specified in pump data sheet, mechanical seals shall be provided. Unless otherwise recommended by the tenderer, mechanical seals shall be of single type with either sliding gasket or bellows between the axially moving face and shaft sleeves or any other suitable type. The sealing faces should be highly lapped surfaces of materials known for their low frictional coefficient and resistance to corrosion against the liquid being pumped.		
j)		The pump supplier shall coordinate with the seal maker in establishing the seal chamber of circulation rate for maintaining a stable film at the seal face. The seal piping system shall form an integral part of the pump assembly. For the seals under vacuum service, the seal design must ensure sealing against atmospheric pressure even when the pumps are not operating. Necessary provision for seal water supply along with complete piping fittings and valves as required shall form integral part of pump supply.		
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-15 Air Conditioning System	Page 29 of 31

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	Annexure –I			
k)	Pump Shaft Motor Shaft Coupling	The pump and motor shafts shall be connected with an adequately sized flexible coupling of proven design with a spacer to facilitate dismantling of the pump without disturbing the motor. Necessary coupling guards shall also be provided.		
l)	Base Plate	A common base plate mounting both for the pump and motor shall be furnished. The base plate shall be fabricated steel and of rigid construction, suitably ribbed and reinforced. Base plate and pump supports shall be so constructed and the piping unit so mounted as to minimise misalignment caused by mechanical forces such as normal piping strain, internal differential thermal expansion and hydraulic piping thrust. Suitable drain troughs and drip lip shall be provided.		
m)	Assembly and Dismantling	Assembly and dismantling of each pump with drive motor shall be possible without disturbing the grouting base plate or alignment.		
n)	Drive Motor (Prime Mover)	The kW rating of the drive shall be based on continuously driving the connected equipment for the conditions specified. However, in cases where parallel operation of the pumps are specified, the actual motor rating is to be selected by the Bidder considering overloading of the pumps in the event of tripping of operating pump(s).		
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-15 Air Conditioning System	Page 30 of 31

ANNEXURE-II

PIPING THICKNESS: Pipes for sizes 200 NB & above shall confirm to IS: 3589 Grade 410. The final thickness shall not be less than that specified as per IS: 3589 as indicated below.

Nominal pipe Size (mm)	Outside Diameter (mm)	Wall Thickness (mm)
200 NB	219.1	4.5
250 NB	273	5
300 NB	323.9	5.6
350 NB	355.6	5.6
400 NB	406.4	6.3
450 NB	457	6.3
500 NB	508	6.3
600 NB	610	6.3

SUB-SECTION–A-16

FIRE PROTECTION AND DETECTION SYSTEM

CLAUSE NO.	TECHNICAL REQUIREMENTS
	FIRE PROTECTION AND DETECTION SYSTEM 1.00.00 GENERAL DESCRIPTION 1.01.00 A comprehensive Fire Detection and Protection System covering all the areas of the power plant including Employer's facilities/ system /buildings (if applicable) is included in the scope of the Contract. 1.02.00 The complete Fire Detection and Protection Systems shall be as per the guidelines/ codes/ standards / rules of TAC/ NFPA / IS: 3034 / OISD etc. and all the systems, equipments and installation shall be got approved from TAC accredited professional(s)-India. 1.03.00 Fire Water Source Water for the Fire Protection system shall be drawn from fire water storage tanks to be provided by the Bidder. Water for filling up the fire water storage tanks shall be drawn from the following two sources: a) From Circulating System blow down b) From raw water header as second source. Fill in line from above two sources shall be in the scope of fire fighting vendor. Bidder shall interconnect the same to each of the fire water tank through individual motorised isolation valve. Raw water make-up line to tanks shall be provided with Basket strainer & an isolation valve of suitable size. 1.04.00 Pressurisation System This system consists of two (2) nos. electric motor driven jockey pumps (1 no. working + 1 no. stand-by). 2.00.00 HYDRANT SYSTEM Hydrant system shall consist of Hydrant pumps, pressurization arrangement, water mains network, hydrant valves, landing valve, water monitors, hoses, branch pipes, nozzle, hose boxes, central hose houses etc. 3.00.00 HVW AND MVW SPRAY SYSTEM 3.01.00 General It shall consist of: Spray pumps, pressurization arrangements, water mains network, deluge valves, alarm valves, flow switches (as applicable), isolation valves, Y-type strainers, spray nozzles/projectors, spray nozzles piping network, detection system, instrumentation, local control panels, cables etc. 3.02.00 Areas to be covered by HVW Spray System. i) All other transformers having oil capacity above 2000Ltrs & located with-in plant boundary. ii) Steam Turbine Lube oil storage tanks, oil coolers and purifier units. iv) Central Lube oil tanks (Both Clean oil & dirty oil units) and purifier units (as applicable) vi) Generator seal oil system tanks, cooler assembly, etc. vii) Turbine Oil canal pipelines in main plant. viii) Boiler burner fronts including fuel oil racks at boiler (As applicable)
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9 Sub Section-A-16 Fire Detection & Protection System Page 1 of 24

CLAUSE NO.	TECHNICAL REQUIREMENTS	एनटीपीसी NTPC		
3.03.00	Areas to be covered under MVW Spray System i) All cable galleries/ cable vault/ cable spreader room in main plant ii) Waste Pit iii) All the un-insulated liquid fuel oil tanks (including LDO tanks) storing fuels of flash point less than 65 deg. C (as applicable). iv) All the Fuel oil pumping (unloading & pressurizing) stations and DG set oil tanks (As applicable)			
4.00.00	Bladder Type Foam Protection System			
4.01.00	GENERAL The fixed foam system of bladder tank foam proportioning type consist of skid mounted foam bladder tank assembly, foam makers, discharge outlets, Interconnection piping, valves, fittings and instrumentation. Semi-fixed system consisting of a separate foam solution ring main around the tank with foam hydrant valves at regular intervals shall also be provided in addition to the water hydrants. The operation of the fixed foam system shall be automatic with the aid of dedicated fire detection system provided in the tank. The semi-fixed system shall be operated through the foam hydrants/ monitors, portable type foam water monitors (wheeled type with in-built foam maker), hoses and nozzles for extinguishing spill fire in and around the tank area.			
5.00.00	FIRE EXTINGUISHERS			
5.01.00	Fire Extinguishers As indicated in Bidder's Scope (Refer relevant Sub-section-Part A, Section VI).			
6.00.00	FIRE DETECTION, ALARM AND CONTROL SYSTEM			
6.01.00	Codes and Standards a. The design, manufacture, testing, performance, etc. of the various components of the analog addressable Fire Detection and Alarm System shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. Nothing in this specification shall be construed to relieve the contractor of this responsibility. b. Unless otherwise specified, the Fire Detection and Alarm System and the components shall conform to the latest applicable Indian or IEC Standards. Equipment complying with any other authoritative National Standards such as British, USA, VDE, etc. will also be considered, provided the parameters specified are equivalent or better than the corresponding IS. c. The Contractor shall be solely responsible for obtaining the required approval and clearance for the different components and systems of the Fire Detection and Alarm System from the following authorities, as applicable: i. Department of Atomic Energy (Certification of safety from Radioactivity). ii. Central Building Research Institute, Roorkee. iii. Central Mining Research Station, Dhanbad.			
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-16 Fire Detection & Protection System	Page 2 of 24

CLAUSE NO.	TECHNICAL REQUIREMENTS
6.02.00	iv. Local Fire Authorities. d. The equipment and the system shall be of types approved by any of the following bodies, as applicable: i. Loss Prevention Council, (LPC), U.K. ii. National Fire Protection Association, (NFPA), USA iii. Under-writers laboratories, (UL), USA iv. Factory mutual(FM) Areas to be covered under Fire detection and alarm System a) Multisensor type detection system (Above and below the false ceiling or below the false flooring as the case may be) i) All switchgear / MCC/battery rooms of main plant, Switchyard control room building, various auxiliary buildings like ash handling system, condensate polishing plant, water treatment plant, pump houses, service building, administrative & auditorium building (if applicable), etc. ii) Cable galleries of main plant, protected by MVW spray system. Further, multisensor detectors shall also be provided inside all cubicles/panels of control room, control equipment room and UPS / Battery charger areas. iii) Above and Below false ceiling areas of all air-conditioned rooms of main plant building, and various control rooms of auxiliaries building b) Linear heat sensing cable detection system Cable Galleries covered under MVW Spray System c) Quartzoid bulb heat detection system Equipments protected by HVW spray system and MVW spray system. d) Suitable nos. of Infrared Detectors (IRDs) shall be provided at strategic location of Waste Pit. Location of IRDs shall be finalized during detailed engineering.
6.03.00	General requirements for all types of Detectors 6.03.01 Detectors shall be housed or mounted in suitable enclosure in such a way that their performance is in no way affected. Special maintenance procedures if any required for the satisfactory operation of the detectors shall be clearly stated in the bid. 6.03.02 Necessary mounting accessories shall be provided for all the detectors. 6.03.03 In case the detectors are offered with their output (on sensing a fire) in the form of an electrical contact, it shall be noted that the contact shall be 'NC' type such that under fire conditions, this contact will open to initiate the fire alarm system. 6.03.04 Detectors shall preferably be designed as plug-in units, which fit into various bases according to place and type of mounting. This would also enable interchangeability. 6.03.05 Detectors shall be provided with the necessary compression type cable terminating glands for the incoming cables of flameproof type or PVC/metallic flexible/rigid conduits.
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9 Sub Section-A-16 Fire Detection & Protection System Page 3 of 24

CLAUSE NO.	TECHNICAL REQUIREMENTS
6.03.06 6.03.07 6.03.08 6.03.09 6.03.10 6.03.11 6.03.12 6.03.13 6.03.14 6.03.15 6.03.16 6.03.17 6.03.18	Depending upon the environmental conditions in which detectors are installed, chlorinated rubber based or epoxy or equivalent paint shall be used for finishing the surface of the enclosure. The coverage or the zone of protection afforded by the detector and recommended height of mounting shall be furnished by the Bidder. The bidder shall furnish the test certificate in support of this. Any metal parts used for detector construction shall be inherently resistant to corrosion or shall be plated or otherwise suitably treated to afford protection against corrosion. The plating or treatment shall in no way affect the detector performance. Any plastic material or any sealing compound used in the detector shall be such as it will not deform or fail under the maximum temperature to be expected. No detector shall contain any moving parts subject to wear and tear and must be able to operate afresh after each alarm release, without its exchange or adjustment. The detector shall be located where the largest combustion gas concentration can be expected. Adequate compensation and considerations shall be made for effects for wind velocities such as air-conditioning system and exhaust fans where dilution of particles of combustion is greater. The exact location of detectors shall be coordinated with other services like air-conditioning grills, light fittings, cable trays etc. to provide aesthetically pleasing appearance. The return air paths of air-conditioning shall be avoided for detector location. The detectors shall not be affected by temperature, humidity; air flow or by drift failures and shall not give any false alarm due to above. The detectors shall not be sensitive to vibrations. Any special mounting arrangements required to counteract vibration shall be included in the contractor scope. The quantity of multi- sensor detectors in each zone shall be based on the coverage factor of 25-sq. meter per detector. However the actual quantity of detectors required, taking into consideration obstructions due to floor beams, ventilation, doors, windows etc., shall be worked out and supplied (based on the actual layout) and installed by the contractor. The detectors shall not give false alarm due to high humidity, temperature, and velocity of air in the surroundings and static electricity conditions. Process actuated switch devices such as pressure switches, flow switches, level switches, etc. shall be provided with suitable individual addressable interface (local or remote) units or modules so that these devices are addressable from the panel.
6.04.00	Infra-red Detectors Application Detection of Fire on Waste pit as well as hot spot beneath the surface Sensor type Infrared
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9 Sub Section-A-16 Fire Detection & Protection System Page 4 of 24

CLAUSE NO.	TECHNICAL REQUIREMENTS			
6.05.00	Working voltage(detection)	24 V DC		
	Working voltage(purging)	230 V AC		
	Purging type	Air purging		
	Location	Head of the waste pit		
	Features	1. Ability to detect both black body and diffusion flame radiation. 2. Reject electric arc, heaters, artificial light sources and sunlight etc 3. Ability to function in heavily dust prone atmosphere without regular maintenance 4. Insensitive to vibrations		
	Annunciations	Trouble in purging, Fault Alarm, Trip LED, Power supply ON		
	Output Controls	Two nos. Change over contacts for Alarm & Trip		
	Accessories	Air purge unit including blowers, starter for blowers, hose pipe etc		
	Linear Heat Sensor Cables			
	Application	Detection of Stationary fire		
	Type	Digital		
	Operating voltage	24 V DC		
	Approval	FM/UL		
	Conductor material	Steel		
	Insulation	Heat sensitive polymer		
	Outer Sheath	Black or colored PVC or flouropolymer suitable for the application environment		
	Installation features for LHSC/IR detectors			
	1. Mounting arrangement have been indicated in tender drawing. 2. The detection zone/loop divisions of LHSC system shall match with MVW spray zones. Conveyors where LHSC shall be installed shall be divided into no. of various zones whereas conveyor for which IR detector is installed shall be considered as one zone.			
	KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-16 Fire Detection & Protection System
				Page 5 of 24

CLAUSE NO.	TECHNICAL REQUIREMENTS
6.06.00	3. Linear heat sensing cable detector shall run in a zigzag fashion (with an included angle of 90 deg) on each top cable tray, bottom tray and every alternate intermediate trays of each section of cable tray without undue sagging and interfering the normal operations. All supporting materials for mounting of LHSC shall be provided by the bidder. Addressable Analog Intelligent Detectors In addition to the features specified under the item General requirements for all types of Detectors, the Addressable Analog Intelligent Detectors shall be provided with the following features: a) Detectors not specifically listed for sensitivity testing from the control panel are not acceptable due to the expense involved with manual testing as required by NFPA 72E. b) The detector shall be suitable for two-wire operation and two-way communication on the intelligent analog signaling circuit. c) The detector shall display a steady LED when in the Alarm State. The LED shall flash when in stand by or normal mode. d) Each detector in a loop shall have short circuit isolator suitable for style-7 wiring as per NFPA-72. e) Address and sensitivity assignments shall be set preferably electronically. However, dip switches / rotary switches for the same are acceptable. The detectors shall be assigned a sensitivity level based on environment, time of day or any programmable function as required by the system user, and shall respond at that level whether in the "on line" or "default" mode. f) The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. g) The detectors furnished shall be listed for use in environments as covered by Factory Mutual and UL and shall be installed according to the requirements of NFPA 72E for open area coverage.
6.07.00	Multi sensor Detectors
6.07.01	Multi sensor detectors shall incorporate a heat detection element and a photoelectric detection element. Both the elements shall be incorporated in a single unit. Both the elements shall be operative at all times and the fire signal shall be available from any or both elements combined together.
6.07.02	The detectors shall be sensitive to very low smoke densities of the order of say 0.05 g/m³. Also it shall be possible to adjust this sensitivity on a step less basis over a range so that the optimum sensitivity could be selected at site to suit the conditions of installations. The coverage area of the smoke detection under standard NFPA test conditions shall not be less than 80-90m².
6.07.03	The detectors shall be complete with a mounting base that includes a terminal box into which the detector can be plugged in. Terminals for looping of the cables shall be provided.
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9 Sub Section-A-16 Fire Detection & Protection System Page 6 of 24

CLAUSE NO.	TECHNICAL REQUIREMENTS	
6.07.04	All detectors shall be provided with built-in response and indicating lamps which shall give local visual indication, when it has operated in dense smoke conditions. The failure of lamp shall not prevent the function of detector.	
6.07.05	In areas such as false ceiling where detectors themselves are not easily accessible, the remote response indicators outside the enclosed areas shall be provided to indicate the fire condition.	
6.07.06	It shall be possible to replace any type of detector head by a different type detector without requiring change in cabling/panel wiring and condition of the zone, originally covered by the detector.	
6.08.00	System Configuration	
6.08.01	Each of the Addressable Fire Alarm panel shall be able to communicate with one another as well as with repeater annunciation panel. The detectors or other devices of any other unit/area shall be addressable only from the respective Addressable Fire Alarm Panel, so that each of the Addressable Fire Alarm Panel is under the control of designated operating personnel at that location. Facility to operate pumps of booster pump house and fire water pump house shall be provided from PC based monitoring station.	
6.08.02	At least one spare loop shall be provided in each of the addressable type fire alarm panel located in control equipment room with complete loop card and all other accessories so that Employer can expand the system in future. Further, at least 10% of loop capacity be left free in each of the connected loop in all the panels, so that, additional devices may be connected to the system in any of the loop by Employer in future.	
6.08.03	Fire system shall be provided with necessary interface hardware and software for dual fibre optic connectivity & interconnection with station wide LAN for two –way transfer of signals for information sharing. The information shall be made available through Ethernet link following TCP/IP standard. The system shall be OPC compliant. All required plant data shall be transferred ensuring complete security. The exact number of points shall be finalized during detailed engineering.	
6.09.00	Analog Addressable Fire Detection and Alarm System	
6.09.01	General Requirements	
6.09.02	This specification in general covers the functional requirements, and general design aspects of Microprocessor based, Analog Addressable Fire Detection Alarm / Annunciation and Control System.	
6.09.03	The following description intends to describe only the brief hardware and functional requirements, scope of hardware requirements etc. but the actual configuration of the system shall be in line with the prevalent normal practices in the industry and shall conform to latest product range of selected manufacturer. The fire detection and control system offered shall be complete in all respects for the safe and reliable operation of the entire system. Any additional hardware/software than those mentioned herein required to make the system complete shall be included in the scope of the Bidder.	
6.09.04	All the system and its equipment specifically detectors, interface modules, panels, power supply, battery chargers etc. shall be furnished from a single source and the same shall be	
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9
		Sub Section-A-16 Fire Detection & Protection System
		Page 7 of 24

CLAUSE NO.	TECHNICAL REQUIREMENTS
6.09.05 6.09.06 6.09.07 6.09.08 6.09.09 6.09.10	new and latest state of the art products of manufacturer engaged in the manufacture of Integrated Microprocessor based Analog Addressable Fire Detection and Alarm System. All equipments such as detectors, panels etc shall be approved and listed by UL/FM/LPCB/VDS. All types of smoke detectors shall be of analogue addressable type. Conventional detectors with interface modules are not acceptable. Each zone of LHSC detector and each IR detector shall be provided with interface module. All the fire detection systems, process actuated switch devices such as pressure/flow/temperature switches and relays of control functions shall be hooked up with the analogue addressable fire detection and alarm system. Required addressable interface units shall be provided for various switch devices by the bidder to make them addressable. The wiring shall be of class-A as per NFPA-72. Bidder shall provide isolators at the start & end of the loop. The complete system shall include, but not be limited to the following : - Master system CPU. - Analog Addressable Fire Detection and Alarm System panels including alarm modules, system supervisory control modules, auxiliary output control modules etc. - PC based monitoring station with colour graphic display terminal with programming and historical archiving facility along with laser printer. - Power supplies, batteries and battery chargers. - Analog addressable type smoke detectors. - Non addressable type conventional detectors (Linear heat sensing cable detector/ infra red type heat detector) and switching devices each with its own addressable interface modules. - Software and hardware as required for complete operation of the system. - Complete Wiring/cabling including its conduits/trays/fixtures etc. - The fire alarm control panel shall function as a communication interface between central processing unit and sensors. This panel shall have facility to process the input signal and to control all the input data received from initiating and indicating devices. - Fire alarm control panel shall have filters to ignore false alarm and increase sensitivity to real fire from sensors. The sensitivity of each detector should be automatically raised if detectors are gradually polluted due to dust and dirt entering inside the detector. If detectors are more polluted the control panel shall give a warning. The trouble report shall indicate the location of device requiring service. - Fire alarm control panel shall have printer to print out the alarm/ trouble occurrences.
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9 Sub Section-A-16 Fire Detection & Protection System Page 8 of 24

CLAUSE NO.	TECHNICAL REQUIREMENTS	
	l) The CPU shall serve as the systems central processor. Software shall be designed especially for fire alarm annunciation system applications and shall monitor status of processing alarms according to priorities, controlling/processing communications and synchronizing all system activities. n) The system shall be able to recognize and indicate an alarm condition in a degrade mode of operation, in the event of processor failure or the loss of system communications to the circuit interface panels. o) All devices shall be individually identifiable for its type, its zone location, alarm set value, alarm and trouble indication by an unique alpha numerical label. p) The software logic modules and system database shall be programmable using a MS - Windows compatible program (latest version) on PC at site and required hardware shall be included in scope of supply. The system software programme shall be password protected and shall include full upload and download capability and during program upload or download through the PC, the capability of alarm reporting shall be retained. The software shall be downloaded to a PC for editing. The software shall enable Employer to add the spare loop provided in the fire alarm panels or addition of additional devices/detectors in any of the fire alarm panel. q) The system shall support the use of Color Graphic display terminal for the display of information in an appropriate format. r) The system shall include software for system data base, historical event log, logic, and operating system. The system shall require no manual input to initialise in the event of a complete power down condition. It shall return to an on line state as an operating system performing all programmed functions upon power restoration. s) Activation of any fire alarm initiating device shall display (LCD alpha numeric display) message in describing the device originating the alarm condition at the Central monitoring station, at alarm panel, simultaneously at the repeater annunciation panel and shall initiate the associated protection systems & other related control functions. Similarly activation of any supervisory circuit, (supervised valve closure, air pressure abnormal, fire pump trouble, water pressure low, etc.) or receipt of trouble report (primary power loss, open or grounded initiating or signaling circuit wiring, battery disconnect etc) shall display at the fire alarm control panel the origin of supervisory condition or origin of trouble condition as the case may be. It shall also record the occurrence of the event, the time of occurrence and the device initiating the same. t) System configuration shall be menu driven and capable of being operated by, a person with no previous computer programming experience. 6.10.00 System Functional Requirements 6.10.01 The fire alarm panel shall evaluate the signals received from the detectors and shall handle the following functions: 1. System self monitoring and fault signaling. 2. Transmission of alarm and fault signals to the respective fire alarm panels and as well as in the repeater panel in fire station. Further, the panel shall activate a hooter/sounds in each of the area locally provided with fire/smoke detection system. Further, the system shall enable operation of spray system from the panel through monitoring station when the system operation is selected under remote, manual mode.	
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-16 Fire Detection & Protection System Page 9 of 24

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
6.10.02	3. Initiate control functions like stoppage of conveyor, closure of fire doors, shutdown of draft fans, air-conditioning and ventilation plant/ equipment, opening smoke extraction vents, switching on smoke extraction equipment, emergency lighting etc. 4. Triggering stationary extinguishing systems such as clean agent system. 5. Supervising of unauthorised removal of a detector head from its base and giving a fault alarm on the control panel. 6. Supervising and monitoring the detection cabling, to indicate fault conditions in case of open/short circuit in the wiring. 7. Supervising by a separate annunciation window, changeover from mains supply to battery supply. "Mains On" indication shall be continuously on, as long as the main supply is available. 8. Facilitating simulation of fire conditions to enable the testing of circuits (without creating actual fire) under the test mode from the fire Alarm panel. 9. The control unit shall contain all the systems main switches lamps and fuses. Switches and lamps shall be easily identified even in closed casings. 10. All the circuits from the detectors to the panels and the circuits from panels to the actuating/operating devices of the respective extinguishing system shall be of closed loop type and shall be supervised for open-circuiting and short-circuiting of cables. The cable fault shall be audio-visually annunciated on the panels. Separate hooters with different tones shall be provided for 'fault' alarms and 'fire' alarms. 11. Actuate solenoid valve in spray system in case of fire from respective fire alarm panel. For achieving this if any additional hardware is required like relays, power supply and cables, the same may be provided.			
	Analog Addressable Fire Detection and Alarm System shall also meet the following functional requirements: i. Each of the system shall support analog addressable detectors of all types, non-addressable type detectors/devices along with its addressable interface units/modules, Video display units etc. ii. Each of the devices and/or detectors shall be individually, uniquely and continuously addressable by the panel to which it is connected. iii. Detectors shall be interrogated for sensitivity settings from the control panel, logged for sensitivity changes indicating the requirement for cleaning and tested by a single technician using the field test routine. Sensitivity of each of the detectors made available in the panel shall be adjustable from the panel. iv. The system shall be capable of self-adjustment to compensate for the accumulation of contaminants that would change the detector sensitivity in either a more or less sensitive direction to prevent false indications or failure to alarm in the actual fire conditions. The system shall annunciate a trouble condition when any analog addressable smoke detector reaches 80% of its alarm threshold due to gradual contamination, signaling the need for service and eliminating unwanted alarm. v. Continuous supervision/monitoring of all the circuits and its components shall be			
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-16 Fire Detection & Protection System	Page 10 of 24

CLAUSE NO.	TECHNICAL REQUIREMENTS			
		made available from the panel for open, short circuits and grounding.		
	vi.	The system shall be able to recognize and indicate and alarm condition in a degraded mode of operation, in the event of processor failure or the loss of system communications to the circuit interface panels.		
	vii.	The system shall be programmable at site and required hardware shall be included in the scope of supply. The system software Programs shall be password protected and shall include full upload and download capability. During program upload or download the system shall retain the capability for alarm reporting. The system shall download to a PC for program editing. The software shall eligible employer to add the spare loop provided in the fire alarm panel or addition of additional devices/detectors in and of loop in any of the fire alarm panel.		
	viii.	The system shall support the use of color interactive History Reporting video display terminal for the display of information in an appropriate format.		
	ix.	The system shall include software for system database, historical event log, logic and operating system. The system shall require no manual input to initialize in the event of a complete power down condition. It shall return to an on line state performing all programmed functions upon power restoration.		
	x.	Software logic modules and system database shall be programmable using a windows compatible program on PC. It shall be possible to program or edit the system database off site after down loading from the panel.		
	xi.	All detectors shall incorporate internal automatic temperature compensation to overcome the effects of either high or low ambient temperatures in the installed environment on the detector sensitivity. The detectors shall be tested at a specified frequency by raising the detector sensitivity level to the alarm threshold, to check the operation of the detector without system alarming automatically by the control panel.		
	xii.	In an alarm or trouble condition the following shall occur on the monitoring station: 1. Sound an audible. 2. Write details of the actuation to a system log file on the PC. 3. Print the details of the actuation to the system printer. 4. Activate the color graphic display system controls, providing functions such as zooming, scrolling of Alarms, troubles, etc.		
	xiii.	System configuration shall be menu driven and capable of being operated by a person with no previous computer programming experience.		
	6.11.00	Panel Display Requirements. System display shall consist of minimum 80 character back lighted alphanumeric LCD display readable at any angle. Thirty-two character customer defined custom messages shall describe the location of the active device. In addition to the above, the following features shall be available. a. The system shall be capable of programming to allow troubles occurred and restored		
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-16 Fire Detection & Protection System	Page 11 of 24

CLAUSE NO.	TECHNICAL REQUIREMENTS			
6.12.00	in the system to be automatically removed from the display queue, eliminating the necessity for individual acknowledging of these events. This feature shall not affect the historical logging of events as programmed. b. As a minimum an LED display for “Alarm”, “Audible Silenced”, “Supervisory”, “Trouble”, “Security”, “Power On”, And “Partial System Disabled”. c. Touch activated membrane switches for “Alarm Acknowledge”, “Audible Silence”, “Supervisory Acknowledge”, “Security Acknowledge”, “Reset”, “Display Hold”, And “Display Next”. d. All membrane switches shall be tactile with audible feedback when pressed. System Software Requirements i) The software shall control the operation, function and display of the graphic system and provide for automatic boot up and run from the hard disk drive of the computer. ii) All project specifics actuating device programming shall be capable of being carried out on site via password access. iii) The system shall monitor all alarm, supervisory; trouble and security conditions detected by the fire alarm control panel and provide separate disk based files, for each condition. These logs may be enabled, disabled, or cleared with password access. This log information is not to be lost upon power failure or fire alarm control panel reset. A utility file shall be provided to sort the log data by date or by device and display this information either on the screen or the system printer. iv) Selective memory storage up to 800 events, shall be stored in flash memory and displayed, printed or downloaded by classification for selective event reports. a. Software shall allow selection of events to be logged, including; inputs as alarms, troubles, supervisors, securities, status changes and device verification; out puts, as audible control and output activation; action, as reset, set sensitivity, arm/disarm, override, password, set time and acknowledge. b. Audible and visual indications shall be generated when memory is 80% and 90% full to allow downloading of data. The system shall be programmable circular logging, assuring that at least the last 400 events will always be stored in non-volatile memory. v) Software has driven logic for adjusting the alarm threshold windows on detectors to compensate for accumulating contamination and keep detector response sensitivity constant. The software shall compensate for either over-sensitized or desensitized units, raising a system flag when a detector approaches the allowable limits of adjustment, indicating a requirement for cleaning. a. Values shall be stored in non-volatile memory allowing activation of all tracking functions within 90 sec of system initiation from a "cold boot". During the boot sequence, alarms from detectors programmed with the feature shall be suppressed.			
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9		Sub Section-A-16 Fire Detection & Protection System Page 12 of 24

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	When the full data history is active all devices shall be checked and any active alarms displayed. b. The control panel shall place each detector in the system in an alarm condition, transparent to the system user, every twenty-four hours as a dynamic check of the accuracy of the alarm threshold setting. Upon reception of the alarm report, the system detector shall be restored to its pretest state. c. The system shall be capable of monitoring the stage of detectors and displaying a message when a detector is approaching the limits of adjustment as a result of contaminates. A second message shall be displayed when the detector reaches the limits of adjustment due to these contaminate. d. The system shall be capable of recognizing that a detector has been cleaned, initiating a series of tests to determine if the cleaning was successful and display a detector cleaned message, readjusting that detectors normal sensitivity setting reference. vi) When an alarm or trouble is registered at the fire alarm control panel the graphics system shall display the first screen image for the first actuated device. The system shall be capable of zooming in for further information if required. At all times when in the alarm or trouble mode the fire control panel status i.e. number of current alarms and or troubles is to be displayed on the graphics screen.			
6.13.00	Power Supply for Fire Alarm Panels & Repeater Alarm Panel			
6.13.01	One set of 24V DC redundant power supply system comprising of 2 x 100% chargers and 1 x 100% batteries shall be provided for each fire alarm panel and repeater alarm panel. The batteries for fire alarm system shall be sealed maintenance free lead acid type. The battery backup for each fire alarm panel and repeater alarm panel shall be 24 hours and 30 minutes (in alarm conditions). At least 25% of the devices shall be considered to be active in alarm conditions. Each of the redundant chargers shall be sized to meet connected load requirements and keep the connected batteries full charged (Float Mode). Furthermore, the charger shall be sized to enable the boost charge of a fully discharged battery in 10 hours while feeding the load.			
6.13.02	The batteries shall be sized as per relevant IEEE standard. For battery sizing calculation, an aging factor of 0.8, a temperature correction factor (based on temperature of 4 deg. C), voltage drop of 2V in cables. Capacity factor, Float Correction Factor, as per Battery Supplier Standard, shall be taken into consideration, if applicable and ambient temperature shall be considered as the electrolytic temperature. The sizing of the battery shall be as approved by Employer during detailed engineering.			
6.13.03	The battery chargers and batteries shall be placed at a suitable location inside the fire alarm panel with partitions.			
6.13.04	The detailed specification related to power supply system of fire detection & protection system shall be as specified in other sections of the technical specification.			
6.14.00	Control & Instrumentation requirements			
6.14.01	The specification for DDCMIS based control system for fire protection system shall be as specified in other sections of the technical specification.			
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-16 Fire Detection & Protection System	Page 13 of 24

CLAUSE NO.	TECHNICAL REQUIREMENTS																
6.14.02	The specification for PC, printer and other HMI items shall be as specified in other sections of the technical specification.																
6.14.03	The specification related to Basic design criteria, Measuring Instruments, Process connection & piping, Control panels, Type test requirements etc shall be as specified in other sections of the technical specification.																
6.15.00	Cabling for fire alarm system All instrumentation cables twisted & shielded, FRLS PVC insulated and sheathed data highway / fibre optical cables, short term fire proof cables including prefabricated cables (with plug-in connectors) etc shall be provided by Contractor. The contractor shall follow the cable philosophy as below: <table><tr><th colspan="2">Application</th><th rowspan="2">Type of cable</th></tr><tr><th>From</th><th>To</th></tr><tr><td>Detectors/Any loop device</td><td>Detector / Isolator/ Interface unit</td><td>Shielded, Twisted, PVC Cu. FRLS cables type “S” Refer Note 2, 3, and 4 below.</td></tr><tr><td>Detector / Isolator / Interface Unit</td><td>JB</td><td>Shielded, Twisted, PVC Cu. FRLS cables type “S” Refer Note 2, 3, and 4 below.</td></tr><tr><td>JB</td><td>Fire alarm Panel</td><td>Shielded, Twisted, PVC Cu. FRLS cables type “S” Refer Note 2, 3, and 4 below.</td></tr></table> Notes: 10% spare pair shall be provided for all cables having more than four pairs. - Type “S” cable shall be multicore control cable having overall shielding & specification similar to instrumentation cable except insulation thickness and voltage grade which shall be 1100 V. Type “S” cable shall also satisfy requirements of Article 760 of NFPA 70. - Cable size of 2 core 1.5 sq.mm FRLS control cable shall be used for loop wiring of control cable. - Cable size of 2 core 2.5 sq.mm FRLS control cable shall be used to provide power supply to various devices in the loop.			Application		Type of cable	From	To	Detectors/Any loop device	Detector / Isolator/ Interface unit	Shielded, Twisted, PVC Cu. FRLS cables type “S” Refer Note 2, 3, and 4 below.	Detector / Isolator / Interface Unit	JB	Shielded, Twisted, PVC Cu. FRLS cables type “S” Refer Note 2, 3, and 4 below.	JB	Fire alarm Panel	Shielded, Twisted, PVC Cu. FRLS cables type “S” Refer Note 2, 3, and 4 below.
Application		Type of cable															
From	To																
Detectors/Any loop device	Detector / Isolator/ Interface unit	Shielded, Twisted, PVC Cu. FRLS cables type “S” Refer Note 2, 3, and 4 below.															
Detector / Isolator / Interface Unit	JB	Shielded, Twisted, PVC Cu. FRLS cables type “S” Refer Note 2, 3, and 4 below.															
JB	Fire alarm Panel	Shielded, Twisted, PVC Cu. FRLS cables type “S” Refer Note 2, 3, and 4 below.															
6.16.00	Detection System for Waste Pit i) Infra Red Detector: (a.) The infra red type (IR) detectors shall be suitable for detecting fires in waste pit. The IR detector shall give audio-visual annunciation locally and in fire alarm panel. (b.) Each of the IR detector shall be provided with its own purging arrangement using blowers, hoses, etc and required power supply shall be derived from the fire alarm panel. Alternatively, bidder may offer separate blowers (2x100%) for purge air supply for all the detectors and the complete air piping from the blowers to each of the IR detector shall be provided by the bidder.																
6.17.00	Detection System of Cable Galleries																
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-16 Fire Detection & Protection System														
Page 14 of 24																	

CLAUSE NO.	TECHNICAL REQUIREMENTS			
6.18.00	i) In cable galleries, MVW spray system shall be actuated either by detection of fire by Linear Heat sensing cable detectors or by fire signal from Multisensor detection system. Apart from the automatic operation of spray system in the detected zone, the adjacent two zones shall also be sprayed with water automatically after a set time delay simultaneously. ii) LHSC detector shall run in a zig-zag fashion (with an included angle of minimum 90° atleast) in each of the top tray, bottom tray and in every alternate trays. The mounting arrangement of LHSC detector shall be as per manufacturer's standard practice. iii) The detection zone/ loop divisions shall match with MVW spray zones. Multisensor Detection System i) Upon detection of fire, multisensor detector shall be annunciated in the respective panels and shall activate a local hooter/sounder in the areas where fire is activated and this fire signal shall be employed to initiate the fire extinguishing system of that area such as automatic MVW spray system of cable galleries, fire extinguishing system of Control rooms/Control Equipment Rooms. ii) Cross zoning of the signal from two adjacent multisensor detectors shall be employed to initiate the fire extinguishing system of inert gas protected areas and MVW spray system of cable galleries. iii) Multisensor detector shall be provided for return air ducts of main plant, which shall consist of intake probe, detector housing, and exhaust pipe etc. The detector shall be mounted outside the duct. iv) The design coverage area for detectors (to be considered) shall not exceed 25 Sq.M. for each detector.			
	7.00.00	FIRE WATER STORAGE, PUMPS & PUMP HOUSE i) Horizontal type centrifugal pumps shall be provided for hydrant, spray and jockey pumps. Maximum speed of the pumps shall be 1500 rpm. However, for jockey pumps the speed upto 3000 rpm is acceptable. The motor driven pump and the corresponding diesel engine driven pump shall completely interchangeable in respect of speed, impeller diameter, etc. ii) Capacity, discharge pressure & quantity of pumps for the hydrant water system and spray water system shall be individually designed as per Tariff Advisory committee (TAC) guidelines. However for minimum design requirement please refer Annexure-II iii) At least one common hydrant and spray pump (diesel engine Driven) of identical capacity to be provided as standby pump so that in case ,any of the working hydrant /spray pump is not available, the total requirement can be met by the standby pump. iv) The headers of spray and hydrant system shall be interconnected with an isolation and a non-return valve so that hydrant pumps can feed to spray system not vice-versa. v) The diesel engine drive of the pump shall conform to the requirements of TAC. Each of the diesel engine shall be provided with batteries (2x100%) and battery chargers (2x100%).		
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-16 Fire Detection & Protection System	Page 15 of 24

CLAUSE NO.	TECHNICAL REQUIREMENTS
	vi) Battery of the diesel engine shall be lead acid type as per IS and shall be large enough to crank the engine twelve times successively, each for a duration of 10 sec. without any charging in between. vii) Each engine shall be provided with fuel oil tank having adequate capacity to hold sufficient fuel oil for a minimum of twelve (12) hours of full load run. The fuel oil tank shall preferably be mounted on the engine. No fuel oil tank will be provided by the Employer. viii) Continuous drive motor rating (at 50⁰C ambient) shall be at least 10% (ten percent) above the maximum load demand of the pump in the entire operating range of the pump. ix) The feeding line of the spray system from the header shall be provided with 2x100% capacity basket type filters to avoid any particles in the spray system. x) The system shall be complete with required instrumentation, control recirculation pipe line with valves for each of the pumps, NRV in discharge outlet etc. xi) Pumps shall be designed for continuous operation at its best efficiency point to meet the specific requirements of the system for which it is to be employed. Pumps of each category shall be suitable for parallel operation. xii) Fire Water Storage Tanks: Two numbers each of 50% capacity vertical cylindrical column supported fixed cone roof type fire water storage tanks shall be provided by the bidder. To avoid vacuum creation inside the tank, two (2) nos. vents each of size 300 NB shall be provided on the roof of the tanks. Bidder shall ensure that the total capacity of fire water storage shall be as per the recommendation of TAC. xvi) Fire water storage tank: Two numbers each of 50% capacity vertical cylindrical column supported fixed cone roof type fire water storage tanks shall be provided by the bidder. To avoid vacuum creation inside the tank, two (2) nos. vents each of size 300 NB shall be provided on the roof of the tanks. Bidder shall ensure that the total capacity of fire water storage tank shall be as per the recommendation of TAC with a minimum capacity of each tank equal to 500 m³. 8.00.00 PIPING AND VALVES 8.01.00 General Data for Pipes etc. i) Mild steel as per IS:1239 (Part-I) medium grade (upto 150 NB) & as per IS:3589 Gr 410 (above 200 NB) or Equivalent for pipes normally filled with water. ii) Mild steel as per IS:1239 (Part-I) medium grade (upto 150 NB) & as per IS:3589 Gr.410 (above 200 NB) or Equivalent and galvanised as per IS:4736 for pipes normally empty and periodically charged with water and foam system application. iii) Pipe protection shall be as follows : To prevent soil corrosion buried pipes / pipes in trench shall be properly lagged with corrosion protective tapes of coal tar type as per IS:15337 or AWWA C 203. The total thickness of protective tapes to be applied on buried pipes / pipes in trench shall be 4.0mm. This can be achieved by using 4.0mm thick tape in single layer or 2.0mm thick tape in double layer. iv) Pipe thickness: a) For Pipe sizes upto 150 NB and above: As per IS:1239 Part-I medium grade.
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9 Sub Section-A-16 Fire Detection & Protection System Page 16 of 24

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	b) For Pipe sizes 200 NB and above refer Annexure-I. v) All valves shall be as per applicable IS/BS codes & approved by TAC for specific fire protection system and shall be provided with locking arrangement (with locks) in open or close condition. Further, all gate/butterfly valves of size 200 mm & above shall be provided with spur gear reduction unit. vi) All the flanges and counter flanges shall conform to ANSI B 16.5 CI 150. vii) Strainer Body as per IS:2062 (tested). viii) Pipe Fittings 1) The material shall conform to ASTM A 234 Gr WPB or ASTM A 105 or equivalent and dimensional standard conforming to ANSI B 16.11 (socket & threaded type), ANSI B 16.9 (for butt welded fittings) and ANSI B 16.5 (for flanges and flanged fittings) as the case may be. Further, galvanised malleable cast iron fittings as per IS:1879 in Cast iron fitting as per BS-1641 are also acceptable. 2) Grooved couplings : Vendor may also use mechanical grooved couplings type fittings in GI pipe lines for HVW / MVW spray system. All materials and products shall be either Underwriters Laboratories (UL) Listed or Factory Mutual (FM) Approved and installed in accordance with NFPA Standard 13 / equivalent Standard. 3) The fittings shall be galvanised as per IS : 4736 for galvanised pipe application. In case of branching connections from GI mains for spray piping network, socket may be welded for more than two pipe reduction instead of standard tees. 4) Fabricated fittings shall not acceptable up to pipe size to 300 NB. For sizes 350 NB and above, fittings may be fabricated as per BS:2633/BS:534. ix) Welding of galvanised iron pipes/fittings would be permitted provided the same is carried out by means of special electrodes suitable for the above application and the same shall be approved by Employer. After, welding, welded portions shall be applied with three coats of zinc silicate treatment/rich paint over one coat of suitable primer. Further, the Contractor shall provide proper zinc paint at the point of welding.			
9.00.00	PAINTING			
9.01.00	All the Equipments shall be protected against external corrosion by providing suitable painting.			
9.02.00	The surfaces of stainless steel, Gunmetal, brass, bronze and non-metallic components shall not be applied with any painting.			
9.03.00	Fire Water Storage Tanks: i) The Contractor shall clean the tank plates and structure steel before erection by wire brushing and air blowing. After erection of tank and hydro testing, tanks are subjected to surface preparation and painting as per procedure detailed below: ii) Surface Preparation : Outside/inside surface preparation shall be carried out by shot blasting as per SA2 ½.			
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-16 Fire Detection & Protection System	Page 17 of 24

CLAUSE NO.
TECHNICAL REQUIREMENTS

- iii) **Inside surface painting:** One coat of epoxy zinc phosphate primer of min. DFT of 30-35 micron followed by three (3) coats of epoxy resin based finish paint with 25 micron as thickness of each coat.
- iv) **Outside surface painting:** One coat of epoxy zinc phosphate primer of min. DFT of 30-35 micron followed by three (3) coats of epoxy resin based finish paint with 25 micron as thickness of each coat.
- v) **Outside bottom surface painting :** One coat of epoxy zinc phosphate primer of min. DFT of 30-35 micron followed by three (3) coats of coal tar epoxy paint with 25 micron as thickness of each coat.

9.04.00

All Steel Surfaces (external) exposed to atmosphere (outdoor installation)

- (i) **Surface Preparation :** The steel surfaces to be applied with painting shall be thoroughly cleaned before painting by wire brushing, air blowing, etc.
- (ii) **Painting:** One (1) Coat of red oxide primer of thickness 30 to 35 microns followed up with three (3) coats synthetic enamel paint, with 25 microns as thickness of each coat. For plant at coastal area, epoxy resin based zinc phosphate primer followed by epoxy resin based paint pigmented with titanium di-oxide shall be used in place of enamel paints.

9.05.00

All Steel Surfaces (external) inside the building (indoor installation)

- (i) **Surface Preparation :** The steel surfaces to be applied with painting shall be thoroughly cleaned before painting by wire brushing, air blowing, etc.
- (ii) **Painting:** One (1) Coat of red oxide primer of thickness 30 to 35 microns followed up with two (2) coats synthetic enamel paint, with 25 microns as thickness of each coat. For plant at coastal area, epoxy resin based zinc phosphate primer followed by epoxy resin based paint pigmented with titanium di-oxide shall be used in place of enamel paints.

9.06.00

Deluge Valves, Alarm Valves, Foam monitors, Water monitors, Foam Proportioning equipments, Foam makers, etc.

Painting of all equipments /.components of FDPS package shall be as per manufacturer's standard practice or as detailed below whichever is superior in quality.

Environment	Paint scheme	Total DFT
Normal / Mild Corrosive Environment	Primer- zinc filled epoxy Finish – Aliphatic Polyurethane (shade RAL3000)(P.O Red)	Min 125 microns
Corrosive Environment (as in coastal areas)	Primer- zinc filled epoxy Intermediate – Epoxy MIO Finish – Aliphatic Polyurethane (shade RAL3000)(P.O Red)	Min 200 microns

CLAUSE NO.	TECHNICAL REQUIREMENTS
10.00.00 11.00.00 11.01.00 11.02.00	MULTIPURPOSE NOZZLE The multipurpose nozzle should be such that water under pressure is applied on fire in the form of a jet, spray or fog. Material of construction for multipurpose nozzle shall be as per manufacturer's standard. Fire Detection and Protection System Equipment Sizing Criteria General Design Criteria i) The fire protection system shall consist of fire water storage tanks, fire water pumping system, fire water hydrant and spray system serving the whole station including Employer's plant/ facilities/ buildings. ii) All major equipment / system components in the entire fire protection & detection system shall have the approval from one of the following: a) Underwriters Laboratories of USA b) LPCB –UK c) VDS d) BIS (for the approval of pumps and valves) e) FM - USA However, design and installation of complete system and requirements shall be approved by TAC accredited professional(s)-India. iii) Any other additional equipment not specifically mentioned in the technical specification but are found necessary to meet the requirements of TAC and also for safe and sound operation of the plant are to be included at no extra cost to Employer. Hydrant System Design philosophy (minimum requirement) i) Category of Hazard and minimum terminal pressure shall be as per TAC norms. ii) Separate Hydrant and spray lines shall be provided for Hydrant system and Spray System respectively. iii) All the landings of boiler staircases, turbine building, transfer point houses, administrative building and other multi-storied structures of the plant shall be provided with hydrant landing valves. v) Each of the landing valves and external hydrant valves associated with the main plant (transformer yard, TG building, boiler area) areas shall be provided with a hose box. Each hose box shall contain two (2) numbers of 15M long hoses & coupling, branch pipes & nozzles, spanner etc. as per TAC guidelines. 1..02 For landing valves of various off-site buildings, the hose box shall have two (2) numbers 7.5 m long hoses, branch pipes, couplings, nozzles, spanners, etc. as per TAC guidelines. vi) The pipelines routed in RCC trenches shall be provided with coating and wrapping. Road, Rail or pipe trench crossing be through trestle/RCC Hume pipes of appropriate
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9 Sub Section-A-16 Fire Detection & Protection System Page 19 of 24

CLAUSE NO.	TECHNICAL REQUIREMENTS
11.03.00	pressure class and the pipe lines shall be provided with coating and wrapping as per specification. HVW & MVW Spray System (as applicable) Design Philosophy (Minimum Requirements) i) Design discharge density shall be as per the rules of TAC and/ or NFPA standards. ii) Deluge valve along with trims like pressure gauge, water motor gong, etc. shall be UL/FM or equivalent approved / listed. The deluge valve (auto resetting type) assembly shall consist of accessories such as water motor gong, alarm test valves, drip/drain valves, strainers for these valves, hydraulic releasing system, solenoid valves, etc. Further, the design features and make of all the projectors / spray nozzles shall be UL/FM or equivalent approved / listed. iii) A strainer ('Y' type) be provided at upstream of deluge valve. iv) Pressure switches be provided in spray and detector piping to exhibit "FIRE" and "SPRAY ON" annunciations and as well as for interlock. v) Wet type pipe detector network shall be provided for spray system using quartzoid bulb detectors. vi) Each of the outdoor deluge valve and accessories shall be provided with housing. vii) Remote manual operation of the deluge valves shall be possible from the respective fire alarm cum control panel through the keyboard operation of PC monitoring station when the system is selected in remote manual mode. The remote manual selection for the operation of spray system on any equipment or any zone shall also be through the monitoring station of the respective panel. Apart from the automatic operation of the deluge valve, the system shall have provision for manual operation of the deluge valve by means of hand operated lever close to the deluge valve assembly. There shall also be a provision to operate deluge valve electrically from a nearby local panel. 11.04.00 Bladder tank Foam Protection System Design Philosophy (Minimum Requirements) i) Complete system shall be designed as per NFPA -11 and TAC. ii) Water for the foam system may be tapped off from the hydrant system. iii) The operation of foam system shall be automatic with the aid of fire detection system provided for the HFO (if applicable) & LDO tanks with a provision for manual operation. Auto/Manual selection switch shall be provided at the local panel. iv) Foam concentrate shall be of 100% AFFF type and shall be provided in 2x100% capacity foam concentrate tanks. v) The minimum effective capacity of each foam bladder tank shall be designed considering the following: a) Simultaneous protection of any of the fuel oil tank or LDO tanks and operation of two hydrants for 60 minutes or b) Minimum capacity if specified elsewhere. vi) A design margin of atleast 10% shall be considered over the calculated foam concentrate capacity and tank capacity. vii) Foam bladder tank assembly shall consist of 2x100% foam concentrate tanks with bladder, fill & drain valve for water and foam concentrate, foam proportioner/ratio controllers along with concentrate supply control valve (hydraulically operated ball valves), vent valves, required instrumentation, etc. Horizontally mounted Tanks shall be of carbon steel as per IS:2062 Grade 'B'/ASME A516 Gr 70 and designed
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9 Sub Section-A-16 Fire Detection & Protection System Page 20 of 24

CLAUSE NO.	TECHNICAL REQUIREMENTS			
		as per ASME code Section VIII for pressure vessels. Bladder tanks shall also be provided with sight gauge with shut-off & drain valve, ladder, pressure relief valve and filling kit.		
	viii)	One number foam proportioner of adequate size shall be provided for each HFO (if applicable) & LDO tanks.		
	ix)	Besides these, one additional foam proportioner of adequate size shall be provided for foam hydrant rings around dyke area. All the proportioners are interconnected by isolation valves (manually operated), in such a way that any of proportioner may cater to the requirement of others. Further, separate isolation valves (manually operated) shall be provided for each proportioner for maintenance.		
	x)	Automatic solenoid valve shall be provided in foam supply line to each of the HFO (if applicable) & LDO tanks at the upstream of foam proportioner. In the event of detection of fire, the signal shall operate the deluge valve and water inlet valve to the designated foam proportioners of the tank, and as well as open the foam solution inlet valve to foam proportioner and thereby foam is injected to the tank under fire from foam makers discharge outlets.		
	xi)	Apart from feeding the individual tank, each set of foam inductors shall deliver foam solution to foam hydrant piping ring around the tank dyke whenever foam injection system is initiated so that spill fires if any may be extinguished by means of foam hydrants, hoses & monitor.		
	xii)	Foam monitor shall conform to relevant International standard / manufacturer's standard.		
	xiii)	The maximum spacing of the foam hydrants around the dyke area shall be similar to that of water hydrant system.		
	xiv)	The minimum foam application rate of 3% foam solution shall be 6.1 lpm/Sq.m (Complete surface area) for fixed roof type tanks.		
	xv)	The system shall incorporate features such as non-return valves to avoid mixing water with foam concentrate pipelines, isolation valves of ratio proportioning devices etc.		
	xvi)	Foam concentrate piping shall be of Stainless Steel (seamless) as per ASTM-A-312 TP-304, Schedule-40s. Fittings shall be of SS forged to ASTM-A-182, F-304 for sizes 15NB to 40NB and S.S. seamless to ASTM-A-403, WP-304, Schedule-40 for sizes 50NB & above. All the piping shall be laid over ground on RCC pedestals. Further, all valves, foam proportioners, etc. in foam concentrate line shall be of stainless steel construction.		
	11.05.00	Fire Detection, Alarm and Control System		
		Design Philosophy (Fire Alarm and Detection System)		
	i.	The DDCMIS based control system for fire water pumps shall indicate the status of each pump, system pressure, operation of hydrant and/ or spray system, failure of starting of pumps, healthiness & failure of batteries/ chargers, main supply, low level of fuel oil of diesel engines, tripping of pumps, low level / very low level of water in the water supply system, status of batteries & chargers of panels and diesel engines etc.		
	ii.	The addressable type fire alarm panels at Control equipment rooms shall receive signal from sensors from various areas/ equipment of the respective units.		
	iii.	The central monitoring station to be located at Central Control Room shall cover the fire detection and protection system of the complete (all the areas) plant. This shall give audio-visual annunciations for fire in each of the risk area / equipment / status of the fire protection system as well as system operator open / short circuit status of detector or control cabling, etc. Further, this shall activate a hooter/sounder in each of the area provided with fire/smoke detection system.		
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-16 Fire Detection & Protection System	Page 21 of 24

- iv. Alarms from all the fire alarm panels shall be repeated simultaneously in repeater panel at Fire station as well as to the DDCMIS system.
- v. The addressable panel shall evaluate the signals received from the detectors, transmit the fire or trouble alarms (audio-visual) to prearranged points, supervise and monitor the complete fire detection & extinguishing circuits, initiate control functions like shutdown of draft fans, air-conditioning and ventilation plant/equipment, closure of Fire dampers in A/C & Ventilation system etc. Opening smoke extraction vents, switching on smoke extraction equipment emergency lighting, tripping of transformer lockout relays etc.
- vi. All the circuits from the detectors to the panels and the circuits from the panels to the actuating devices (such as solenoid valves, deluge valves, push buttons etc.) shall be closed loop type and shall be supervised for open and short circuiting. The trouble signal also be annunciated in the respective panels.

Facilities shall be provided on the fire alarm panel for simulating fire conditions, sensitivity adjustment, isolation of detectors etc. from the panel.

ANNEXURE-I

PIPING THICKNESS:

Pipes for sizes 200 NB & above shall confirm to IS: 3589 Grade 410. The final thickness shall not be less than that specified as per IS: 3589 as indicated below.

Nominal pipe Size (mm)	Outside Diameter (mm)	Wall Thickness (mm)
200 NB	219.1	6.3
250 NB	273	6.3
300 NB	323.9	7.1
350 NB	355.6	8.0
400 NB	406.4	8.0
450 NB	457	8.0
500 NB	508	8.0
600 NB	610	8.0

Annexure-II

Technical Data:

1. Fire water pumps	Hydrant	Spray	Jockey
Number of pumps	2(1 motor driven & 1 diesel engine driven)	2 (1motor driven & 1 diesel engine driven)	2 (both motor driven)
Design Capacity	273m³/hr	273 m³/hr	40 m³/hr
TDH of pump (MWC)	88 (min) or as per system reqt.	88 (min) or as per system reqt.	88 (min) or as per system reqt.
MOC	Casing:IS:210 Gr. FG 260 (2.5% Ni), Impeller: Bronze IS:318 Gr.II, Impeller shaft, coupling :SS316		
2. Hydrant Valve	Oblique female type as per IS:5290		
	MOC: Body/bonnet/stop valve/valve seat/trim : SS304/SS316		
3. Water monitor	As per IS:8442 Type-I, Size: 75mm, Nozzle dia: 38mm		
	MOC: Water barrel/reducer/elbow: CS (seamless)/SS Nozzle: Copper alloy / SS confirm in to IS:3444		
4. Water branch pipe & nozzle	As per IS:903 / IS:2871		
	MOC: Branch pipe: SS316 (Gr 4 of IS:3444) (both ends) Nozzle : SS316 (Gr 4 of IS:3444), Size: min 16mm & max 25mm		
5. Water line Gate /Valve	- Design Code: a) IS:14846 or BS:5150 (for valves coming inside fire water pump house) b) BS:5150 (for valves at other locations) - Pressure rating: PN1.6 (as per IS:14846) / PN16 (as per BS:5150) -Working Pr. :12Kg/cm2		
	MOC: Body/bonnet/Yoke/Wedge : CI to IS:210 FG-200 Spindle: SS to ASTM-A-276 type 410		
6. Check Valve	Below 50NB size	50NB & above	
	Design Code; IS:778 (below 50NB)	IS:5312 / BS:5153	
	MOC: Body/cover/flap: Leadcd tin bronze to IS:318 Gr. LTB-2	CI to IS:210 FG-200	
7. Butterfly Valve	Design Code: Double flanged or lugged wafer type of low leakage rate confirming to BS:EN:593/API-609/AWWA C-504 Pressure class: PN 16		
	MOC: Body & Disc : Cast Iron, Shaft : SS 410 / SS 420 Seat Rings : EPDM		

SUB-SECTION–A-17

NOT USED

SUB-SECTION–A-18

NOT USED

SUB-SECTION–A-19

NOT USED

SUB-SECTION–A-20

NOT USED

SUB-SECTION–A-21

ASH HANDLING PLANT AND CRANE

CLAUSE NO.	SCOPE OF SUPPLY & SERVICES		
1.00.0 1.02.00	WASTE FEED CRANE & BOTTOM ASH CRANE WASTE FEED CRANE Type of crane: To be decided by the bidder to meet the entire functional requirement Volumetric capacity of grab (m³): Minimum 8 (m³) Lifting capacity of crane (T): 12 (T) Minimum The cranes shall be designed as per applicable international standard. Maintenance platform with proper approach all along the Crane movement shall be provided. BOTTOM ASH CRANE Type of crane: To be decided by the bidder to meet the entire functional requirement Volumetric capacity of grab (m³): Minimum 1.5 (m³) Lifting capacity of crane (T): Minimum 5 (T) The cranes shall be designed as per applicable international standard. Maintenance platform with proper approach all along the Crane Trolley Movement shall be provided.		
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9	SUB-SECTION- A-21 WASTE FEED CRANE & BOTTOM ASH CRANE	PAGE 1 of 1

SUB-SECTION–A-22

NOT USED

SUB-SECTION–A-23

NOT USED

SUB-SECTION-A-24

LP DOSING AND OXYGENATED TREATMENT SYSTEM.

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	LP DOSING AND OXYGENATED TREATMENT SYSTEM			
1.00.00	General			
1.01.00	The vendor shall supply LP dosing as per the vendors standard proven method			
	If the proposed method is Combined Water Treatment (CWT) using Oxygen Dosing in the feed water, generally as per the guidelines of EPRI, USA/VGB, Germany/CEGB, UK / relevant Japanese standard. The following parameters of feed water are proposed to be maintained :			
	Cation Conductivity	≤ 0.2 micro siemens / cm		
	Hydrazine	Nil		
	pH value (25 degree C)	8-8.5		
	Oxygen	20-200 ppb		
	Iron	≤ 10 ppb		
	Copper	≤ 2 ppb		
	Silica	≤ 20 ppb		
1.02.00	If the proposed method is All Volatile type of Treatment (AVT) using ammonia and hydrazine dosing shall be used. The following parameters shall be maintained in case of AVT.			
	Cation Conductivity	≤ 0.25 ms / cm		
	Hydrazine	10-15 ppb		
	pH value (25 degree C)	9.0-9.6		
	Oxygen	≤ 7 ppb		
	Iron	≤ 10 ppb		
	Copper	≤ 2 ppb		
	Silica	≤ 20 ppb		
	Or otherwise Vendor shall propose suitable kind of treatment as per vendor's proven practice.			
1.03.00	Sodium and Chloride limit in case of both CWT & AVT feed water shall be maintained upto 2 ppb each at Condensate Polishing Plant outlet (if applicable). It is proposed to install 100% capacity Condensate Polishing Unit (if the system is applicable for waste to energy plant).			
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9	SUB-SECTION- A – 24 LP DOSING AND OXYGENATED TREATMENT SYSTEM	PAGE 1 OF 4

CLAUSE NO.	TECHNICAL REQUIREMENTS				
	The proposed design features of the Condensate polishing plant is indicated in Sub Section A-2 (Equipment Sizing Criteria) of Part B, Section VI, book 1 of 5 of technical specification and considering the above the Boiler Feed Water Treatment System shall be designed, supplied and installed by the Contractor.				
1.04.00	The chemical regime given above is indicative only. Bidder shall furnish in his offer the appropriate chemical regime, which shall be discussed & finalised in case of award.				
2..00.00	Oxygen Dosing System (if applicable) Complete Oxygen Dosing System shall be supplied and installed by the Bidder. It is proposed to dose Oxygen at two (minimum) locations in the Condensate and in Feed water circuit of each unit. i.e one at outlet of condensate polishing Plant and another at the outlet of deaerator (suction line to feed water pumps). Additional dosage points if required as per manufacturer's standard practice shall also be included by the Bidder. Each of the dosing locations shall be provided with a set of Oxygen cylinders with required cylinder isolation/check valves, cylinder manifolds, isolation valves in the common manifold, piping from manifold, dosing (automatic type) valves of regulating valve, check (non-return type) valve, Instruments for measurement of oxygen & conductivity of condensate & feed water lines at the downstream of dosing locations, associated control system etc. The dosing rate shall be regulated automatically by control system based on the quality of condensate water and feed water quality as the case may be. The control system shall facilitate selection of oxygen dosing locations. Regulating type valves shall be provided with isolation valves at upstream & downstream end to facilitate replacement/repair of regulating valve. At each dosing locations, system shall be designed as per the requirement considering the condensate and feed water flow requirement.				
3.00.00	All Volatile Treatment (AVT)				
3.01.00	For AVT, Bidder shall include in his scope all necessary hardware including storage tanks, measuring tanks, mixing arrangement, however oxygen cylinders shall have redundancy of 100% for each unit. However minimum details for AVT are given below:				
3.02.00	Tanks Vertical and cylindrical design with dished/conical ends, SS-304 material of construction, shell thickness 3 mm for the tanks.				
3.03.00	Ammonia Measuring tank	Ammonia Mixing/ storage tank	Hydrazine Measuring tank	Hydrazine Mixing/ storage tank	
	i) Storage Capacity (in litres)	125	2300	30	2300
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9		SUB-SECTION- A – 24 LP DOSING AND OXYGENATED TREATMENT SYSTEM	PAGE 2 OF 4

CLAUSE NO.	TECHNICAL REQUIREMENTS					
3.04.00	ii)	Nos.	1 No./skid	1 No./Skid	1 No./Skid	1 No. Skid
	iii)	Concentration of aqueous ammonia solution shall be 29.4%				
	iv)	Concentration of hydrazine solution shall be 35%				
	Transfer pumps					
	<u>Item Description</u>		<u>Ammonia pump</u>		<u>Hydrazine pump</u>	
	Material (Pump internals in contact with chemicals)		SS-304		SS-304	
	Capacity		to suit requirement		to suit requirement	
	Nos. required		1 no. (1x100%) per unit		1 no. (1x100%) per unit	
	Concentration		30% concentration		35% concentration	
	Type of pump		Hand pump		Hand pump	
3.05.00	Metering pumps					
	<u>Item Description</u>		<u>Ammonia pump</u>		<u>Hydrazine pump</u>	
	Material (Pump internals in contact with chemicals)		SS-304		SS-304	
	Capacity (LPH)		0-50		0-50	
	Nos. required		2nos. (2x100%) / per skid		2 no. (2x100%) per skid	
	Rated pressure		45 Kg/sq.cm(g)		45 Kg/sq.cm(g)	
	Type of pump		Reciprocating Pump		Reciprocating Pump	
	CHEMICALS TO BE HANDLED					
	Normal		30% conc.	Ammonia	0.6% conc.	Hydrazine solution
	Wet Laying		15% conc.	Ammonia	35% conc.	Hydrazine solution
(D.)	MATERIAL FOR PIPING & FITTINGS					
	<u>Item Description</u>		<u>Ammonia pump</u>		<u>Hydrazine pump</u>	
	Piping		SS-304 /316		SS-304/316	
	Fittings		A 182 GR.F304/316		A 182 GR.F304/316	
	VALVES		A182 GR.F304/316		A182 GR.F304 /316	
	END CONNECTION		SW/ ANSI B16.11		SW/ ANSI B16.11	
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9		SUB-SECTION- A – 24 LP DOSING AND OXYGENATED TREATMENT SYSTEM		PAGE 3 OF 4

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	Note : Capacity of various tanks & pumps are tentative minimum. It is contractor's responsibility to design/size these tanks & pumps depending upon system requirement/design and submit the same to Employer for approval. The minimum storage capacity for storage tanks of both Ammonia & Hydrazine shall be for 48 hours requirement.			
3.07.00	Each unit shall be provided with a skid of hydrazine & ammonia dosing comprising of metering pumps (2x100%), strainer (2x100%), piping, valves, instrumentation etc. for both normal operation dosing as well as dosing required for wet laying of boiler. The capacity of tanks and parameters of pumps given are indicative & minimum. Final parameters shall be as per system requirements.			
3.07.00	Control and Instrumentation Requirements			
3.07.01	The bidder shall supply all necessary Control & Instrumentation for satisfactory operation of dosing system. The control of system shall be through BOP C&I part of DDCMIS.			
3.07.02	The bidder shall supply all field instruments, devices as per the approved schemes as a minimum. These field instruments should confirm to requirements specified in the control and instrumentation section of this volume.			
3.07.03	It is intended to control dosing system from BOP C&I part of DDCMIS, including ON/OFF command of individual pumps. However Bidder shall provide local prewired control panel complete with i) Start/stop push buttons ii) Indicating lamps iii) Local/Remote selection iv) Stroke position indicator v) Rise/Lower push buttons for stroke position vi) Local LED based annunciation driven by DDCMIS vii) Stroke position indicator on the panel.			
3.07.04	The normal mode of operation of dosing system shall be through BOP C&I part of DDC MIS. Local/Remote selection is to be done from Remote (CR) and indication for the same is to be provided on local panel.			
3.07.05	The ON/OFF commands for individual pumps from local push buttons shall act on the respective drives through BOP C&I part of DDC MIS.			
3.07.06	The stroke position and adjustment will be done by 4-20 mA D.C. signal from BOP C&I part of DDCMIS and the pumps stroke actuation should be suitable for accepting 4-20 mA D.C. signal. The pumps are to be provided with 24 V DC, two wire LVDT type position feed back transmitter which will generate 4-20 mA signal indicating stroke position.			
KAWAS WTE PROJECT (2X350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9	SUB-SECTION- A – 24 LP DOSING AND OXYGENATED TREATMENT SYSTEM	PAGE 4 OF 4

SUB-SECTION–A-25

SERVICE ELEVATORS CRANE, HOIST & MONORAIL

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	SERVICE ELEVATORS CRANE, HOIST & MONORAIL			
1.00.00	SERVICE ELEVATORS			
1.01.00	DESIGN CRITERIA AND OPERATIONAL SPECIFICATION			
1.01.01	Design Elevator shall be of conventional for Main control room and TG floor of panoramic type with five glass panels on rear side. The elevator shall meet the quality of international standard. The quality of glass panel on rear should be of highest grade from safety point of view and should meet the best standard.			
1.01.02	The final landing elevations for all buildings shall be subject to approval by the Employer after award.			
1.01.03	Elevators shall be designed based on following criteria :			
	i)	Design/construction/installation codes.	:	Latest edition of IS: 14665 (all parts)
	ii)	Load carrying capacity	:	680 kg. (or suitable for 10 persons) for passenger elevator for control room and TG building
	iii)	Rated speed	:	1.0 m/sec.
	iv)	Position of machine room	:	Directly above the elevator shaft.
	v)	Machine room	:	Machine room and window air conditioner of minimum 2T capacity per elevator shall be provided by bidder.
1.02.00	CONSTRUCTION Construction of the elevators shall specifically meet all requirements of the codes indicated and shall have following additional features:			
	i)	Flooring of Cabin	:	Vitrified ceramic tiles of mat finish.
	ii)	Car enclosure & car panels	:	Stainless Steel
	iii)	Handrails on 3 sides	:	Mirror Stainless Steel
	iv)	False ceiling	:	Powder painted
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9		SUB-SECTION-A-25 SERVICE ELEVATORS CRANE, HOIST & MONORAIL
PAGE 1 OF 6				

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	v)	Car opening & Hoist way opening	:	Protected by central opening sliding Stainless Steel door
	vi)	CABIN ACCESSORIES	:	The following accessories shall be provided : a) Recessed fluorescent light fittings on car floor. b) Car control station c) Emergency stop switch. d) 5/15A, 3 pin plug socket with switch on top of lift car.
	1. AUTOMATIC RESCUE DEVICE (ARD) - (BATTERY DRIVE): Bidder to provide a modern Advanced electronic drive system of "RESCUING Passenger Trapped in a ELEVATOR".			
	2. EMERGENCY SAFETY DEVICES : The lift shall be provided with safety Device attached to the lift car frame and placed beneath the car. The safety device shall be capable of stopping and sustaining the lift car up at governor tripping speed with full rated load in car.			
	3. Elevator shall have Floor announcement system & Braille switches			
	1.02.01	All steel embedment for fixing landing doors/indicators etc. to the Elevator well shaft and fascia plate shall be supplied by the Bidder.		
	1.02.02	Guide rails complete with supporting brackets for the car and counter weights. Bidder to take care of granite tiles (approx 80 kg) to be provided for cabin flooring in selecting counter weights.		
	1.02.03	Elevator drive machines complete with electric motor, reduction gear unit, suspension ropes, buffers for the cars and the counter weights and other drive and control mechanism. All foundation anchor bolts, sleeves, anchoring steel and any item required to complete the job satisfactorily shall be provided by the bidder. The bidder shall also provide for the grouting of anchor bolts, sleeves, anchoring steel, etc. and other anchorages		
	1.02.04	Any other steel works as well as all other accessories/components not specified in the specification but necessary for making the Elevator complete.		
	1.02.05	All minor building work including the supply of steel items, associated with installation of equipment in the machine room hoist way, hoist way door, frames and Elevator pit, shall form part of bidders scope of service, Employer will provide the Elevator-well complete with foundation and brick walls around the lit-well together with overhead machine room. The		
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9	SUB-SECTION-A-25 SERVICE ELEVATORS CRANE, HOIST & MONORAIL	PAGE 2 OF 6

CLAUSE NO.	TECHNICAL REQUIREMENTS			
1.03.00	machine room will be provided with R.C.C. floor slab with necessary pockets for anchor bolts and slots. OPERATION			
1.03.01	Elevator shall have provisions to meet following operational requirements : a) Selective Duplex collective, automatic operation with or without attendant through illuminated push button station located inside the lift car. b) Door operating shall be automatic door operation and electronic door protection system for opening/closing of car and landing doors. c) Bidder shall provide car operating panel with luminous buttons, car position indication in car (both visual and audio) combined with direction arrows, overload warning indicator, battery operated alarm bell and emergency light and fan & hands free speaker telephone set with suitable battery, charger & controls. d) Bidder shall provide emergency indicator to indicate the location of elevator in case of elevator being stuck up between the floors through automatic flashers (both audio & visual) e) Bidder shall provide electronic door detector (Infra red curtain type). f) Two push buttons, one for upward movement and the other for downward movement at each intermediate landing and one push button at each terminal landing shall be provided in order to call the car. Digital hall position indicator at all floors, tell lights at all floors shall also be provided by the bidder. g) For facilitating the movement of visually & hearing impaired persons, hall lantern and car arrival chimes shall be provided. h) All fixtures shall be in stainless steel face plates. i) Push buttons shall be fixed in the car for holding the doors open for any length of the time required. j) All other safety/protection/operation interlocks as required by IS:14665 (latest edition).			
1.04.00	Elevator Electricals:			
1.04.01	Electric motor: The driving motors shall conform to I.S 325 and suitable for the Variable Voltage Variable Frequency (VVVF) application. All motors shall be squirrel cage induction type, suitable for operation at 415V (+/- 10% variation) , 3 phase, 3 wire, 50HZ (+3% to -5% variation) supply. Motors shall be provided with thermal class 130 (B) or better insulation			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9	SUB-SECTION-A-25 SERVICE ELEVATORS CRANE, HOIST & MONORAIL	PAGE 3 OF 6

CLAUSE NO.	TECHNICAL REQUIREMENTS			
1.04.02	Controls: The controls shall be Variable Voltage and Variable frequency type and shall provide smooth and constant acceleration and retardation under all conditions of operation . Suitable control panel shall be provided in the machine room.			
1.04.03	Cables and wiring: All the cables except trailing cables shall be as per IS:1554-1 or IS-7098-I. the PVC outer sheath of these cables shall be flame retardant, low smoke (FRLS) type with the following FRLS properties. a) Oxygen index of min. 29 (as per IS:10810 Part-58) b) Acid gas emission of max. 20% (as per IEC-754-I). c) Smoke density rating shall not be more than 60% (as per ASTMD-2843). The circular trailing cables shall be either in accordance with IS 4289 Part-I (Elastomer insulated) or IS-4289 Part-II (PVC insulated). The flat type trailing cables if offered shall be in accordance with IEC-60227-6. All wiring / cabling between the equipments in the lift machine room and that between the machine room and equipments in the lift well and at the landings shall be wired in HDP conduits/ galvanized steel conduits to be supplied by the contractor. Alternatively armored cables may be used.			
1.04.04	Earthing: The elevator structures and all Electrical equipment, including metal conduits shall be effectively earthed with the earth conductors provided in the machine room as per IS: 3043.			
DATA SHEET				
i) Type of services : Passenger				
ii) Load carrying capacity : As per specification				
iv) Rated speed One (1) meter/second				
v) Total Travel : TG hall- As per layout Control room- As per layout				
vi) No. of floor to be served : TG hall and control room - To be decided during detailed engineering.				
vii) Method of control : Variable voltage variable frequency (VVVF)				
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9	SUB-SECTION-A-25 SERVICE ELEVATORS CRANE, HOIST & MONORAIL	PAGE 4 OF 6

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	viii) Position of M/c room : Directly above lift shaft ix) Size of platform : As per IS14665 & manufacturer's standard latest. x) Size of lift well : -do- xiii) Specification code : As per IS:14665 (5 parts) (Latest Edition). xiv) Design seismic co-efficient : According to the IS 1893-1977			
2.00.00	CRANE, HOIST & MONORAIL			
2.01.00	Suitable EOT Crane/HOT Crane/Monorail beams with hoists/Chain Pulley Blocks of adequate capacity, to meet the erection and maintenance requirements are to be provided by the vendor for the various areas/equipment. Some of the areas/equipment not covered by TG hall EOT cranes are indicated below. For balance areas/equipment, not listed hereinafter, the requirements of Specification shall be followed. (a) Feed water heaters (if applicable) & deaerator. (b) Various pumps & Heat Exchangers. (c) Air cooled Condenser (if applicable) (d) Vacuum Pumps (if applicable) (e) Control Fluid Room (f) Auxiliary cooling water (clarified) pumps and DM cooling water pumps of ECW systems. (g) Central Lube Oil System room. (h) Any other equipment. The above requirement is indicative only, the requirement given in the respective chapter is to be adhered to.			
2.02.00	The EOT cranes shall be designed as per IS-3177 (Latest edition) class -2 duty and the monorail hoists (hand operated) shall be designed to duty class 2 to IS 3832. Electrical wire rope hoist shall be designed as per IS:3938 (latest).			
2.03.00	The design, manufacture inspection and testing of the crane shall comply with the requirment of latest version of IS:3177			
2.04.00	The stipulations of all statutory codes like Indian Electricity Act, Indian Electricity Rules, Factory Acts, Local Municipality Act etc. shall however prevail over the specification requirements, incase any conflict arises between this specification and the statutory codes.			
2.05.00	For the hoists with more than 2.0 ton lifting capacity or more than 06.0 M lift, motor operated hoist block for both long travel and lift shall be provided. Other hoist blocks shall be of hand			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9	SUB-SECTION-A-25 SERVICE ELEVATORS CRANE, HOIST & MONORAIL	PAGE 5 OF 6

CLAUSE NO.	TECHNICAL REQUIREMENTS			
3.00.0	operated type for both travel and lift. However, all monorails coming out of the building shall be provided with electric hoist block, irrespective of load and lift. For hand operated hoists, the hoists shall be suitable for operation from floor level. Hand chain shall be provided for long travel of trolley and the Hoisting mechanism. The operator shall be able to control the movement of the monorail hoist with the help of floor operated pendant. The creep speed for vertical movement shall also be provided as per the system requirement. Mobile Cranes: In case open pump houses are provided in the following areas, mobile cranes of suitable capacity confirming to relevant IS code are to be provided as under 1. PT Plant & DM Plant Area : 2 No. mobile cranes Note: Proper approach road for movement to shed is to be made. The capacity of mobile cranes shall be calculated based on the maximum load to be lifted with 25% margin.			
	4.00.00	DESIGN CRITERIA AND OPERATIONAL SPECIFICATION FOR GOODS ELEVATOR Design The design of goods elevator shall meet the quality of international standard. The final landing elevations for goods elevator in Boiler shall be subject to approval by the Employer after award.		
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9	SUB-SECTION-A-25 SERVICE ELEVATORS CRANE, HOIST & MONORAIL	PAGE 6 OF 6

SUB-SECTION–A-26

PRE-COMMISSIONING & COMMISSIONING ACTIVITIES.

CLAUSE NO.	एनटीपीसी NTPC TECHNICAL REQUIREMENTS
1.00.00 1.01.00 1.02.00 1.03.00 2.00.00	PRE-COMMISSIONING ACTIVITIES, COMMISSIONING OF FACILITIES AND INITIAL OPERATIONS GENERAL The pre-commissioning and commissioning activities including Guarantee tests, checks and initial operations of the equipment furnished and installed by the Contractor shall be the responsibility of the Contractor as detailed in relevant clauses in Technical Specification. The Contractor shall provide, in addition, test instruments, calibrating devices, etc. and labour required for successful performance of these operations. If it is anticipated that the above test may prolong for a long time, the Contractor's workmen required for the above test shall always be present at Site during such operations. It shall be the responsibility of the Contractor to provide all necessary temporary instrumentation and other measuring devices required during start-up and initial operation of the equipment systems which are installed by him. The Contractor shall also be responsible for flushing & initial filling of all oils & lubricants required for the equipment furnished and installed by him so as to make such equipment ready for operation. The Contractor shall be responsible for supplying such flushing oil and other lubricants unless otherwise specified elsewhere in these specifications & documents. The Contractor upon completion of installation of equipments and systems, shall conduct pre-commissioning and commissioning activities, to make the facilities ready for sustained safe, reliable and efficient operation. All pre-commissioning/commissioning activities considered essential for such readiness of the facilities including those mutually agreed and included in the Contractors quality assurance program as well as those indicated in clauses elsewhere in the technical specifications shall be performed by the Contractor. TESTING / COMMISSIONING PROCEDURES The contractor shall submit his testing / commissioning check lists and procedures for various equipments / systems covered under the contract at least 18 months before the actual commissioning of the equipments / systems for review and approval of employer. The testing / commissioning procedures are to be of a standard format in order to maintain consistency of presentation, content and reporting. The list of commissioning check lists and procedures to be submitted and their content details shall be agreed upon during preaward discussions. An indicative list of Testing / Commissioning procedures/schedules and Standard Checklists and the details regarding the contents of testing/commissioning are enclosed as annexure at the end of this sub-section of section-VI, Part B. The actual list of such equipments / systems shall depend on the equipments / systems being supplied by the contractor. i) Annexure-I : Standard Checklist of items ii) Annexure-II : Testing / Commissioning Procedure/schedules iii) Annexure-III : Commissioning procedures requiring approval of Employer. iv) Annexure – IV : Demonstration/Acceptance test procedures during Commissioning/Initial operation v) Annexure – V : Brief write up on Contents of Testing / Commissioning Procedures Procedure/schedules shall be approved by the employer.
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9 SUB-SECTION- A-26 PRE-COMMISSIONING & COMMISSIONING ACTIVITIES PAGE 1 OF 13

CLAUSE NO.	TECHNICAL REQUIREMENTS			
3.00.00	PRECOMMISSIONING & COMMISSIONING ACTIVITIES			
3.01.00	General The pre-commissioning activities including some of the important checks & tests for certain major equipment/ systems (as a minimum) are described below, although it is the Contractor's responsibility to draw up a detailed sequential & systematic list of checks / tests and various activities / procedures connected with pre-commissioning of the complete facilities with all systems, sub-systems and equipment supplied and installed by him and get the same approved by the Employer.			
3.02.00	PRE-COMMISSIONING ACTIVITIES/TESTS:			
	Steam Generator			
3.02.01	Hydraulic Testing of Pressure Parts On completion of installation of the Steam Generator pressure parts and high pressure boiler external piping & non boiler external piping a hydraulic test in accordance with the requirements of the Indian Boiler Regulations, shall be performed by the Contractor. However, making use of valves/control valves supplied by others and installed on the contractor's piping system during hydraulic testing shall be subjected to the acceptance of respective valve supplier otherwise hydraulic cap/blanking arrangement as required shall be used. The procedure adopted for hydraulic test and preservation shall have the prior approval of the Employer. The detailed schemes and procedure for carrying out hydraulic testing shall be prepared and furnished by the contractor and it shall be discussed and finalized during detailed engineering stage. The water for hydraulic test shall be made alkaline by addition of suitable chemicals. After the test, the Steam Generator and high pressure external piping shall be suitably drained and preserved. All blank flanges, removable plugs, temporary valves, pipes & fittings, spools, other accessories and services required for carrying out hydraulic testing of boiler external pipings & non boiler external pipings and boiler & its pressure parts shall be furnished by the Contractor. The pressurization equipment including water piping and any chemicals for preservation, needed for the above test shall also be furnished by the Contractor. Any defect noticed during the testing shall be rectified and the unit shall be retested by the Contractor. In the case of branch connections/ tap-off piping (in others scope) from contractor's scope of piping are not ready or not erected at the time of hydrostatic testing of piping in contractor's scope, then the contractor to supply/use necessary blanking arrangement as required at these tap-off /branch connections. The hydraulic test shall be considered successful only on certification to that effect by the concerned inspecting authority as per the provision of the IBR and the Project Manager.			
3.02.02	Air & Gas Tightness Test After completion of installation of furnace tubes and/or inner skin casing wherever applicable ducts and airheaters, and before commencement of application of thermal insulation a test shall be performed on the Steam Generator by the contractor to prove or to establish the tightness of the erected equipments from the outlet of FD fan through Steam Generator to the stack. Such test shall be done, as far as possible, with all mountings like soot blowers etc. installed in position. The procedure adopted for such tests shall have the prior approval of the Employer. Normally physical leak detection method by pressurising the section under			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9	SUB-SECTION- A-26 PRE-COMMISSIONING & COMMISSIONING ACTIVITIES	PAGE 2 OF 13

CLAUSE NO.	TECHNICAL REQUIREMENTS			
3.02.03	test by running FD Fan / PA Fan / Temporary blower, as the case may be, is adopted. The contractor may adopt any other better method of testing. All equipments including any temporary blanking, if required, for the above test shall be provided by the Contractor. The Contractor's air and gas tightness test procedure shall be such that it shall enable conductance of air/gas tightness test on the ducts in segmented manner (as and when these duct segments are ready), so that these duct segments can be immediately released for application of insulation after their air/gas tightness tests. Contractor shall made all necessary arrangement for conducting tests in this manner. Any blanking etc. on the duct side required for testing of duct segments shall be provided by Contractor. Contractor shall bring fan / blower (s) of adequate size / capacity and other necessary instruments so that these tests can be conducted without necessity of FD / PA fans. The above equipment shall be brought to site by the Contractor on temporary basis and shall be taken back after successful completion of air / gas tightness test.			
	Chemical Cleaning of Pressure Parts The Contractor shall perform thorough and efficient cleaning operations of all the internal parts of the boiler, like economiser, water wall / evaporator, separator, feed water line, piping, start-up recirculation lines and associated piping and all other pressure parts and associated high pressure piping covered under these specifications (except those portions which are to be steam blown). The cleaning operation shall consist of De-mineralised (DM) water flushing, the chemical cleaning using acids like hydrofluoric acid or as recommended by the manufacturer, DM water rinsing, DM water flushing, nitrogen capping etc. Complete chemical cleaning procedure, the scheme and layout including parameters of the pumps, size of tanks, materials of construction, the rate of consumption and total requirements of steam and water for such cleaning process shall have the approval of the Employer. The Contractor shall furnish all labour, materials such as the required chemicals and other consumables, all equipment such as acid/chemical transfer and acid/chemical circulating pumps complete with drive motors, acid storage and acid/chemical mixing tanks, all temporary piping, valves and specialities and local instruments for pressure, temperature and flow measurements and any other items needed to carry out the process. All equipment required for chemical cleaning of Steam Generator shall be supplied by the contractor. The Contractor shall take care to dispose off the used chemicals and the effluents from the cleaning operations, after neutralisation, meeting all the statutory regulations and in a manner acceptable to the Project Manager and which would comply with the norms of the State Pollution Control Board. This includes construction of suitable neutralization pit, channels, disposal equipments etc. The Contractor shall specifically make all necessary arrangements for prevention of any fire accidents, explosions etc. during the performance of the chemical cleaning operations. The Contractor shall ensure that during the cleaning process the procedure adopted shall be such as to consume minimum demineralized water. The cleaning procedure shall include final flushing and draining of the boiler under a nitrogen gas cap and/or filling the boiler with inhibited water or any other proven procedure recommended by the manufacturer for the preservation of the boiler which is acceptable to the Employer. The Contractor shall furnish a detailed procedure for boiler preservation during detailed engineering for Employer's approval.			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9	SUB-SECTION- A-26 PRE-COMMISSIONING & COMMISSIONING ACTIVITIES	PAGE 3 OF 13

CLAUSE NO.	TECHNICAL REQUIREMENTS			
3.02.04	All equipment needed for such preservation including the nitrogen cylinders, interconnecting piping and any regulating equipment for N2 cap and other preservatives shall be provided by the Contractor for the Steam Generator and the same shall also become the property of the Employer after completion of the chemical cleaning.			
	The Contractor shall provide adequate safety and protective equipment for all his employees and ensure that they are worn at all times of danger. Specialized treatment equipment (such as required for first aid when using hydrofluoric acid/chemical) must be provided at the place of handling acid/chemical. An acid/chemical cleaning report and log of each cleaning must be provided by the Contractor to the Employer, immediately after the cleaning operation.			
	Steam Blowing			
	Steam blowing of complete Superheaters, Reheaters and various boiler external piping and non boiler external piping shall be carried out by the Contractor as per requirements/scope of work (indicated in Part-A & Part-B, Section-VI) of this specification. Temporary materials as required for steam blowing of these piping systems shall be supplied by the contractor.			
	Steam blowing of contractor's scope of piping systems shall be performed without valves/control valves supplied in steam blowing circuit otherwise valve supplier's acceptance to include these valves for steam blowing operation is to be submitted by the contractor. Based on the above the Contractor shall give recommended procedures, method of blowing and scheme for steam blowing indicating clearly additional system, if any, to be cleaned by steam blowing and furnish data/ write-up/ layouts/ drawings to that effect to the Employer for approval.			
	The Contractor shall furnish his recommendations regarding use of various test equipments and instruments and termination/acceptance criteria for steam blowing, which in any case shall meet the steam turbine-generator requirements.			
	The systems which should be ready and operational before steam blowing shall be made ready/operational by the Contractor by the scheduled date for starting of steam blowing.			
	For equipments/components installed on high pressure external piping, such as various thermo-wells, flow meter, control valves, HP Bypass valves etc., the Contractor shall comply with guidelines to be followed during steam blowing, with respect to removal / blanking / replacement of such items their internals etc. by spool pieces as given by the respective manufacturer/sub-contractor.			
	Supply of all such spools (as above) and/or blanks, temporary piping and supports etc. as required, cutting / welding / edge preparation and rewelding required for blanking, temporary piping connection and/or for replacements by spool pieces shall be the responsibility of the Contractor. After steam blowing removal of spool pieces & temporary piping and reinstallation of various components, shall also be the responsibility of the Contractor.			
	In the case of branch connections/ tap-off piping are not ready or not erected at the time of steam blowing operation then the contractor to supply/use necessary blanking arrangement as required at these tap-off / branch connections.			
It will be the responsibility of the Contractor to operate the Steam Generator and its accessories equipment to generate adequate steam at the parameter and quality in line with the requirements of steam blowing procedure. The Contractor shall make adequate provisions for temporary enhancement of fuel oil firing capacity of the steam generators by changing oil gun tips etc. as may be required so as to be able to conduct complete steam blowing operation by oil firing alone. All necessary precautions to avoid fires and cold end corrosion of Air preheater, during such oil firing at enhanced SG loads, shall be taken by the Contractor.				
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9	SUB-SECTION- A-26 PRE-COMMISSIONING & COMMISSIONING ACTIVITIES	PAGE 4 OF 13

CLAUSE NO.	TECHNICAL REQUIREMENTS
	The Contractor shall ensure successful and timely completion of steam blowing of all systems and will render all help/services as required including: (i) Services of test/operating personnel/supervisors. (ii) Extending all cooperation during erection, pre-commissioning of plant and equipment to be made ready and operational before starting steam blowing. (iii) Extending all cooperation for interface engineering of equipments/components of temporary system required for steam blowing operation. (iv) Contractor's engineers shall be available for all coordination meetings arranged by the Employer for finalizing the details of temporary system for steam blowing. For the steam blowing operation, steam conditions like pressure, temperature etc. at the Steam Generator outlet shall be so selected that a minimum cleaning ratio/ disturbance factor of 1.6 is achieved. A cycle of heating, cooling and blowing/ purging, is to be repeated to ensure thorough cleaning of the interior of the pipes/ tubes etc. The final indication of cleanliness shall be demonstrated by purging through target plates positioned at the discharge point. 3.02.05 BAG FILTER Complete pre-commissioning work including tests of facilities such as air and gas tightness tests of bag filter, pressure drop test of bag filter, gas distribution test of bag filter etc. and all other tests as mutually agreed in the Contractor's quality assurance program as well as those identified in the specification. 3.02.06 Any other pre-commissioning activity such as floating of safety valves etc. as considered essential for readiness of facilities for commencement of commissioning activities shall also be undertaken by the Contractor. 3.03.00 Demonstration/Acceptance tests during Commissioning/Initial Operation The following tests shall be demonstrated during commissioning for which the bidder has to furnish the procedure and get the approval of the employer: 3.03.01 Start-up, Loading, Unloading and Shutdown Capabilities (For Turbine Generator) (i) Unit Start Up Start-up time (upto full load), and loading capabilities for the Turbine Generator together for cold start conditions, warm start conditions and hot start conditions as indicated by the Contractor in the offer and accepted by the EMPLOYER shall be demonstrated, ensuring that the various turbine operational parameters like vibration, absolute and differential expansion, eccentricity and steam-metal temperature mismatch etc. are within design limits. (ii) Sudden Total Loss of External Load On occasions, the steam turbine generator unit may experience sudden total loss of all external load. Under these conditions, the steam turbine generator unit shall not trip but shall continue to be in operation under the control of its speed governor to supply power for the plant auxiliary load with HP bypass in operation while staying within the agreed limits of steam to metal temperature mismatch, exhaust hood temperature, absolute and differential expansion, vibration and eccentricity. The
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9 SUB-SECTION- A-26 PRE-COMMISSIONING & COMMISSIONING ACTIVITIES PAGE 5 OF 13

CLAUSE NO.	TECHNICAL REQUIREMENTS			
3.03.02	(iii)	Steam Metal Temperature Mismatch Limitation	same shall be demonstrated. Further, the provisions of Part-B, Section-VI, shall also be complied with.	
	(iv)	Different load points	The steam-metal temperature differential for cold, warm and hot start up , loading / unloading and shutdown conditions shall be within the permissible limits indicated by the Bidder in the offer and accepted by the Employer.	
3.03.03	Turbine Generator Set Capability		The steam turbine generator unit shall be capable of delivering at generator terminals the output as indicated by the BIDDER in the heat balances submitted along with his bid, under the following condition.	
	(a)	Maximum continuous output at generator terminals corresponding under rated steam conditions, at a specified WBT & RH at cooling tower and 3% make up.		
3.03.03	Turbine Auxiliaries			
	(i)	H.P Bypass Capabilities	The HP Bypass system should satisfy the following functional requirements under automatic interlock action. It should come into operation automatically under the following conditions:	
3.03.03	(a)	Generator circuit breaker opening.		
	(b)	HP stop valves closing due to turbine tripping.		
3.03.03	(c)	Sudden reduction in demand to house load (if applicable).		
	Under all these conditions, while passing the required steam flows as per the relevant heat balances, the condenser should be able to swallow the entire steam without increasing the exhaust hood temperature and condenser pressure beyond the maximum permissible value indicated by the BIDDER in his offer and accepted by the EMPLOYER. The same shall be demonstrated.			
3.03.03	(ii)	Steam Condensing Plant for main turbine		
	(a)	Temperature of condensate, at outlet of condenser, shall not be less than saturation temperature corresponding to the condenser pressure at all loads.		
3.03.03	(iv)	Feed water heaters (if applicable) & Deaerator		
	(a)	TTD's and DCA's of feed water heaters in line with HBD heat balance shall be demonstrated.		
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9		SUB-SECTION- A-26 PRE-COMMISSIONING & COMMISSIONING ACTIVITIES
PAGE 6 OF 13				

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	(b)	Dissolved O2 content in Deaerator effluent at deaerator outlet without chemical dosing at all loads, not to exceed 0.005 CC/ litre determined as per ASTM-D-888 - Reference method-A or Indigo Carmine method.		
	(c)	Difference between saturation temperature of steam entering the deaerator and temperature of feed water leaving deaerator.		
	(v)	Condensate Extraction Pumps		
	(a)	Each CEP set shall be capable of delivering flow & total dynamic head corresponding to runout point as specified.		
	(b)	The vibration, noise level and parallel operation of any two of the three pumps shall be demonstrated.		
	(vi)	Drip Pumps (if envisaged)		
	(a)	Each drip pump shall be capable of delivering flow & total dynamic head corresponding to design point as specified.		
	(b)	The vibration and noise level shall be demonstrated.		
	(vii)	Boiler feed pumps		
	(a)	Each boiler feed pump set shall be capable to deliver flow and total dynamic head corresponding to runout point as specified elsewhere.		
	(b)	The vibration, noise level and parallel operation of any two of the three pumps shall be demonstrated as per specification requirements.		
3.03.04	Balance Pumps, Blowers, Fans, Compressors and rotating equipment.			
	a)	The vibration, noise level and parallel operation, wherever applicable, of the pumps, blowers, fans, compressors and rotating equipment shall be demonstrated.		
	b)	Pumps, blowers, fans, compressors and rotating equipment shall be capable of delivering flow and head corresponding to design point as specified.		
3.03.05	Demonstration of boiler operation, rate of change of load and sudden load change withstand capability			
	Refer Sub section-A-02 and A-03 ,Part-B(Mechanical), Section VI of Technical Specification..			
3.03.06	No fuel gas support shall be required above 60% of waste throughput			
	Contractor shall demonstrate that oil support for flame stabilization shall not be required beyond 60% of waste throughput load when firing the waste fuel from the range identified.			
3.03.09	Capabilities of all drives			
	After completion of installation of drives, contractor shall demonstrate the capability of all drives as specified elsewhere in Section VI Part B of Technical Specifications.			
3.03.10	Margin on Fans			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9	SUB-SECTION- A-26 PRE-COMMISSIONING & COMMISSIONING ACTIVITIES	PAGE 7 OF 13

CLAUSE NO.	TECHNICAL REQUIREMENTS			
3.03.11	After completion of installation of fan drives, Fans, inlet and outlet ducting, measuring equipments etc. contractor shall demonstrate the margin on seal air fans, primary fans, Forced draft fans and induced draft fans as specified elsewhere in Section VI Part B of Technical Specifications. Cold Air Velocity Test (CAVT) A CAVT shall be conducted on each Steam Generator during commissioning before its initial operation to establish the average cold air velocity and the velocity distribution at minimum three predetermined sections (Employer's Choice) of steam generator. The data obtained from the CAVT will be used to compute the actual flue gas velocities as well as their distribution at the test sections during actual operation by correlating the CAVT data with the test/computed data from Thermal Performance Test as per Clauses 1.03.04 (iii) sub section-IV, Section-VI- Part-A. Should the CAVT results after this correlation with TPT data indicate actual localized high flue gas velocity zones/ mal-distribution of gas flow and/or flue gas laning, suitably designed stainless steel screens at required SG cross sections shall be provided by the Contractor to bring the deviation of the localized gas velocity within $\pm 20\%$ of average gas velocity specified. Through this test the Contractor shall also demonstrate the compliance with the specification requirements regarding the maximum allowable flue gas velocities at various sections of the Steam Generator, refer sub-sectdion-A-03, Part-B of Technical Specifications. The detailed CAVT procedure shall be to Employer's approved. The Contractor shall submit a detailed CAVT report and the computations of actual velocities after correlating CAVT data with TPT data to the Employer for approval.			
3.03.13	Performance characteristic of fans (PA/FD/ID fan capacity, head developed, etc.)			
3.03.14	Passenger & good elevators for steam generator – overload tests, travel and hoist speed checks.			
3.03.16	Bag filter Air in Leakage Contractor shall demonstrate that Bag filter air in leakage shall be limited to 1% of the total gas flow under guarantee point condition.			
3.03.17	Pressure Drop Across Bag filter Contractor shall demonstrate that the maximum flue gas pressure drop across the bag filter under specified guarantee point condition shall not exceed 20 mmwc or as per the vendors proven practice.			
3.04.00	Pre-commissioning & Commissioning activities requiring approval of the employer: (a) Hydraulic Test for STG integral piping, heat exchangers, condenser tubes & condenser, equipment cooling water system pipes and associated equipment etc. shall be done. The hydraulic test of other piping system as per statutory requirement and specified elsewhere shall also be carried out. All equipment needed for the tests shall be furnished by the Contractor. (b) Oil flushing of lube oil system, control & jacking oil system, etc. for turbines shall be done. Entire flushing oil requirement & refilling with fresh oil and other consumables along with flushing equipment shall be met by the Contractor.			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9	SUB-SECTION- A-26 PRE-COMMISSIONING & COMMISSIONING ACTIVITIES	PAGE 8 OF 13

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	(c) High Pressure (HP) bypass tests, vacuum tightness test as per approved procedures shall be done by the Contractor after arranging & lining up of all the necessary equipment by him. (d) Steam blowing & chemical cleaning, as applicable of integral piping of the turbo-generator, Low pressure piping, Power cycle piping & other piping in the scope of the Contractor shall be done by the Contractor. (e) Steam blowing & chemical cleaning, as applicable of integral piping of CEP sets & other piping in the scope of the Contractor shall be done by the Contractor. (f) All tests and activities pertaining to the CEP and its drive as per manufacturer's recommendations and as given in the chapter and covered in the specification. (g) Steam blowing & chemical cleaning, as applicable of integral piping of Drip Pump sets & other piping (if applicable) shall be done by the Contractor. (h) All tests and activities pertaining to the Drip Pump and its drive (if applicable) as per manufacturer's recommendations and as given in the chapter and covered in the specification. (i) Steam blowing & chemical cleaning, as applicable of integral piping of the Heaters & other components shall be done by the Contractor. (j) All tests and activities pertaining to the Heater as per manufacturer's recommendations and as given in the chapter and covered in the specification. (k) Oil flushing of lube oil system, control & jacking oil system, for BFP sets shall be done. Entire flushing oil requirement & refilling with fresh oil and other consumables along with flushing equipment shall be met by the Contractor. (l) Steam blowing & chemical cleaning, as applicable of integral piping of BFP sets & other piping shall be done by the Contractor. (m) All tests and activities pertaining to the BFP and its drive as per manufacturer's recommendations and as given in the chapter and covered in the specification. (n) Hydraulic Test for all low and high pressure piping, equipment cooling water system pipes and associated equipment etc. shall be done as per statutory requirement and specified elsewhere shall be carried out. All equipment needed for the tests shall be furnished by the Contractor. (o) All tests and activities pertaining to the Generator and Excitation as per manufacturer's recommendations and covered in the specification. (p) All tests and activities pertaining to the Generator Auxiliaries viz Primary water system, Seal oil system, Gas system etc., as per manufacturer's recommendations and covered in the specification. (q) Any other pre-commissioning checks/ tests and activities as described below and also those mutually agreed between the Contractor & the Employer shall be undertaken.			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9	SUB-SECTION- A-26 PRE-COMMISSIONING & COMMISSIONING ACTIVITIES	PAGE 9 OF 13

CLAUSE NO.	TECHNICAL REQUIREMENTS			
3.05.00	COMMISSIONING OF FACILITIES General Upon completion of pre-commissioning activities/test the Contractor shall initiate commissioning of facilities. During commissioning the Contractor shall carryout system checking and reliability trials on various parts of the facilities. 			

CLAUSE NO.	TECHNICAL REQUIREMENTS			
3.05.02	(i) Checks on correct functioning of the Combustion control system (as per vendors proven method). (k) Calibration tests of orifice, flow nozzles, instruments and control equipment to the extent included in these specifications. (l) Tests on Control & Instrumentation (C&I) Equipments:			
	LIST OF TEST / ACTIVITIES TO BE PERFORMED ON TG & AUXILIARY (but not limited to folowing) A) COMMISSIONING TESTS/CHECKS 1. Test running of all pumps 2. Condenser vacuum test, feed water heater operational tests (if applicable) & checking of all parameters as per approved heat balance diagrams. 3. Test for HP bypass valves operation & their control system. 4. Test for operation of governing control system for turbines. 5. Standard commissioning tests and procedures as per Contractor's practice for steam turbine generator and other equipment / auxiliaries within the Contractor's scope of work. 6. Checks on operation of all individual control loops in the turbine generator control system. 7. Checks on correct functioning of the Turbine Protection System (TPS), Turbine Supervisory Control System (TSCS) for main turbine, Automatic Turbine Run-up System (ATRS), Automatic Testing of Turbine (ATT) (if applicable) 8. Standard commissioning tests and procedures as per Contractor's practice for CEP and other equipment / auxiliaries within the Contractor's scope of work. 9. Checks on operation of all individual control loops in the CEP control system. 10. Standard commissioning tests and procedures as per Contractor's practice for Drip Pump (if applicable) and other equipment / auxiliaries within the Contractor's scope of work. 11. Checks on operation of all individual control loops in the Drip Pump control (if applicable) system. 12. Feed water heater (if applicable) operational test for establishing correct cascaded flow, heater water levels and checking of all parameters as per approved heat balance diagram.			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9	SUB-SECTION- A-26 PRE-COMMISSIONING & COMMISSIONING ACTIVITIES	PAGE 11 OF 13

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	13.	Standard commissioning tests and procedures as per contractor's practice for heaters and de-aerator and other equipment/auxiliaries within the contractor's scope of work.		
	14.	Checks on operation of all individual control loops in the heater and deaerator control system.		
	15.	Standard commissioning tests and procedures as per Contractor's practice for BFP and other equipment / auxiliaries within the Contractor's scope of work.		
	16.	Checks on operation of all individual control loops in the BFP control system.		
	17.	Calibration tests of orifice, flow nozzles, instruments and control equipment to the extent included in these specifications.		
	18.	Checks on operation of all rotating equipments to ascertain level of noise and vibration		
	19.	Checks on operation of all static equipments to ascertain level of noise and vibration		
	20.	Standard commissioning tests and procedures as per manufacturer's practice for Generator, Excitation and its auxiliaries within the Contractor's scope of work.		
3.06.00	Balance of Plant equipment & systems			
	All pre-commissioning tests & activities as required for successful running of the equipment or as mentioned in the technical specification elsewhere shall be performed by the contractor.			
4.00.00	Initial Operation			
	Upon completion of system checking/tests and as a part of commissioning of facilities, complete plant/facilities shall be put on initial operation for a period of thirty (30) days or 720 hours as stipulated in General Technical Requirements.			
5.00.00	The Contractor shall conduct all the commissioning tests and undertake commissioning activities pertaining to all other auxiliaries and equipments including all Electrical & C&I equipment/systems not specifically brought out above but are within the scope of work and facilities being supplied & installed by the Contractor and follow the guidelines indicated above or elsewhere in these technical specifications (Section-VI).			
6.00.00	The Contractor shall conduct the comprehensive guarantee tests on the Steam Generator in co-ordination with the Steam Generator to establish the functional guarantee values at stipulated conditions as per Sub-section-IV, Part-A, Section-VI.			
7.00.00	The Contractor shall conduct all the commissioning tests and undertake commissioning activities pertaining to all other auxiliaries and equipments including all Electrical & C&I equipment/systems not specifically brought out above but are within the scope of work and facilities being supplied & installed by the Contractor and follow the guidelines indicated above or elsewhere in these technical specifications (Section-VI).			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9	SUB-SECTION- A-26 PRE-COMMISSIONING & COMMISSIONING ACTIVITIES	PAGE 12 OF 13

CLAUSE NO.	TECHNICAL REQUIREMENTS			
8.00.00	COMMISSIONING SPARES			
8.01.00	It will be the responsibility of the Contractor to provide all commissioning spares including consumable spares required for initial operation till the Completion of Facilities. The Contractor shall furnish a list of all commissioning spares within 60 days from the date of Notification of Award and such list shall be reviewed by the Employer and mutually agreed to. However, such review and agreement will not absolve the Contractor of his responsibilities to supply all commissioning spares so that initial operation do not suffer for want of commissioning spares. All commissioning spares shall be deemed to be included in the scope of the Contract at no extra cost to the Employer.			
8.02.00	These spare will be received and stored by the Contractor at least 3 months prior to the schedule date of commencement of initial operation of the respective equipment and utilized as and when required. The unutilized spares and replaced parts, if any, at the end of successful completion of guarantee tests shall be the property of the Contractor and he will be allowed to take these parts back at his own cost with the permission of Employer.			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9	SUB-SECTION- A-26 PRE-COMMISSIONING & COMMISSIONING ACTIVITIES	PAGE 13 OF 13

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	ANNEXURE-I			
	STANDARD CHECKLIST This is an indicative list of items. The actual list shall depend on the Equipment / System being supplied by the contractor. MECHANICAL VALVES 1. Manually Operated Valve 2. Electrically Operated Valve 3. Pneumatically Actuated Valve 4. Hydraulically Actuated Valve 5. Safety Valve 6. Electromatic Relief Valve 7. Steam Trap 8. Non Return Valve (including Hydraulic/ Pneumatic QCNRVS) 9. Control Valve 10. Relief Valve 11. Differential Pressure Regulating Valve 12. Butterfly valve (Electrically Operated) 13. Butterfly valve (Manually Operated) 14. Butterfly valve (Fourway -Electrical) 15. One spare EOTV for steam blowing TANKS & PRESSURE VESSELS 1. Tanks (metal) up to 20 M³ 2. Tanks (Large Storage) 3. Pressure Vessel (Below 17 bars) 4. Air Receiver 5. Pressure Vessel – Access Door PUMPS 1. Pump-Low Pressure Centrifugal (Motor driven) 2. Pump-Up to 350HP 3. Pump-Sump installation 4. Gear Pump/Screw pump PIPE WORK SYSTEM 1. Steam services 2. Water services 3. Oil / Fire Resistant fluid system			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9	ANNEXURE-I OF SUB-SECTION- A-26 PRE-COMM. & COMM. ACTIVITIES	PAGE 1 OF 5

CLAUSE NO.	TECHNICAL REQUIREMENTS	एनटीपीसी NTPC	
	4. Air services (Compressor) 5. High pressure services 6. Constant load support 7. Spring supports 8. Leachate system 9. Hangers and other Supports <u>STRAINER AND FILTER</u> 1. Strainer / Filter Basket Type 2. Strainer Rotary (Low Pressure) 3. Filter & Strainers Centrifugal Separators 4. Filter & Strainer Y-Type 5. Filter & Strainer (Plate Type) 6. Purifier 7. Filter – Compressed Air Line <u>HEAT EXCHANGER</u> 1. Heat Exchanger (General) 2. Heat Exchanger – Oil / Water 3. Rotary / tubular Air Heater 4. SCAPH <u>FANS & COMPRESSORS</u> 1. Fans –Non-Pressure Lubricated 2. Fans – Axial Flow / centrifugal flow pressure Lubricated 3. Compressors-General <u>DAMPERS & GATES</u> 1. Manually Operated Damper 2. Pneumatically Operated Damper 3. Electrically Operated Damper 4. Manually Operated Gates 5. Pneumatically Operated Gate 6. Electrically Operated Gate <u>DUCT WORK</u> 1. Air & Flue Gas Ducting 2. Expansion Joints 3. Observation & Access Door <u>CRANES AND ELEVATORS</u> 1. Auxiliary Overhead Crane 2. Travel Support Structure for Crane		
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9	ANNEXURE-I OF SUB-SECTION- A-26 PRE-COMM. & COMM. ACTIVITIES
		PAGE 2 OF 5	

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	3. Long Travel & Cross Traverse Motion of Crane 4. Main Aux. Hoist Motion (Crane) 5. Crane Electric Hoist POWER TRNAMISSION 1. Power Transmission Gear Box 2. Bearings 3. Fluid Couplings BOILER & AUX.SYSTEM 1. Soot Blower Long Retractable 2. Wall Deslagger/Soot Blower 3. Bottom Ash Hopper & extractor 4. Fly Ash Hopper 5. Lubricator –Compressed Air Lines 6. Wind Box Assembly / grate air supply assembly 7. Mixer / Stirrer 8. Compressed Air Breathing Apparatus 9. Gas Burner 10. Ignitors 11. Scanner 12. Manual Lubricators 13. Air Motor (if applicable) 14. Driers-Non Regenerative /Regenerative 15. Waste pit 16. Waste crane 17. Flue gas conditioning tower 18. Lime, activated carbon, urea / ammonia injection system 19. Bag filter 20. Grate actuator system 21. SNCR DeNOx system ELELCTRICAL 1. D.C. Motor 2. HV Squirrel Cage Induction Motor 3. 415 V Squirrel Cage Induction Motor 4. Motor Operated Actuators 5. Soot Blower (Deslagger) 6. Soot Blower (Long Retractable)			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9	ANNEXURE-I OF SUB-SECTION- A-26 PRE-COMM. & COMM. ACTIVITIES	PAGE 3 OF 5

CLAUSE NO.	TECHNICAL REQUIREMENTS	एनटीपीसी NTPC			
	7. Soot Blower (any other in air heater if any) 8. Aux. Control and Relay Panel Desk 9. LT SWITCHGEARS/MCC a) STANDARD CHECLISTS FOR ALL TYPES OF RELAYS USED IN SWITCHGEARS PROTECTION SYSTEM B) PT CARRIAGE AND CUBICLES C) CABLE/BUS DUCT/BUS BARS D) CONTRACTOR MODULE E) SWITCH FUSE MODULE F) MASTER PANEL OF LUBE OIL PANEL G) FEEDER PANEL OF LUBE OIL PANEL H) SPACE HEATER AND CABLE MODULE I) HT CIRCUIT BREAKER J) 415 V CIRCUIT BREAKER K) POWER CABLE L) AUXILIARY CABLE M) D.C. CABLE N) EXPLOSION PROOF ELECTRICAL EQUIPMENT O) JUNCTION BOX P) CONTROL TRANSFORMER MODULE Q) BRUSH GEAR ASSEMBLY R) AUX. CONTROL AND RELAY PANEL DESK S) INDICATING INSTRUMENT T) RECORDING INSTRUMENT u) INTEGRATING INSTRUMENT CONTROL & INSTRUMENTATION 1. Conductivity Measuring Equipment Including Test Procedures 2. pH Analyser Including Test procedure 3. Silica Analyser 4. Level Switch (Float Actuated) 5. Level Switch (Electrode Type) 6. Level Switch (Displacer Actuated) 7. Transmitter (Float Operated Pneumatic Output including Testing procedures 8. Level indicator (Float/Pulley Type) 9. Local Temperature Indicator Including Test Procedure 10. Resistance Thermometer Element Including Test procedure 11. Thermocouple Element and Connecting Cable 12. Thermocouple and Resistance Thermometer Convertor/Transmitter Including Test Procedures 13. Temperature Switch Including Test Procedure 14. Cold Junction Boxes 15. O₂, CO₂, CO, TOC, ph, H₂O, SO_x, NO_x, Dust, Hg etc., Analyser 16. Pressure and Vacuum Gauge	KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9	ANNEXURE-I OF SUB-SECTION- A-26 PRE-COMM. & COMM. ACTIVITIES	PAGE 4 OF 5

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	17. Pressure and Vacuum Switch Including Test procedures 18. Differential Pressure Transmitter including Test Procedures 19. Differential pressure switch including Test procedures 20. Flow indicator (Variable Area) 21. Orifice plate 22. Flow Switch 23. Nozzle 24. Flow Integrator (pneumatic input) including test procedure 25. Flow indicator (Float Operated) Including Test Procedure 26. Venturi (Fluid) 27. Flow Switch (Magnetic Type) 28. Limit Switches 29. Turbine Supervisory Measuring System 30. Position Measurement & Indication Including Test procedures 31. Vibration Measurement 32. Digital Indicator 33. Moving Coil Indicator Including Test Procedures 34. Recorder Including Test procedure 35. Flame Scanner 36. Electrical Auto Manual Control Station 37. Push Button Module 38. Test Procedure for Electronic Modules of DDCMIS 39. Alarm Annunciator Equipment Including Test Procedure 40. Test procedure for Adjustment of Modulating Controller-PID Term 41. Test Procedure Indicating Controller-Electrical Input & Pneumatic Output			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9	ANNEXURE-I OF SUB-SECTION- A-26 PRE-COMM. & COMM. ACTIVITIES	PAGE 5 OF 5

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	ANNEXURE-V BRIEF WRITE UP ON THE CONTENTS OF TESTING / COMMISSIONING PROCEDURE Testing / Commissioning Procedure is required to be of a standard format in order to maintain consistency of presentation, content and reporting. These should contain the following sections to make the document a self contained one. 1. Plant Details / Design data 2. Objective 3. Proposal 4. Services Required 5. Safety Precautions / safety protocol 6. Emergency Procedures 7. State of the Plant (Status in respect of erection completion of Mech, Elect and C&I items) 8. Method 9. Completion / Acceptance Criteria 10. Appendix • Result • Log sheet • Drawing etc.			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9	ANNEXURE-V SUB-SECTION- A-26 PRE-COMM. & COMM. ACTIVITIES	PAGE 1 OF 1

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	ANNEXURE-IV			
	Demonstration/Acceptance tests during Commissioning/Initial Operation			
	The following tests shall be demonstrated during commissioning for which the bidder has to furnish the procedure and get the approval of the employer:			
	1. Start-up, Loading, Unloading and Shutdown Capabilities (For Turbine Generator) 2. Turbine Generator Set Capability 3. Turbine Auxiliaries 4. Balance Pumps, Blowers, Fans, Compressors and rotating equipment. 5. Balancing of Primary / Secondary air flow 6. Demonstration of boiler operation, rate of change of load and sudden load change withstand capability 7. Steam Temperature Imbalance 8. No fuel oil support shall be required above 60% Waste throughput 9. Capability of all drives 10. Margin on Fans 11. Cold Air Velocity Test (CAVT) 12. Flue gas Emission parameters as per required level mentioned in specification. 13. Thermal Load range diagram points LP1 to LP 5 and LP design. (LP – Load point) 14. DeNOx SNCR capability 15. Waste grab crane capability 16. Waste feed hopper capability – without chocking / arching / building 17. Furnace temperature with residence as per Indian norms (SWM 2016)			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9		ANNEXURE-IV SUB-SECTION- A-26 PRE-COMM. & COMM. ACTIVITIES
PAGE 1 OF 1				

CLAUSE NO.	 TECHNICAL REQUIREMENTS																																										
	ANNEXURE-III COMMISSIONING PROCEDURES REQUIRING APPROVAL OF CORPORATE OS DIVISION OF EMPLOYER <table border="1"> <thead> <tr> <th>S.NO.</th><th>DESCRIPTION</th></tr> </thead> <tbody> <tr><td>1.</td><td>BOILER HYDRAULIC TEST & PRESERVATION</td></tr> <tr><td>2.</td><td>OIL FLUSHING OF LUB OIL SYSTEM OF ROTARY EQUIPMENTS</td></tr> <tr><td>3.</td><td>DETERGENT FLUSHING OF PRE-BOILER AND CONDENSATE SYSTEMS</td></tr> <tr><td>4.</td><td>AIR & GAS TIGHTNESS TEST FOR FURNACE AND DUCTS</td></tr> <tr><td>5.</td><td>AIR IN LEAK TEST OF BAG FILTER</td></tr> <tr><td>6.</td><td>CHEMICAL CLEANING OF BOILER</td></tr> <tr><td>7.</td><td>STEAM BLOWING & OIL FLUSHING OF FUEL OIL LINES</td></tr> <tr><td>8.</td><td>STEAM BLOWING OF BOILER, ASSOCIATED STEAM LINES & AUX STEAM LINES</td></tr> <tr><td>9</td><td>COMMISSIONING OF GRATE FEEDING SYSTEM</td></tr> <tr><td>10</td><td>COMMISSIONING OF FLUE GAS CONDITIONING TOWER</td></tr> <tr><td>11</td><td>FLUSHING & HYDRAULIC TEST OF TG LUB OIL & JACKING OIL SYSTEMS</td></tr> <tr><td>12</td><td>FLUSHING & HYDRAULIC TEST OF CONTROL FLUID SYSTEM</td></tr> <tr><td>13</td><td>OIL FLUSHING OF LUB OIL SYSTEM OF MDBFP</td></tr> <tr><td>14</td><td>COMMISSIONING OF HP BYPASS SYSTEM</td></tr> <tr><td>15</td><td>COMMISSIONING OF GRATE AND ITS HYDRAULIC SYSTEM</td></tr> <tr><td>16</td><td>COMISSIONING OF WASTE CRAB CRANE / ASH CRANE</td></tr> <tr><td>17</td><td>FLUSHING & HYDRAULIC TEST OF GENERATOR PW SYSTEM</td></tr> <tr><td>18</td><td>GENERATOR AIR TIGHTNESS TEST</td></tr> <tr><td>19</td><td>CONDENSER FLOOD TEST & VACUUM TIGHTNESS TEST</td></tr> <tr><td>20</td><td>GENERATOR TESTING PROCEDURE FOR 1ST SYNCHRONISATION</td></tr> </tbody> </table>	S.NO.	DESCRIPTION	1.	BOILER HYDRAULIC TEST & PRESERVATION	2.	OIL FLUSHING OF LUB OIL SYSTEM OF ROTARY EQUIPMENTS	3.	DETERGENT FLUSHING OF PRE-BOILER AND CONDENSATE SYSTEMS	4.	AIR & GAS TIGHTNESS TEST FOR FURNACE AND DUCTS	5.	AIR IN LEAK TEST OF BAG FILTER	6.	CHEMICAL CLEANING OF BOILER	7.	STEAM BLOWING & OIL FLUSHING OF FUEL OIL LINES	8.	STEAM BLOWING OF BOILER, ASSOCIATED STEAM LINES & AUX STEAM LINES	9	COMMISSIONING OF GRATE FEEDING SYSTEM	10	COMMISSIONING OF FLUE GAS CONDITIONING TOWER	11	FLUSHING & HYDRAULIC TEST OF TG LUB OIL & JACKING OIL SYSTEMS	12	FLUSHING & HYDRAULIC TEST OF CONTROL FLUID SYSTEM	13	OIL FLUSHING OF LUB OIL SYSTEM OF MDBFP	14	COMMISSIONING OF HP BYPASS SYSTEM	15	COMMISSIONING OF GRATE AND ITS HYDRAULIC SYSTEM	16	COMISSIONING OF WASTE CRAB CRANE / ASH CRANE	17	FLUSHING & HYDRAULIC TEST OF GENERATOR PW SYSTEM	18	GENERATOR AIR TIGHTNESS TEST	19	CONDENSER FLOOD TEST & VACUUM TIGHTNESS TEST	20	GENERATOR TESTING PROCEDURE FOR 1 ST SYNCHRONISATION
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TESTING / COMMISSIONING PROCEDURES

Following is an indicative list of equipments / systems for which Testing / Commissioning procedures are to be submitted. The actual list will depend on the equipment / system being supplied by the Contractor.

S. No	DESCRIPTION
Boiler	
1.	ID Fan
2.	FD Fan
3.	PA Fan
4.	Air Heater
5.	Scanner Air Fans
6.	Grate Firing System
7.	Gas burner System
8.	Soot Blower System
9.	Aux. Steam System
10.	Waste crane & ash crane System
11.	HP Bypass System
12.	Secondary and primary control dampers and system
13.	Boiler Chemical Analysis Equipment
14.	SH Spray system
15.	Chemical Dosing System
16.	Boiler Air and Gas System -Interlock Operation
17.	Boiler Start-up system
18.	Waste Feeders (Ram feeder)
19.	Bag Filter

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	20.	Dosing System for chemicals		
	21.	Seal Air Fans / burner sealing / cooling fan		
	22.	SNCR (DeNOx system)		
	23.	Flue gas conditioning system		
	24.	Boiler Safety Valves		
	LIST OF TEST / ACTIVITIES TO BE PERFORMED ON TG & AUXILIARY			
	(BUT NOT LIMITED TO THE FOLLOWING)			
	A) TESTING SCHEDULES			
	1.	TURBINE ON BARRING GEAR		
	2.	BEARING AND JACKING OIL INITIAL CIRCULATION (if applicable)		
	3.	HP BYPASS SYSTEM		
	4.	GOVERNOR OIL CONTROL SYSTEM		
	5.	VACUUM RAISING PLANT		
	6.	CONDENSER SYSTEM		
	7.	CENTRAL OIL PURIFICATION PLANT		
8.	HYDRAULIC TEST PROCEUDRE FOR			
	A)	LUB OIL SYSTEM		
	B)	CONTROL OIL & JACKING OIL SYSTEM		
	C)	GENERATOR SEAL OIL SYSTEM (if applicable)		
	D)	GENERATOR STATOR WATER SYSTEM (if applicable)		
	E)	GENERATOR GAS SYSTEM (Alternatively, pneumatic test with suitable leak detection method shall also be acceptable subject to owner's approval)		
	F)	HEATERS		
10.	OIL FLUSHING OF LUB OIL SYSTEM			
11.	OIL FLUSHING OF CONTROL & JACKING OIL SYSTEM			
12.	OIL FLUSHING OF GENERATOR SEAL OIL SYSTEM (if applicable)			
13.	ALKALI FLUSHING FOR CONDENSATE SYSTEM			
KAWAS WTE PROJECT (2 X 350 TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-A BID DOC. NO.: CS-2600-001-9		ANNEXURE-II SUB-SECTION- A-26 PRE-COMM. & COMM. ACTIVITIES
PAGE 2 OF 4				

CLAUSE NO.	 TECHNICAL REQUIREMENTS
	14. HP BYPASS SYSTEM 15. CONDENSER FLOOD TEST 16. CONDENSER VACUUM TIGHTNESS TEST 17. STEAM BLOWING OF GLAND SEAL PIPE LINES, AUX. STEAM PIPELINE 18. CEP 19. Drip Pump (if applicable) 20. HEATER 21. DEAERATOR 22. BFP 23. BEARING AND JACKING OIL INITIAL CIRCULATION 24. GOVERNOR OIL CONTROL SYSTEM 25. HYDRAULIC TEST PROCEDURE FOR A) LUB OIL SYSTEM B) CONTROL OIL & JACKING OIL SYSTEM C) WATER SYSTEM D) HEAT EXCHANGERS 26. OIL FLUSHING OF LUB OIL SYSTEM 27. OIL FLUSHING OF CONTROL & JACKING OIL SYSTEM 28. STEAM BLOWING OF GLAND SEAL PIPE LINES, AUX. STEAM PIPELINE 29. HT MOTORS B) COMMISSIONING SCHEDULE 1. Turbine Gland sealing system for Main Turbine (if applicable) 2. HP Bypass system 3. Turbine Initial Run up for Main Turbine 4. Lube Oil / Governing Oil System for Main Turbine 5. LP HEATERS 6. HP HEATERS (if applicable) 7. DEAERATOR STEAM OPERATION

CLAUSE NO.

TECHNICAL REQUIREMENTS

8. Lube Oil / Governing Oil System for BFP
9. Generator and excitation system
10. Generator seal oil system (if applicable)
11. Generator stator water system
12. Generator gas system

OFFSITE	
1.	Raw Water System
2.	Clarified Water System
3.	DM Plant
4.	Cooling Tower
5.	Compressed Air System
6.	Fire Protection & Detection System
7.	Air Conditioning and Ventilation System
8.	Ash Handling System • Bottom Ash System • Coarse Ash System(Economiser Ash) • Fly Ash System (ESP and APH) • Ash Disposal System • Ash water System
9.	Fuel Gas System

SUB-SECTION–A-27

VENTILATION SYSTEM

CLAUSE NO.	TECHNICAL REQUIREMENTS			
1.00.00	GENERAL			
1.01.00	This section of specification covers details of system specifications, detailing the areas to be ventilated, basis of design, brief description of the system, equipment and services to be furnished by bidder. The supply, delivery and erection of the entire equipment listed here shall be in bidder's scope of work.			
2.00.00	AREAS TO BE VENTILATED			
2.01.00	The areas to be ventilated by Evaporative Cooling system are as follows:- i) All floors and areas of turbine & Boiler House other than the areas which are air conditioned. ii) Switch gear rooms and cable gallery areas of turbine / Boiler. iii) Any other area where equipment heat load is high and requires ventilation by evaporative cooling process.			
2.02.00	The areas to be ventilated by Mechanical Ventilation process (using Roof extractors/ Supply and/or Exhaust fans) shall consist of but not limited to the following:- i) All the pump Houses like, Fuel oil pressurizing pump house, fuel oil unloading pump house, fire water pump house, hydrant & spray booster pump house, CW pump house, Raw & Make-up water pump house, Ash water pump house, Ash slurry pump house, etc. ii) Battery rooms, Lube oil purification room, non-A/C areas of SWAS room. iii) Switchgear rooms/MCC/Battery rooms in various auxiliary buildings. iv) Air Compressor house. v) Complete Water treatment Plant building facilities such as PT, DM, Chlorination, CW Treatment plant etc. vi) Air Conditioning Plant Equipment areas (vii) A/C plant room, MCC room, Battery room, etc in Service & Administrative building. (viii) Central workshop, Permanent stores, CHP workshop, Canteen, etc. ix) All Toilets & Pantries (to be provided with propeller exhaust fans) x) Battery rooms of various remote I/O rooms. xi) Any other areas which are not covered either by Air-Conditioning system or by Evaporative cooling system.			
3.00.00	Not used			
4.00.00	EQUIPMENT DESCRIPTION - VENTILATION SYSTEM			
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-27 Ventilation System	Page 1 of 24

CLAUSE NO.	TECHNICAL REQUIREMENTS			
4.01.00	Air Washer Unit			
4.01.01	Each double skin Air Washer Units (- Modular Type ,Evaporative System) shall consist of the various Sections such as Air washer chamber / Casing, Tank, Distribution plates, set of metallic/fabric filters at suction, suction louvers, bird screens, water headers, Spray nozzle, piping, pumps, valves, Drift eliminators, Fans, and all other required accessories. Housing/Casing of Air Washer Unit The housing/casing of the Air Washer Unit shall be double skin construction. (25±2)mm thick Double Skin Panels shall be made of 0.80 mm pre-painted sheet on outer side and 0.8 mm Galvanized sheet (275 GSM) inside with 40kgs/cub mtr density, fire retardant P.U. insulation injected in between. This panel shall be screwed on to the aluminum frame work with soft rubber Gasket in between to make the joints air tight. Frame work for each section shall be jointed together with soft rubber gasket in between to make the joints air tight with suitable size air tight access door at various sections for maintenance. The entire fan section housing shall be mounted on rolled formed GSS Channel frame work.			
4.01.02	The air washer tank shall be fabricated from MS plate of minimum 6 mm thick and inside and outside surface of the tank shall be spray galvanized (minimum 60 microns DFT). Minimum depth of the tank shall be 600 mm. Tank construction shall be such that the suction screen can be replaced while the unit is operating. Tank shall be provided with overflow, drain with valve, float valve makeup connection with a gate valve backup, quick fill connection with globe valve etc. The overflow pipe shall be connected to drain pipe after isolating valve on drain pipe.			
4.01.03	The distribution plate shall be fabricated out of 18G galvanised steel sheets & galvanised steel angle supports with minimum 50% free area.			
4.01.04	Air washer shall be two-bank construction (one uni-flow and the other cross flow). All header and stand pipes shall be galvanised. Cat Walks of suitable width shall be provided for maintenance of nozzles.			
4.01.05	The spray nozzles shall be of brass or bronze with chrome plating and shall be self cleaning type. The nozzle shall be designed to produce fine atomised spray and shall be properly spaced to give a uniform coverage of the air washer section. The pressure drop through the nozzle should be in the range of 1.4 to 2.4 Kg/cm2			
4.01.06	The eliminator plates shall be of 24G thick GS sheets class 275 or from 100% virgin PVC of minimum finished thickness of 2 mm. The eliminator section made of GSS shall have minimum six bends. The PVC eliminators shall be UV stabilised using Titanium di-oxide and shall withstand the weathering test as per IS:4892 for 500 hrs. Type test report of the compound testing carried out in any reputed laboratory shall be submitted for approval. All supports, tie rods and space bar shall be of either galvanised steel or PVC construction and shall be complete with suitable drip tray and drain pipe.			
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-27 Ventilation System	Page 2 of 24

CLAUSE NO.	TECHNICAL REQUIREMENTS 
4.01.07	An airtight inspection door of 600mm X 700mm size and a water marine light be provided for each air washer unit.
4.01.08	Suitable number of brass screen shall be provided in the air washer tank to arrest the dirt entering the circulating water pump suction. Suitable GI grid shall be used inside the screen for reinforcement
4.01.09	The specification for centrifugal fans shall generally be as indicated below. However, the fan shall be of DIDW type for turbine & Boiler House.
4.01.10	Saturation efficiency of Air Washer units shall be minimum 90%.
4.02.00	Not used
4.03.00	Centrifugal Fan
4.03.01	The casing shall be of welded construction fabricated with heavy gauge galvanised sheet steel or MS sheet with spray galvanization (minimum 60 micron DFT). The minimum thickness of casing shall be 3 mm. It shall be rigidly reinforced and supported by structural angles. The seams shall be permanently sealed air-tight. Split casings shall be provided on larger sizes of fans. Casing drain with valves shall be provided wherever required.
4.03.02	The impeller shall have die-formed backward-curved blades tie welded to the rim and back plate to have a non overloading characteristic of the fan. Rim shall be spun to have a smooth contour. If required intermediate stiffening rings shall be provided. Shaft sleeves shall be furnished wherever required. The impeller, pulley and shaft sleeves shall be secured to the shaft by key and/or nuts.
4.03.03	The bearing shall be self aligning, heavy duty ball, roller or sleeve bearing. They shall be adequately supported. They shall be easily accessible and lubricated properly from outside.
4.03.04	Inlet guard shall be spun to have a smooth contour. Inlet screen, if provided, shall be of galvanised wire mesh of 25 mm square.
4.03.05	Base plate with necessary number of spring type vibration isolators or ribbed neoprene rubber pad or cushy foot mounting shall be provided. The vibration isolators should have a minimum of 70% efficiency.
4.03.06	The first critical speed of the rotating assembly shall be at least 25% above the opening speed.
	The fans shall be provided with V-belts and sheaves. All belts shall be sized for 150% rated HP. All V-belt shall be equipped with removable belt guards that do not impede the air flow to the fan inlet. There shall be a minimum of two belts per drive.
4.04.00	Axial Fans
4.04.01	These fans shall have fixed / variable pitch cast aluminum blades of aerofoil design.
4.04.02	The fan casing shall be of heavy gauge sheet steel construction.
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9
Sub Section-A-27 Ventilation System	Page 3 of 24

CLAUSE NO.	TECHNICAL REQUIREMENTS 
4.04.03	Necessary rain protection cowl, inlet and outlet cones, bird protection screen, adjustable damper, vibration isolators, back draft dampers etc. shall be provided.
4.04.04	The speed of the fan shall not exceed 960 rpm for fan with impeller diameter above 450 mm and 1400 rpm for fan with impeller diameter 450 mm or less. However for fans having static pressure of 30 mm WC or above the speed of the fan shall not exceed 1440 rpm for fan with impeller diameter of above 450 mm and 2800 rpm for fan with impeller diameter of 450 mm or less. The first critical speed of rotating assembly shall be atleast 25% above the operating speed.
4.04.05	All other accessories like supporting structure etc. as required shall be provided.
4.04.06	Fans of capacity 1000 m ³ /hr & lower shall be of propeller exhaust type.
4.05.00	Roof Ventilators
4.05.01	The roof extractors shall be “COWL” type.
4.05.02	Impeller shall be of axial flow type, cast Aluminium in one piece and dynamically balanced. Casing shall be heavy gauge sheet steel construction of 3 mm thick for impeller upto 750 mm diameter and 5 mm for fans with impeller of diameter 750 and above. In casing, access door with locking arrangement be provided.
4.05.03	The cowl shall be designed for weather protection of the fan also inside of the roof on which the extractor is installed. Galvanised bird screen of 15 mm Square be provided with the cowl. All accessories, steel supports as required will be provided.
4.05.04	The speed of the fan be limited as per limitation given above for axial fans.
4.05.05	All accessories rain protection exhaust hood, transformation piece, vibration isolators, steel supports vibration isolators, bird screen, etc. as required shall be provided.
4.05.06	The vibration level for fans shall be as per ISO: 14694.
4.06.00	BALANCE EQUIPMENT SPECIFICATION
4.06.01	Centrifugal Pumps a) Type : Horizontal Centrifugal, Axially split type casing pump b) Impeller : Closed type c) Material of Construction : i) Casing : 2% Ni Cast Iron : IS:210 Gr. FG-260 ii) Impeller : Bronze IS:318 Gr-2 iii) Wearing rings : Bronze iv) Shaft : SS 316
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9
Sub Section-A-27 Ventilation System	Page 4 of 24

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
4.06.02	v) Shaft sleeve	:	SS 316	
	vi) Lantern ring	:	Brass / Bronze	
	vii) Packing	:	Asbestos	
	viii) Base Plate	:	Carbon steel as per IS:2062	
	ix) Speed	:	Maximum 1500 rpm	
	Other requirements	:	To refer to Annexure-I titled “Horizontal Pumps” of this sub section.	
	Piping and Fittings (Material & Standard)			
	a) Circulating water piping of Ventilation System	:	Heavy grade-IS: 1239 or Equivalent upto150 NB and IS: 3589 or Equivalent for pipes beyond 200 NB with thickness as detailed at Annexure-II . The piping upto 100 mm diameter shall be of galvanized steel (galvanization shall be as per IS: 4736) and those above 100 mm dia. shall be black steel. The piping shall be adequately supported.	
	b) Drain piping	:	Same as (a) above & galvanised as per IS: 4736.	
	c) Fittings	:	1) The steel fittings shall conform to ASTM A234 Gr WPB and dimensional standard to ANSI B 16.9/ANSI B16.11 / Equivalent for sizes 65 NB and above. 2) For sizes 50 NB and below, the material shall conform to ASTM A-105. 3) All steel flanges shall be of slip on type and shall conform to ANSI B 16.5 4) For pipe sizes above 350 NB, fabricated fittings from sheets of adequate thickness may be used. The bend radius in case of mitre bends shall be minimum 1.5 times the nominal pipe diameter and angle between two adjacent sections shall not be more than 22.5 deg and shall be as per BS:2633/BS:534. 5) Fittings, flanges and pipe joints of refrigerant piping shall conform to	
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-27 Ventilation System	Page 5 of 24

CLAUSE NO.	TECHNICAL REQUIREMENTS एनटीपीसी NTPC
	ANSI B31.5 4.07.00 VALVES 4.07.01 Technical data sheet of the various types of valves (Gate, Globe, Butterfly and check valve) shall be as per Annexure – III. 4.07.02 Valves shall have full sizes port and suitable for horizontal and as well as vertical installation. 4.07.03 Valves for regulating duty shall be of globe type suitable for controlling throughout its lift. 4.07.04 All safety /relief valves shall be so constructed that the failure of any part does not obstruct the free discharge. 4.07.05 Valves shall be furnished with back seating arrangement for replacing while working under full working pressure. 4.07.06 Manual gear operators be provided for valves of size 250 NB and above in case of Gate valve & Globe valve. 4.07.07 All valves shall be supplied with companion flanges, nut bolts & washers etc. 4.08.00 AIR FILTERS 4.08.01 Pre Filter 1) Type : Flange / Cassette 2) Pre-filter shall contain washable non-woven synthetic fibre or High density Polyethylene (HDPE) media having 18G GSS / 16G Al alloy frame. The filter media shall be supported with HDPE mesh on air inlet side & Aluminium expanded metal on exit side or G.I. wire mesh on both sides. 3) Other requirements : (as applicable) a) Suitable aluminium spacers be provided for uniform air flow; b) Casing shall be provided with neoprene sponge rubber sealing. c) Capable of being cleaned by water flushing. d) Density of filter medium shall increase in the direction of air flow in case of metallic filter. e) Filter media shall be fire retardant and resistant to moisture, fungi, bacteria & frost. 4) Efficiency : Average arrestance of 65 - 80 % when tested in accordance with
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9 Sub Section-A-27 Ventilation System Page 6 of 24

CLAUSE NO.	TECHNICAL REQUIREMENTS			
4.08.02	BS:6540/ASHRAE – 52 – 76 / EN-779.			
	5)	Minimum thickness	:	50 mm
	6)	Face Velocity	:	Not more than 2.5 m/sec.
	7)	Pressure drop	:	Initial pressure drop - Not to exceed 5.0 mm WC at rated flow.
				Final pressure drop - Upto 7.5 mm WC.
	Fine Filters (Microvee type)			
	1)	Type	:	Flange / Cassette
	2)	Fine filter shall contain washable non-woven synthetic fibre or High density Polyethylene (HDPE) media having 18G GSS / 16G Al alloy frame. The filter media shall be supported with HDPE mesh on air inlet side & Aluminium expanded metal on exit side or G.I. wire mesh on both sides.		
	3)	Other requirements	:	a) A neoprene sponge rubber sealing shall be provided on either face of the filter frame.
				b) Capable of being cleaned by air or water flushing.
			c) Filter media shall be fire retardant and resistant to moisture, fungi, bacteria & frost.	
4)	Efficiency	:	Average arrestance > 90% when tested in accordance with BS:6540/ASHRAE–52-76 / EN-779.	
5)	Minimum thickness	:	150 mm or 300 mm.	
6)	Face Velocity	:	Not more than 1.2 m/sec for 150 mm and not more than 2.4 m/sec. for 300 mm.	
7)	Pressure drop	:	Initial pressure drop - Not to exceed 10 mm WC at rated flow ; Final pressure drop-Up to 25 mm WC.	
4.09.00	Low Pressure Air Distribution System.			
4.09.01	Material of air distribution system shall be through galvanised steel sheet (Conforming to Grade 275 of IS: 277) or Aluminium alloy (grade 19000 / SIC or 3100 / NS3 of IS:737)			
4.09.02	Thickness of rectangular ducts shall be as follows:			
	Larger Dimension of duct (mm)	Thickness of GI sheet(mm)	Thickness of Aluminium sheet (mm)	
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9		Sub Section-A-27 Ventilation System
Page 7 of 24				

CLAUSE NO.	TECHNICAL REQUIREMENTS 			
4.09.03	up to 750 mm 0.63 (24 G) 0.80			
	751 to 1500 0.80 (22 G) 1.00			
	1501 to 2250 1.00 (20 G) 1.50			
	2251 & above 1.25 (18 G) 1.80			
	Thickness of round ducts shall be as follows:			
	Diameter of Round duct (mm) Thickness of GI sheet(mm) Thickness of Aluminium sheet (mm)			
	150 to 500 0.63 0.80			
	501 to 750 0.80 1.00			
	751 to 1000 0.80 1.00			
	1001 to 1250 1.00 1.50			
4.09.00	Duct Fabrication and Supports: a) Duct fabrication shall be as per the latest relevant BIS/SMACNA standard. b) The ducts routed inside the buildings with larger side greater than 2250 mm shall be supported by 16mm MS rods and 50x50x3 mm MS double Angles while those below 2250 mm shall be supported by 10mm MS Rods and 40x40x3 MS angles. The duct supports shall be at a distance of not more than 2000mm for ventilation ducts. The MS rods for these ducts routed inside the building shall be hung from the existing floor beams/wall beams/roof beams/columns as provided by the Employer with provision of necessary auxiliary or special steel members or by hooks or can be provided by contractor by dash fasteners fixed to the ceiling slab. No supports shall be taken from horizontal/vertical bracings of the structures. All items of duct support including MS rods, MS angles and double angles, auxiliary or special steel members, hooks, dash fasteners coach screws and all other supporting material required shall be provided by the bidder. c) Where the sheet metal duct connects to the intake or discharge of fan units a flexible connection of fire retarding, at least 150 mm width shall be provided of closely woven, rubber impregnated double layer asbestos/canvas or neoprene coated fibre glass. d) All curves, bends, off-sets and other transformations shall be made for easy and noiseless flow of air. The throat of every branch duct shall be sized to have the same velocity as in the main duct to which the branch duct is connected.			
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-27 Ventilation System	Page 8 of 24

CLAUSE NO.	TECHNICAL REQUIREMENTS	एनडीपीसी NTPC	
	e) Wherever duct passes through a wall, the opening between masonry and duct work shall be neatly caulked or sealed to prevent movement of air from one space to the adjoining space. f) Wherever pipe hangers or rods pass through the ducts, light and streamline easement around the same shall be provided to maintain smooth flow of air. g) Access doors shall be provided in the duct work or casing on the both sides of the equipment to be serviced. All access doors shall be of adequate size and shall be lined with substantial felt edging to prevent air leakage. Access doors shall be of built up construction, structurally strong and each shall have at least two hinges. Access doors shall have two rust proof window sash of approved type. All doors shall be set so as to flush with insulation or plaster finish on the duct.		
4.10.00	Splitters and dampers shall be provided for equipment/area isolation and for proportional volume control. The same shall be minimum 16 gauge GS sheet of quadrant type with suitable locking device, mounted outside of duct in accessible position.		
4.11.00	Gravity operated back draft dampers shall be installed in association with supply air system in order to maintain positive pressure inside MCC/switchgear and cable gallery areas.		
4.12.00	Diffusers, Grills & Dampers:		
4.12.01	Supply air diffusers/grills with volume control dampers be provided for all areas provided with evaporative cooling system.		
4.12.02	Inlet/Exhaust air grills/louvers are required for all negatively pressure ventilated areas. Back draft dampers shall be provided for all areas pressurised under ventilation system.		
4.12.03	The diffusers/grills shall be of powder coated mild steel construction for Ventilation system.		
4.12.04	Supply air grills shall be of double deflection type.		
4.12.05	All volume control (VC) damper shall be operated by a key from the front of the grills/diffusers and shall be GI sheet.		
4.12.06	The thickness of frames of Diffusers, grills & VC dampers shall be of minimum 20 gauge and thickness of louvers shall be of minimum 26 gauge.		
4.12.07	Suitable vanes shall be provided in the duct collar to have uniform and proper air distribution.		
4.12.08	Bank of Baffles wherever required shall also be provided.		
4.12.09	Fire dampers shall be motor operated type and shall have fire rating of minimum 90 minutes.		
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-27 Ventilation System
			Page 9 of 24

CLAUSE NO.	TECHNICAL REQUIREMENTS	एनटीपीसी NTPC	
4.12.10	All plenum chambers of connections to fans, dampers etc shall be constructed in 18 gauge GS sheet and supported on MS angle frames.		
4.12.11	All ducting surfaces, grills, dampers coming in contact with corrosive fumes or gases shall be painted with three coats of epoxy paint over a coat of suitable primer.		
5.00.00	Thermal and Acoustic Insulation		
5.00.01	A) Application with Glass Wool		
5.01.00	All surfaces to be insulated both thermally and acoustically shall be thoroughly cleaned, dried and an adhesive (CPRX compound of Shalimar Tar Products or Equivalent) be applied @ 1.5 Kg /Sqm on the surface.		
5.01.02	Insulation material (either expanded polystyrene foam or Glass Wool/ Glass fiber or Equivalent) shall be struck to the surface. All the joints shall be sealed with bitumen.		
5.01.03	Insulation mass to be covered with 500 gauge polythene sheet with 50 mm overlaps and sealing all joints on hot side.		
5.01.04	Insulation Finish of types specified under shall be provided thereafter.		
	B) Application with Nitrile Rubber:		
	(a) All surfaces to be insulated shall be properly cleaned.		
	(b) A suitable adhesive such as SR 998 or equivalent shall be applied over the surfaces to be insulated and insulation material surfaces.		
	(c) Insulating material shall than be pasted onto the surfaces in a manner to avoid stretching and any air entrapment within.		
	(d) Two layers of Glass Cloth with a suitable adhesive as SR 998 or equivalent shall be then applied over the insulating material to avoid surface weathering.		
	C) Application with FR Closed Cell Chemically Cross Linked Polyethylene Material (XLPE)		
	(a) All surfaces to be insulated shall be properly cleaned of any dust, grease and moisture.		
	(b) A suitable adhesive, normally, a pressure sensitive acrylic base, such as SR 998/STAR Glue R242 or Neosole AA 900 or equivalent shall be used to paste the insulating material over the cleaned surface.		
	(c) XLPE cut to size for each surface, with overlaps provided for two faces shall be stuck to the surfaces in a manner to avoid air entrapment. The extent of over-lap shall be equivalent to the thickness of the material to be applied. The adhesive is applied on both the surfaces to be insulated and the insulation foam material.		
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-27 Ventilation System
			Page 10 of 24

CLAUSE NO.	TECHNICAL REQUIREMENTS 				
5.02.00	(d) Application of the insulating material to surfaces should preferably be carried out at ground level, in a clean dust free area. (e) All joints- lateral & longitudinal, shall be taped with self adhesive aluminium foil tape 75 mm wide. The insulation over the surface shall be then held in position with 12mm wide PVC straps at every 600mm, to provide a neat & clean finish. Type of Insulation & Finish				
	Sl. No.	Surface	Insulation Material	Insulation Form	Thick (mm) Finish (mm)
	1.	Supply & return air duct	Resin bonded glass wool or Closed Cell Elastomeric Nitrile Rubber Or FR Closed Cell Chemically Cross Linked Polyethylene (XLPE) with Al foil face	Roll /Slab sheet Roll	50 19 19 F-3 As per manufacturer std. F-3(a)
	2.	Acoustic insulation of duct	Resin bonded Glass wool	Slab	25 As per specifications
	3.	Exposed air duct	Resin bonded Glass wool Or FR Closed Cell Chemically Cross Linked Polyethylene (XLPE) with Al foil face	Roll Roll	50 19 F-4 F-4(a)
5.03.00	Specification for insulation shall be as follows: -				
	Insulation Material		Code	Thermal conductivity	Density Kg/m ³
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9		Sub Section-A-27 Ventilation System	Page 11 of 24

CLAUSE NO.	TECHNICAL REQUIREMENTS			
5.04.00			(w/m/°C)	
	Resin bonded glass wool	IS:8183	0.049 at 50°C	i) 24 (For thermal insulation) ii) 48(For acoustic insulation)
	Mineral wool pipe section Min.Gr.2	IS:9842	0.043 at 50°C	144
	Closed Cell Elastomeric Nitrile Rubber		0.036 at 20°C	60-70
	FR Closed Cell Chemically Cross Linked Polyethylene (XLPE)		0.033 at 23° C	33 ± 3
	Note : Insulation used for HVAC application shall be CFC/HCFC free			
	The specification for various finishes shall be as follows			
	a)	Finish F-1 <u>Step-1</u> Wrapping of Poly-Bonded Hessain (PBH – to act as vapour seal) on outer surface of insulation with 50 mm overlap stitching and sealing of overlap with synthetic adhesive like CPRX or Equivalent compound. <u>Step-2</u> The surface then shall be wrapped with 19 mm mesh 24 SWG GI wire netting, butting all the joints and laced down with 22 SWG lacing wire. <u>Step-3</u> Sand cement (4:1) plaster shall be applied in two layers totalling to 12.5 mm thick, the second layer being brought to a smooth finish. A water proofing compound shall be added to the cement before its application.		
	b)	Finish F-1(a) (With FR Closed Cell Chemically Cross Linked Polyethylene Material)		
		Wrapping of two layers of 7 mil 10x10 mesh glass cloth dipped in suitable adhesive such as SR 998 or equivalent.		
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-27 Ventilation System	Page 12 of 24

CLAUSE NO.	TECHNICAL REQUIREMENTS एनटीपीसी NTPC			
	c) Finish F-2 Step-1 Insulation shall be covered with 500g polythene with 50mm overlap and sealing of overlap with synthetic adhesive like CPRX or Equivalent compound. Step-2 Same as Step-2 of Finish F-1 above. Step-3 Same as Step-3 of Finish F-1 above. d) Finish F-3 Step-1 Same as Step-1 of Finish F-2 above Step-2 The polythene shall be covered with 30 gauge Aluminium sheet and locking of joints with self-locking screws at a pitch of minimum 100 mm. e) Finish F-3(a) (With FR Closed Cell Chemically Cross Linked Polyethylene Material) Al foil faced XLPE material applied over duct surfaces, shall be covered with 30 gauge aluminium sheet, having tongue-in-groove joints and these are held in position with self drilling self tapping screws (SDST) at a distance of 150mm. f) Finish F-4 Step-1 Same as Step-1 of Finish F-1 above. Step-2 Same as Step-2 of Finish F-1 above. Step-3 Same as Step-3 of Finish F-1 above. Step-4 Application of 3 mm thick coat of water proofing compound "SHALIKOTE 30" or Equivalent and wrapped with fibre glass RP tissue followed by final coat of 3 mm thick water proofing compound "SHALIKOTE 30" or Equivalent over the RP tissue. Step-5 After the above treatment, 22G Aluminium sheet cladding, properly stitched at all joints shall be provided over the external surface. g) Finish F-4(a) (With FR Closed Cell Chemically Cross Linked Polyethylene Material) Application of aluminium sheet 22G cladding to be provided over the XLPE insulating material. Cladding sheet is held in position with SDST screws @ 150 mm C/C over tongue-in-groove joints applied with afelt for sealing joint against water ingress. Al sheet joints to be done in a manner to shed water.			
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-27 Ventilation System	Page 13 of 24

CLAUSE NO.	TECHNICAL REQUIREMENTS			
5.05.00	For all inspection covers and hatches on equipment, pump casing, valve bodies and flanges (100 mm and above), insulation shall be applied so as to facilitate removal without minimum damage to the insulation by encasing the insulation in 24 gauge GI box or 22 gauge Aluminium sheet metal boxes which are bolted together around the equipment. However continuity of the vapour seal between the static and removable portions of the insulation is to be maintained			
5.06.00	Acoustic Insulation All ducts up to a distance of 5 meters from Air washer unit fan, UAF fan and other centrifugal fan outlet shall be acoustically lined from inside with 25 mm thick resin bonded glass wool of 48 Kg/Cu.M density and 30 gauge perforated aluminium sheet having 5 mm dia perforation at 8 to 10 mm centre-to-centre distance. Insulation shall be fixed on wooden frame of 600 x 600 mm dimension. Fiber glass tissue sheet shall be applied over the outer surface of insulation before applying perforated aluminium sheet. Application of acoustic insulation shall be inline with the requirements specified above.			
6.00.00	Plant Control			
6.01.00	GENERAL			
6.01.01	Brief scheme of controlling the operation is described below. Detailed description of the control system for safe and efficient operation of the plant shall be elaborated, got approved from Employer.			
6.02.00	Air Washer Units (AWU) & Unitary Air Filtration Units (UAF) (If applicable)			
6.02.01	Air washer units shall be started/stopped by initiation from Main DDCMIS based control system of A/C plant (provided by contractor) for Main plant area, ESP control room and water system control room. Starting/stopping of pumps shall be automatic upon such initiation.			
6.02.02	The operation of the pumps shall be interlocked with the low level of water in the sump. High level of the sump shall be alarmed.			
6.03.00	Miscellaneous control requirements			
6.03.01	Separate emergency local stop push button shall be provided for each pump, fans, etc. of Ventilation system.			
6.03.02	The status of each pump, fans, etc. of Ventilation system is available on OWS in control room locally.			
6.03.03	All the alarms related to failure of equipments, tripping of equipments, source of failure / reason due to which the equipment is stopped / tripped, low & high limits of parameters such as level, temperature, pressure drop, pressure etc shall be provided for each pump, fan, AWU etc. in the control system.			
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-27 Ventilation System	Page 14 of 24

CLAUSE NO.	TECHNICAL REQUIREMENTS			
6.03.04	The fans (both supply and exhaust fans) associated with mechanical ventilation system shall be operated locally.			
7.00.00	CODES & STANDARDS			
7.01.00	The design, manufacture and performance of equipment shall comply with all currently applicable statues, regulations and safety codes in the locality where the equipments are to be installed. Nothing in this specification shall be considered to relieve the bidder of this responsibility.			
7.01.02	Unless otherwise specified, equipment shall conform to the latest applicable Indian or IEC standard. Equipment complying with other authoritative standards such as British, USA, ASHRAE etc. will also be considered if it ensures performance equivalent or superior to Indian Standard.			
8.00.00	PAINTING			
8.01.00	Painting Details for Vendor’s Equipments/Other Items			
	a) All the Equipments shall be protected against external corrosion by providing suitable painting. b) The surfaces of stainless steel, Galvanised steel, Gunmetal, brass, bronze and non-metallic components shall not be applied with any painting. The Contractor shall clean the external surfaces and internal surfaces before Erection by wire brushing and air blowing. The steel surface to be applied with painting shall be thoroughly cleaned before applying painting by brushing, shot blasting etc as per the agreed procedure. c) For all the steel surfaces (external) exposed to atmosphere (outdoor installation), a coat of red oxide primer of thickness 30 to 35 microns followed up with three coats of synthetic enamel paint, with 25 microns as thickness of each coat, shall be applied. For plant at coastal area, epoxy resin based zinc phosphate primer followed by epoxy resin based paint pigmented with titanium di-oxide shall be used in place of enamel paints. d) For all the steel surfaces inside the building (indoor installation), a coat of red oxide primer of thickness 30 to 35 microns followed up with two coats of synthetic enamel paint, with 25 microns as thickness of each coat, shall be applied. For plant at coastal area, epoxy resin based zinc phosphate primer followed by epoxy resin based paint pigmented with titanium di-oxide shall be used in place of enamel paints. e) For centrifugal/axial/Roof extractor fans - Casing shall have hot dip/ spray galvanization (minimum 60 micron DFT). f) However for all parts coming in contact with acid fumes (in Battery rooms), a coat of epoxy resin based zinc phosphate primer of minimum thickness 30 to 35 microns followed up with undercoat of epoxy resin based paint pigmented with Titanium dioxide of minimum thickness of 25 microns shall be applied and a top			
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-27 Ventilation System	Page 15 of 24

CLAUSE NO.	TECHNICAL REQUIREMENTS			
8.02.00	coat consisting of one coat of epoxy paint of approved shade and colour with glossy finish of minimum thickness of 25 microns.			
	Employer's Painting Scheme of Steel Surfaces (To be followed by the Vendor for affected areas as described in Subsequent clauses) (a) All steel surfaces shall be provided with self curing Inorganic Zinc Silicate Primer Coat (Solid by Volume Minimum 60%) of Minimum 75 Micron Dry Film Thickness (DFT) applied over blast cleaned surface to near white metal conforming to Sa 2 ½ finish of Swedish standard SIS-05-5900. The Primer shall be applied in Shop immediately after blast cleaning by Airless spray technique. (b) Primer Coat shall be followed with the application of Intermediate Coat of Polyamide Cured pigmented Titanium Dioxide (TiO2) or Micaceous Iron Oxide (MIO) Epoxy based Paint (Solid by Volume Minimum 60%) of Minimum 75 Micron DFT. This Coat shall be applied in Shop after an interval of Minimum overnight (from the application of Primer Coat) by Airless spray technique. (c) Intermediate Coat shall be followed with the application of Finish Coat of Polyamide Cured colour pigmented Epoxy based Paint (Solid by Volume Minimum 60%) of Minimum 75 Micron DFT. This Coat shall be applied after an interval of Minimum overnight and maximum indefinite (from the application of Intermediate Coat) either before Erection by Airless spray technique or after Erection by brush and / or spray. Colour and shade of the Coat shall be as approved by the Employer. The finish Coat thickness of 75 Micron can be built up either in Single application at Shop or in two applications one at Shop and the other at Site. (d) Finish Coat shall be followed with the application of Final Finish Coat of Polyurethane based colour pigmented Paint (Solid by Volume Minimum 40%) of Minimum 25 Micron DFT. This Coat shall be applied within Seven (7) days (from the completion of Finish Coat), after Erection by brush and / or spray. Colour and shade of the Coat shall be as approved by the Employer.			
8.03.00	Touch-up Paining on damaged areas (a) For Coatings damaged up to metal surface Surface preparation shall be carried out by Manual Cleaning. Minimum 6 inches adjoining area with existing Coating shall be roughened by Wire brushing, emery paper rubbing etc., for best adhesion of patch Primer. Primer Coat of self-priming Epoxy Touch-up Primer applied by brush immediately after the surface preparation. (Minimum DFT 100 Microns). Over this Primer Coat, Intermediate Coat, Finish Coat and Final Finish Coat shall be applied as covered above by brush with Intermediate Coat applied within seven (7) days of application of touch up Primer. (b) For Coatings damaged upto Intermediate Coatings (i.e. where Primer is intact). Damaged area including Minimum 6 inches adjoining area with existing Coating should be roughened by wire brushing, emery paper rubbing etc., for best adhesion of patch Primer without damaging the Primer Coat.			
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9		Sub Section-A-27 Ventilation System
Page 16 of 24				

CLAUSE NO.	TECHNICAL REQUIREMENTS			
8.04.00	Touch-up Primer, Intermediate, Finish and Final Finish Coats shall be applied as specified above for Coatings damaged up to metal surface.			
	Painting to be provided by Vendor over Welded areas / areas exposed after removal of temporary supports / Touch-up Painting on damaged areas of Employer's Structures, where interconnection, Welding / modification etc. has been carried out by the Bidder.			
	(a) Clean the surface to remove flux spatters and loose rust, loose Coatings in the adjoining areas of Weld seams by wire brush and emery paper.			
	(b) Painting procedure to be followed as mentioned above for Touch-up Painting on damaged areas.			
9.00.00	Ventilation System Equipment Sizing Criteria			
9.01.00	DESIGN PHILOSOPHY – Ventilation System			
	1. Air changes per hour in evaporative/ mechanically ventilated areas shall be as follows:			
	i)	For all evaporative cooled areas	-	8
	ii)	General areas	-	20
	iii)	MCC / Switchgear rooms and Battery rooms& other areas where gaseous fumes/ vapours are generated	-	30
	2. However in areas producing lot of heat, temperature shall be the criteria as follows:-			
	a) Inside temperature shall be minimum 3 deg.C below the design ambient temperature during summer for evaporative cooled areas.			
	b) Inside Temperature shall be maximum 3 deg.C above the design ambient temperature during summer for mechanically ventilated areas.			
	Note : Dry bulb temperature during summer season mentioned in Sub- Section-A-15 , Section VI, Part-B, Design philosophy shall be considered as Design Ambient Temperature for above.			
	The criteria which gives higher number of air changes/higher quantity of air of either of condition (Cl. 1 or 2) flow shall be selected.			
	3. All ventilation systems shall operate on 100% fresh air. All mechanically ventilated areas shall be positively ventilated by means of supply air fans fitted with filters and exhaust fans. MCC / switchgear and cable gallery areas shall be provided with gravity operated back draft dampers in association with supply air fans in order to maintain positive pressure. Battery rooms and other fumes/odour generating areas shall be negatively ventilated by means of exhaust air fans / roof exhausters. Supply air fan catering for electrical areas (MCC & Switchgear rooms) shall be provided with pre-filters and fine filters and for other areas shall be provided with pre-filter only.			
	4. All the equipments of Ventilation system shall be designed for continuous duty.			
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9		Sub Section-A-27 Ventilation System
Page 17 of 24				

CLAUSE NO.	TECHNICAL REQUIREMENTS	एनटीपीसी NTPC	
	5. The supply air ducts of evaporative type ventilation system shall be provided with automatic (motorised) fire dampers (of 90 minutes fire rating) entry in switchgear room, cable galleries etc. The operation of these automatic dampers shall be interlocked with the fire alarm system and shall also possible from the control panel remote manually. 6. Circulating water Capacity for Air washer units shall be minimum 1 Cu.M/hr per 1000 Cu.M /hr of air flow. Velocity through piping shall be limited to 2.0 m/sec and for gravity flow the same shall be limited to 1.5 m/sec. Air distribution system shall be sized to have a constant frictional drop along its length and air velocity through ducts shall not exceed 12.5 m/sec. 7. The air washer unit shall be designed for a maximum velocity of 2.7 m/sec and at least 90% saturation efficiency. 8. For pumps, continuous motor rating (at 50⁰C ambient) shall be atleast 10% above the maximum load demand of the pump in the entire operating range. For fans, compressors and blowers continuous motor rating (at 50⁰C ambient) shall be atleast 10% above the maximum load demand at the design duty point. 9. Supply air fans, exhaust air fans & ventilations of each area shall be provided with local starter panels.		
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-27 Ventilation System Page 18 of 24

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	Annexure- I			
1)	SCOPE This specification covers the design, material, construction features, manufacture, inspection, testing the performance at the Vendor's/Sub-Vendor's Works and delivery to site of Horizontal Centrifugal Pumps.			
2)	CODES AND STANDARDS The design, material, construction, manufacture inspection and performance testing of Horizontal Centrifugal Pumps shall comply with all currently applicable statutes, regulations and safety codes in the locality where the Equipment will be installed. Nothing in these specifications shall be construed to relieve the Vendor of this responsibility. The Equipment supplied shall comply with the latest applicable Indian Standards listed below. Other National Standards are acceptable, if they are established to be equal or superior to the Indian Standards.			
3)	List of Applicable Standards. IS : 1520 : Horizontal Centrifugal Pumps for clear cold fresh water IS : 5120 : Technical requirements of rotodynamic special purpose pumps API : 610 : Centrifugal pumps for general refinery service. IS : 5639 : Pumps Handling Chemicals & corrosion liquids IS : 5659 : Pumps for process water HIS : Hydraulic Institute Standards, USA ASTM-1-165-65 Standards Methods for Liquid Penetration Inspection. In case of any contradiction with aforesaid standards and the stipulations as per the technical specifications as specified hereinafter the stipulations of the technical specifications shall prevail.			
4)	DESIGN REQUIREMENTS a) The Pump shall be capable of developing the required total head at rated capacity for continuous operation. Also the pumps shall be capable of being operated to give satisfactory performance at any point on the HQ characteristics curve. The operating range of the pump shall be 40% to 120% of the duty point unless otherwise mentioned elsewhere. The maximum efficiency of pump shall preferably be within ± 10% of the rated design flow as indicated in data sheets. b) The total head capacity curve shall be continuously rising from the operating point towards shut-off without any zone of instability and with a minimum shut-off head of about 15% more than the design head.			
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-27 Ventilation System	Page 19 of 24

CLAUSE NO.	TECHNICAL REQUIREMENTS			
c)	Pumps of a particular category shall be identical and shall be suitable for parallel operation with equal load division. The head Vs capacity and BHP Vs capacity characteristics should match to ensure even load sharing and trouble free operation throughout the range. Components of identical pumps shall be interchangeable.			
d)	Pumps shall run smoothly without undue noise and vibration. Peak to peak vibration limits shall be restricted to the following values during operation:			
	Speed	Antifriction Bearing	Sleeve Bearing	
	1500 rpm and below	75.0 micron	75.0 micron	
	3000 rpm	50.0 micron	65.0 micron	
	The noise level shall not exceed 85 dBA overall sound pressure level reference 0.0002 microbar (the standard pressure reference for air sound measurement) at a distance of 1 M from the equipment surface.			
e)	The pumps shall be capable of starting with discharge valve fully open and close condition. Motors shall be selected to suit to the above requirements. Continuous Motor rating (at 50 deg.C ambient) shall be atleast ten percent (10%) above the maximum load demand of the pump in the entire operating range to take care of the system frequency variation and no case less than the maximum power requirement at any condition of the entire characteristic curve of the pump.			
f)	The kW rating of the drive unit shall be based on continuously driving the connected equipment for the conditions specified. However, in cases where parallel operation of the pumps are specified, the actual motor rating is to be selected by the Bidder considering overloading of the pumps in the event of tripping of operating pump(s).			
g)	Pumps shall be so designed that pump impellers and other accessories of the pumps are not damaged due to flow reversal.			
h)	The Contractor under this specification shall assume full responsibility in the operation of pump and motor as a unit.			
5)	DESIGN CONSTRUCTION			
a)	Design and construction of various components of the pumps shall conform to the following general specifications. For material of construction of the components, data sheets shall be referred to.			
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-27 Ventilation System	Page 20 of 24

CLAUSE NO.	TECHNICAL REQUIREMENTS	एनटीपीसी NTPC		
b)	Pump Casing Pump casing shall have axially or radially split type construction as specified. The casing shall be designed to withstand the maximum shut-off pressure developed by the pump at the pumping temperature. Pump casing shall be provided with a vent connection and piping with fittings & valves. Casing drain as required shall be provided complete with drain valves, piping and plugs. It shall be provided with a connection for suction and discharge pressure gauge as standard feature. It shall be structurally sound to provide housing for the pump assembly and shall be designed hydraulically to minimum radial load at part load operation.			
c)	Impeller Impeller shall be closed, semi-closed or open type as specified elsewhere and designed in conformance with the detailed analysis of the liquid being handled. The impeller shall be secured to the shaft, and shall be retained against circumferential movement by keying, pinning or lock rings. On pumps with overhung shaft, impellers shall be secured to the shaft by a lockout or cap screw which tightness in the direction of normal rotation.			
d)	Impeller/Casing Wearing Rings Replaceable type wearing rings shall be provided at suitable locations of pumps. Suitable method of locking the wearing ring shall be used. Wearing rings shall be provided in pump casing and/or impeller as per manufacturer’s standard practice.			
e)	Shaft The critical speed shall be well away from the operating speed and in no case less than 130% of the rated speed. The shaft shall be ground and polished to final dimensions and shall be adequately sized to withstand all stresses from rotor weight, hydraulic loads, vibration and torques coming in during operation.			
f)	Shaft Sleeves Renewable type fine finished shaft sleeves shall be provided at the stuffing boxes/mechanical seals. Length of the shaft sleeves must extend beyond the outer faces of gland packing of seal end plates so as to distinguish between the leakage between shaft and shaft sleeve and that past the seals/gland. Shaft sleeves shall be fastened to the shaft to prevent any leakage or loosening. Shaft and shaft sleeve assembly should ensure concentric rotation.			
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-27 Ventilation System	Page 21 of 24

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
k)	Pump Shaft Motor Shaft Coupling	The pump and motor shafts shall be connected with an adequately sized flexible coupling of proven design with a spacer to facilitate dismantling of the pump without disturbing the motor. Necessary coupling guards shall also be provided.		
l)	Base Plate	A common base plate mounting both for the pump and motor shall be furnished. The base plate shall be fabricated steel and of rigid construction, suitably ribbed and reinforced. Base plate and pump supports shall be so constructed and the piping unit so mounted as to minimise misalignment caused by mechanical forces such as normal piping strain, internal differential thermal expansion and hydraulic piping thrust. Suitable drain troughs and drip lip shall be provided.		
m)	Assembly and Dismantling	Assembly and dismantling of each pump with drive motor shall be possible without disturbing the grouting base plate or alignment.		
n)	Drive Motor (Prime Mover)	The kW rating of the drive shall be based on continuously driving the connected equipment for the conditions specified. However, in cases where parallel operation of the pumps are specified, the actual motor rating is to be selected by the Bidder considering overloading of the pumps in the event of tripping of operating pump(s).		
KAWAS WTE PROJECT (2X350TPD) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-2600-001-9	Sub Section-A-27 Ventilation System	Page 23 of 24

ANNEXURE-II

PIPING THICKNESS: Pipes for sizes 200 NB & above shall confirm to IS: 3589 Grade 410. The thickness as mentioned below are the minimum specified nominal thickness as per IS: 3589. Tolerance as code shall be applicable.

Nominal pipe Size (mm)	Outside Diameter (mm)	Wall Thickness (mm)
200 NB	219.1	4.5
250 NB	273	5
300 NB	323.9	5.6
350 NB	355.6	5.6
400 NB	406.4	6.3
450 NB	457	6.3
500 NB	508	6.3
600 NB	610	6.3