AMENDMENT

TO

STANDARD TECHNICAL SPECIFICATION FOR RETROFIT OF WET LIMESTONE BASED FLUE GAS DESULPHURISATION (FGD) SYSTEM IN A TYPICAL 2 x 500 MW THERMAL POWER PLANT

CENTRAL ELECTRICITY AUTHORITY
NEW DELHI

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Amendment to "Standard Technical Specification for Retrofit of Wet Limestone Based Flue Gas Desulphurisation (FGD) System in a Typical 2x500 MW Thermal Power Plant."
(Issued by CEA in December 2017)

Sl. No.	Specification clause	Description	To be read as
	Section-1, General Notes, Applicability and Project Specific Information		
1.	Clause No. 1.1 (iii)	Partial treatment of flue gas: The compliance of emission norms of 100 mg/Nm^3& 200 mg/Nm^3, the required SO_2 removal efficiency of FGD system to be installed shall be in the range 90- 95%. For compliance of emission norms of 600 mg/Nm^3, the required SO_2 removal efficiency of FGD system needs to be in the range 60- 70%. The partial bypass of raw flue gas helps in increasing the temperature of the mixed flue gas and increases the buoyancy of exit flue gas leading to its wider dispersion. It also reduces the problem of moisture condensation in chimney. In this specification, partial bypass of raw flue gas has not been envisaged considering complexity of damper control scheme and operational issues involved. Instead, 100% treatment of the flue gas has been considered with required level of SO_2 emission in treated gas to be achieved by the FGD supplier as per his optimization for height of the absorber, limestone slurry feed etc.	Partial treatment of flue gas and use of existing chimney: The compliance of emission norms of 100 mg/Nm^3 & 200 mg/Nm^3, the required SO_2 removal efficiency of FGD system to be installed shall be in the range 90- 95%. For compliance of emission norms of 600 mg/Nm^3, the required SO_2 removal efficiency of FGD system needs to be in the range 60- 70%. The partial bypass of raw flue gas helps in increasing the temperature of the mixed flue gas and increases the buoyancy of exit flue gas leading to its wider dispersion. It also reduces the problem of moisture condensation in chimney. However, provision of control dampers is required for part bypass of raw flue gas which involve complex control scheme and there are operational issues also. Alternatively, 100% treatment of the flue gas can be considered with required level of SO_2 emission in treated gas to be achieved by the FGD supplier as per his optimization for height

		However, in case for applicable emission norms of 600 mg/Nm^3, the purchaser intends to adopt FGD scheme with partial bypass with/ without GGH as per his own assessment, the standard specification shall need to be modified for incorporation of relevant changes as required to this effect.	of the absorber, limestone slurry feed etc. In case of thermal power plants with permissible SO_2 emission norm of 600 mg/Nm^3 and FGD plant retrofit envisaged with GGH, the temperature of mixed flue gas to be discharged through chimney shall be considerably higher than saturation temperature of moisture in it. Further, if SO_3 concentration in the flue gas is low, the corrosion potential on chimney flue(s) shall be considerably reduced. In such case, the provision of new wet chimney may not be considered essential and existing chimney (without anti- corrosive lining) can be used for discharge of the treated flue gases. The aspect of partial bypass of raw flue gas has not been considered in this specification (reference SO_2 emission limit being 200 mg/Nm^3) and a new wet chimney has been envisaged for discharge of treated flue gases. However, in case of plant with applicable SO_2 emission norms of 600 mg/Nm^3 and SO_3 level in flue gas being low (say below 10 ppm), the purchaser, based on his own assessment, can adopt FGD scheme with GGH & partial bypass and use existing chimney without going for lining etc. The standard specification shall need to be modified for incorporation of relevant changes as required to this effect.

2.	Clause No. 1.1 (iv)	Gas to gas heat exchanger (GGH): The use of gas to gas heat exchanger (GGH) in FGD system has got both merits and demerits. The GGH has advantage of reducing the temperature of inlet raw flue gas to the absorber which reduces potential of damage to scrubber internals in case of flue gas excursion and mal- operation etc. Reheating of treated flue gas helps in preventing stack condensation and also increases the buoyancy of flue gas exiting from the chimney resulting in dispersion of pollutants over a wider area and consequently reduced ground level concentration of pollutants. However, GGH requires additional space, results in additional pressure drop, leakage issues apart from adding to the cost. Even with GGH, chimney flue(s) may require additional protection by way of lining or resistive painting. The standard specification has been drawn without GGH. However, in case the purchaser intends to provide for GGH in the FGD system as per his own assessment, the standard specification shall need to be modified for incorporation of relevant changes as required to this effect.	Gas to gas heat exchanger (GGH): The use of gas to gas heat exchanger (GGH) in FGD system has got both merits and demerits. The GGH has advantage of reducing the temperature of inlet raw flue gas to the absorber which reduces potential of damage to scrubber internals in case of flue gas excursion and mal-operation etc. Reheating of treated flue gas helps in preventing stack condensation (due to superheating of saturated moisture) and also increases the buoyancy of flue gas exiting from the chimney resulting in dispersion of pollutants over a wider area and consequently reduced ground level concentration of pollutants. However, GGH requires additional space, results in additional pressure drop, leakage issues apart from adding to the cost. The standard specification has been drawn without use of GGH. However, in case the purchaser intends to provide for GGH in the FGD system as per his own assessment, the standard specification shall need to be modified for incorporation of relevant changes as required to this effect.

3.	Clause No. 1.1 (v) (b)	New wet chimney & suggested height: For a thermal power plant fitted with FGD, the required height of the chimney is governed by quantum of SO_2 being emitted from the chimney. Vide draft notification dated 16.10.2017, MoEF&CC has specified stack height for thermal power plants with FGD installation for public comments. The stack height required to be provided is indicated as below: Power generation capacity: Stack height: - 100 MW and above $H=6.902(Qx0.277)^{0.555}$ or 100 m whichever is more - Less than 100MW $H=6.902(Qx0.277)^{0.555}$ or 30 m whichever is more Q = Emission rate of SO_2 in kg/hr H = Physical stack height in meter. Final stipulation on requirement of chimney height is yet to be notified. Considering that permissible levels of SO2 emission varies as per unit size/ vintage and that number of units connected to a chimney vary on case to case basis, the calculated height of the chimney does not follow a gradual pattern w.r.t. unit size. Further, chimney height should not be less than boiler height. Based on overall consideration of various factors involved, the	New wet chimney & suggested height: For a thermal power plant fitted with FGD, the required height of the chimney is governed by quantum of SO_2 being emitted from the chimney. Vide gazette notification G.S.R. 593 (E) dated 28.06.2018, MoEF&CC has specified stack height for thermal power plants with FGD installation for public comments. The stack height required to be provided is indicated as below: Power generation capacity: Stack height: - 100 MW and above $H=6.902(Qx0.277)^{0.555}$ or 100 m whichever is more - Less than 100MW $H=6.902(Qx0.277)^{0.555}$ or 30 m whichever is more Q = Emission rate of SO_2 in kg/hr (total of all unit's connected to the stack) H = Physical stack height in meter. Considering that permissible levels of SO_2 emission varies as per unit size/ vintage and that number of units connected to a chimney vary on case to case basis, the calculated height of the chimney does not follow a gradual pattern w.r.t. unit size. Further, chimney height should not be less than boiler height. Based on overall consideration of various factors involved, the suggested appropriate height of the chimney for

		suggested appropriate height of the chimney for different size of units installed up to 31.12.2016 is as below: **Unit size** / **No. of units connected to the chimney** / **1** / **2** / **Suggested height of wet chimney (m)*** < 250 MW / 100 / 125 ≥ 250 MW and < 500 MW / 125 / 150 ≥ 500 MW / 150 / 150 The suggested appropriate height of the chimney for different size of units installed from 1.1.2017 is as below: **Unit size** / **No. of units connected to the chimney** / **1** / **2** / **Suggested height of wet chimney (m)*** < 250 MW / 100 / 100 ≥ 250 MW and < 500 MW / 125 / 125 ≥ 500 MW / 150 / 150 *purchaser is required to check & review for adequacy of indicated chimney height as per final notification of MoEF&CC and accordingly incorporate in the standard specification.	different size of units installed up to 31.12.2016 is as below: **Unit size** / **No. of units connected to the chimney** / **1** / **2** / **Suggested height of wet chimney (m)*** < 250 MW / 100 / 125 ≥ 250 MW and < 500 MW / 125 / 150 ≥ 500 MW / 150 / 150 The suggested appropriate height of the chimney for different size of units installed from 1.1.2017 is as below: **Unit size** / **No. of units connected to the chimney** / **1** / **2** / **Suggested height of wet chimney (m)*** < 250 MW / 100 / 100 ≥ 250 MW and < 500 MW / 125 / 125 ≥ 500 MW / 150 / 150 *purchaser is required to check & review for upward revision of indicated chimney height, if any, as per applicable calculations and accordingly incorporate same in the standard specification.

4.	Clause No. 1.1 (xiv)	Absorber lining material: The clause 4.3.1 (vii) specifies the absorber tower, oxidation tank, absorber internals & other parts, absorber outlet duct to be provided with minimum 2 mm thick lining/ cladding of SS 317 LMN / Alloy 31/ Hastelloy C22/ C 59/ C276 or equivalent. The purchaser, as per his own assessment and considerations, may decide to go in for other applicable materials also such as rubber lining (minimum 4 mm thick), flake glass lining (minimum 3 mm thick). In such case, necessary changes shall need to be incorporated in the relevant sections of the standard specification.	Absorber lining material: The clause 4.3.1 (vii) specifies the absorber tower, oxidation tank, absorber internals & other parts, absorber outlet duct to be provided with minimum 2 mm thick lining/ cladding of SS 317 LMN / Alloy 31/ Hastelloy C22/ C 59/ C276 or equivalent. The purchaser, as per his own assessment and considerations, may decide to go in for other applicable materials also such as rubber lining (minimum 4 mm thick), flake glass lining (minimum 3 mm thick), ceramic tiles, absorber in GRP material. In such case, necessary changes shall need to be incorporated in the relevant sections of the standard specification.
5.	Clause No. 1.1 (xv)	Chimney lining material: The clause 4.20 (i) specifies the chimney flue liner cladding to be made of 2 mm thick Titanium (Grade 2 as per ASME SB265) or C-276 alloy over 8 mm thick (minimum) mild steel base metal of flue liner. The purchaser, as per his own assessment and considerations, may decide to go in for other applicable materials also such as C22 alloy, Borosilicate Block lining. In such case, necessary changes shall need to be incorporated in the relevant sections of the standard specification.	Chimney lining material: The clause 4.20 (i) specifies the chimney flue liner cladding to be made of 2 mm thick Titanium (Grade 2 as per ASME SB265) or C-276 alloy over 8 mm thick (minimum) mild steel base metal of flue liner. The purchaser, as per his own assessment and considerations, may decide to go in for other applicable materials also such as C22 alloy, Borosilicate Block lining or complete flue(s) of fire retardant GRP/ FRP. In such case, necessary changes shall need to be incorporated in the relevant sections of the standard specification.

	Section-3, System Description and Scope		
6.	Clause No. 3.2.1 (iii) (b)	Each absorber tower shall be provided with multiple limestone slurry spray levels (minimum 4 nos.) or a single spray level as per bidder or his collaborator's proven and standard practice. In case of multiple spray level design absorber, each spraying level shall be provided with one individual limestone slurry recirculation pump. One spray level shall be kept as spare to meet 100% availability of the FGD plant in case of failure of any one slurry recirculation pump or one spray level. In case of single spray level design absorber, multiple numbers of identical slurry recirculation pumps shall be provided with one number recirculation pump kept as standby pump. In case of bubbling type absorber with flue gas bubbling through the limestone slurry, gas distribution system to the slurry and 3x50% gas cooling water pumps shall be provided to cool and saturate the incoming hot flue gas.	Each absorber tower shall be provided with adequate number of multiple limestone slurry spray levels or a single spray level as per bidder or his collaborator's proven and standard practice. In case of multiple spray level design absorber, each spraying level shall be provided with one individual limestone slurry recirculation pump. One spray level shall be kept as spare to meet 100% availability of the FGD plant in case of failure of any one slurry recirculation pump or one spray level. In case of single spray level design absorber, multiple numbers of identical slurry recirculation pumps shall be provided with one number recirculation pump kept as standby pump. In case of bubbling type absorber with flue gas bubbling through the limestone slurry, gas distribution system to the slurry and 3x50% or 2x100% gas cooling water pumps shall be provided as per requirement and bidder's standard & proven practice.
7.	Clause No. 3.2.1 (iii) (e)	Emergency quenching system including dedicated water tank of adequate capacity, 2 x 100% capacity pumps and associated piping to cool the flue gas inlet to the absorber in case of sudden rise in flue gas temperature.	Emergency quenching system including dedicated water tank of adequate capacity, 2 x 100% capacity pumps and associated piping to cool the flue gas inlet to the absorber in case of sudden rise in flue gas temperature. Alternatively, the bidder may offer gravity system for supply of emergency quenching water as per his proven and standard practice.

	Section-4, Mechanical Works		
8.	Clause No. 4.3.1 (viii)	The absorber slurry tank shall be designed for 6 minutes retention based on the design absorber slurry flow rate.	The absorber slurry tank shall have adequate retention volume as per standard and proven practice of the bidder and same shall be subject to approval of the purchaser during detail engineering.

The above amendments are based on resolution of the issues raised/ identified on CEA's Standard Technical Specification for Retrofit of Wet Limestone Based Flue Gas Desulphurisation (FGD) System in a Typical 2x500 MW Thermal Power Plant (issued in December, 2017), as per discussions held on 13.8.2018 in the meeting of the committee constituted for preparation of the subject specification. These amendments shall be read in conjunction with CEA's Standard Technical Specification for Retrofit of Wet Limestone Based Flue Gas Desulphurisation (FGD) System in a Typical 2x500 MW Thermal Power Plant (issued in December, 2017).

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