Owner:
HINDALCO INDUSTRIES LIMITED
Ahura Centre, 1st Floor, B Wing, Mahakali Caves Road, Andheri (East), Mumbai - 400 093, India

EPCM Contractor:
W. L. GORE & ASSOCIATES (Pacific) Pte, Ltd. India Branch
703, A-Wing, 215 Atrium, Andheri Kurla Road, Mumbai 400059, India

Nominated Subcontractor - Engineering, Quality Control, Supervision:
SMARTLuth Solution and Service Pvt. Ltd.
Unit No: 503, 5th Floor, ECO Centre, EM-4 Sector-V, Salt Lake City, Kolkata - 700091, India

# Hindalco Renusagar U5 1 x 80 MW PF Captive Power Plant

## Flue Gas Desulfurization Project (FGD) with GORE™ $SO_2$ Control System

## FGD-Technical Specification with Equipment Sizing

| ISSUED FOR | APPROVAL ☒ | INFORMATION ☐ | MANUFACTURING ☐ | CONSTRUCTION ☐ | AS-BUILT ☐ |
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| 00 | 10/03/2022 | First Submission | S.Das | S.Chakraborty | | M.Deb |
| Rev. | Date | Description of revision | Prepared | Checked | | Approved |

| | | |
|---|---|---|
| Hindalco Renusagar U5 1 x 80 MW PF Captive Power Plant | Doc. No.: S21001 - TS01 - 05HSD - 227201 | |
| Flue Gas Desulfurization Project (FGD) with GORE™ $SO_2$ Control System | Gore Doc. No.: RPDU5.PG.001 | page |
| **FGD-Technical Specification with Equipment Sizing** | GORE Job No.: RPDU5 | Rev. : 00 |
| | File: FGD- Technical Specification with Equipment Sizing | |

**Intent:**

Flue Gas De-sulphurisation system is introduced on Unit # 5- 1 x 80 MWe of Coal Fired Captive Power Plant at Renusagar Power Division, Sonbhadra, Uttar Pradesh, India, in order to meet the present emission standard, set by MOEF for $SO_x$ control, which is < 600 mg/$Nm^3$ at 6 % $O_2$ dry. The design incorporates provision for attaining SOx level of <200 mg/Nm3 at 6% $O_2$ dry in future by adding more number of modules.

**Design Basis FGD Plant**

We have taken cognizance of the anticipated performance and actual performance data at BMCR and 100% TMCR and the above coal analysis provided by RENUSAGAR CPP, namely, Oxygen and Flue Gas temperature at ESP inlet and outlet, and the following gas analysis to derive at the gas flow, temperature, $SO_x$ emissions to form the design basis of the FGD system offered.

**Flue Gas Duct**

| **Flue Gas Duct** | **KKS System Code: 50HTA** | |
|---|---|---|
| **Flow through ID fan individual discharge** | m3/hr | 293335 |
| Flow in m3/s | m3/s | 81.48 |
| Gas temperature | DegC | 148 |
| Dimension of Individual duct selected | m x m | **1.8 x 3.6** |
| There shall be 02 No's such ducts from individual ID and discharge. | | |
| **Flow through Common duct to Booster Fan suction*(Flow to match Booster Fan)** | m3/s | 163.0 |
| Flow velocity considered | m/s | 12.6 |
| Dimension of BF suction duct selected | m x m | **3.6 x 3.6** |
| **Flow through Common duct of Booster Fan discharge** | m3/s | 157.4 |
| Flow velocity considered | m/s | **15.5** |
| Diameter of Booster Fan discharge duct selected | m | **3.6** |
| **Flow through MCU** | m3/s | 157.4 |
| Velocity considered through MCU | m/s | 4.92 |
| Dimension of MCU duct selected (Depth x width x height) | m x m x m | **4 x 8.0 x 15.0** |

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## Fan System

| **Booster Fan** | **1 x 100% MCR** | | **KKS Identification** | **50HSC10AN001** | |
|---|---|---|---|---|---|
| **Medium handled** | **Flue Gas – Analysis (% by Volume, wet): $CO_2$ – 10.8; $O_2$ – 6.62; $N_2$-72.73; Moisture – 9.84. Flue Gas with dust concentration of 120 mg/Nm3 and SOx level- 1246 mg/$Nm^3$** | | | | |
| **Type** | **Centrifugal, Double Suction – Single Outlet, simply supported, backward bladed impeller, Motor driven. Fan inlet / outlet orientation shall be as per tender layout as per Annexure.** | | | | |
| **Control of Fan** | **VFD as primary & RVC or MLD (Pneumatic Actuated) as secondary.** | | | | |
| **Max. Speed** | **~990 RPM** | | | | |
| **Basic Design Parameter** | | | | | |
| **Cases** | | **100% BMCR(Present)** | **Fan Design (Present)** | **100% BMCR(Future)** | **Fan Design (Future)** |
| **Volume flow** | **$m^3$/hr.** | **5,86,669.00** | **6,45,350.00** | **5,86,669.00** | **6,45,350.00** |
| | | **Above flow figures are at (-) 25 mmwc and 148 °C** | | | |
| **Temperature** | **°C** | **148** | **148** | **148** | **148** |
| **Static Pressure at Duct tapping point** | **mm WC** | **(-)25** | **(-)25** | **(-)25** | **(-)25** |
| **Static Pressure at Fan I/L** | **mm WC** | **(-)60** | **(-)67** | **(-)60** | **(-)67** |
| **Static Pressure at Fan O/L** | **mm WC** | **(+)206** | **(+)249** | **(+)238** | **(+)289** |
| **Fan Differential** | **mm WC** | **266** | **316** | **298** | **356** |
| **Site Barometric Pr.** | **mmHg** | **736** | **736** | **736** | **736** |

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Hindalco Renusagar U5 1 x 80 MW PF Captive Power Plant
Flue Gas Desulfurization Project (FGD) with GORE™ $SO_2$ Control System

**FGD-Technical Specification with Equipment Sizing**

Client Doc.: S21001-TS01 -05HSD- 227201
GORE Doc.: RPDU5.PG.001
Rev.: 00 dated 10/03/2022
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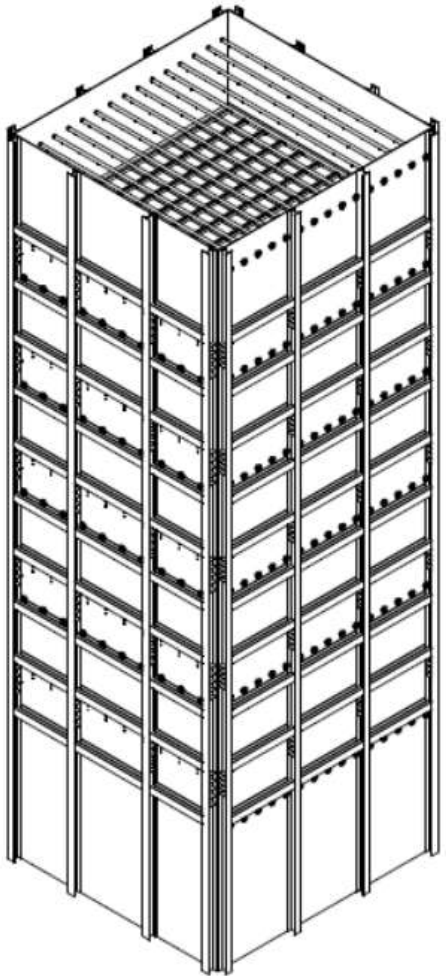
**FGTR (Flue Gas Treatment Reactor)**

The Flue Gas Treatment Reactor (FGTR) is stacked with layers of Gore™ SPC catalyst modules arranged in 165 stacks with a maximum of 22 vertical layers (inclusive of 5 of catalyst management layers), arranged with a maximum of 5 vertical layers per stack in series , for SOx capture with sufficient space for future addition of layers. The gas velocity through the modules will be designed to a maximum of 2.2 mtr/ sec.



| FGTR Module Description | FGTR KKS No: 50HSD10BA001 | |
|---|---|---|
| No. of stacks | Nos | 165 |
| Stack Arrangement | Nos | 11 x 15 |
| No. of layers | Nos | 15 to 22 |
| No of layers for future case | Nos | 27 |
| No. of modules | Nos | 2475 to 3630 |
| Module Weight (Dry) | kg / module | 40 |
| Module Weight (Wet) | kg / module | 80 |
| Module Wet Weight Variability | % | ± 10% |

| | | |
|---|---|---|
| Flue gas flow (before cooling) | $Nm^3/h$, wet | 3,79,591 |
| Flue gas flow (after cooling) | $Nm^3/h$, wet | 4,01,991 |
| Flue gas flow | $Am^3/h$ | 5,86,669 |
| Inlet Temperature | °C | 148 |
| Operating Temperature | °C | 53 |
| SO2 inlet conc. | $mg/Nm^3$, dry @6% O2 | 1,590 |
| SO2 inlet conc. | $mg/Nm^3$, dry | 1,446 |
| SO2 inlet conc. | $mg/Nm^3$, wet | 1,246 |
| SO2 outlet conc. | $mg/Nm^3$, dry @6% O2 | 500 |
| SO2 outlet conc. | $mg/Nm^3$, dry | 455 |
| SO2 outlet conc. | $mg/Nm^3$, wet | 392 |
| SO2 Efficiency | % | 65% |
| GSCS Module Pressure Drop | Pa/layer | 65 |
| GSCS Total Pressure Drop | Pa | 1430 |
| Acid dewpoint | °C | 64 |

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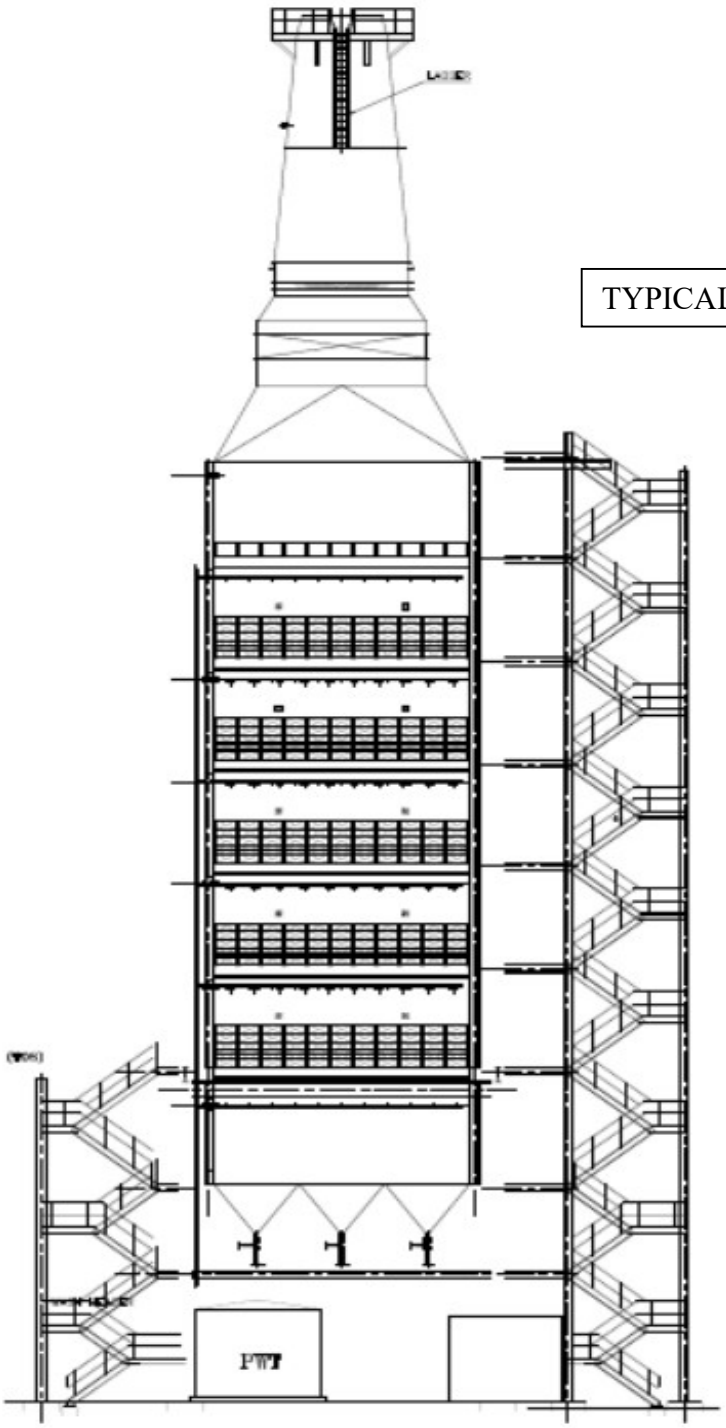
TYPICAL FGTR & WET STACK



**MCU (Mist Cooling Unit)**

The centrifugal booster fan of the unit will discharge the total flue gas to the Mist Cooling Unit (MCU) where the flue gas will be conditioned by spray water cooling to a saturation point with Relative Humidity close to 100% saturation. The gas temperature at the outlet is expected to be at circa 53 °C after the Mist Cooling Unit. After the Mist Cooling Unit (MCU), the saturated flue gas will enter the Reactor Tower via flow streamliners for SOx capture.

| **Mist Cooling Unit** | **KKS No: 50HTH10AC001** | |
|---|---|---|
| **Flue gas vol flow rate to MCU** | **$M^3$/hr** | **566640** |
| **Flue gas temp at inlet to MCU** | **deg C** | **148** |
| **Temp after MCU** | **deg C** | **53.0** |
| **Water required to be added to achieve saturation** | **$M^3$/hr** | **22.0** |
| **Blowdown from MCU** | **$M^3$/hr** | **7.00** |
| **Water flow required at MCU inlet** | **$M^3$/hr** | **29.0** |
| **Margin on Flow** | **%** | **32** |
| | | |

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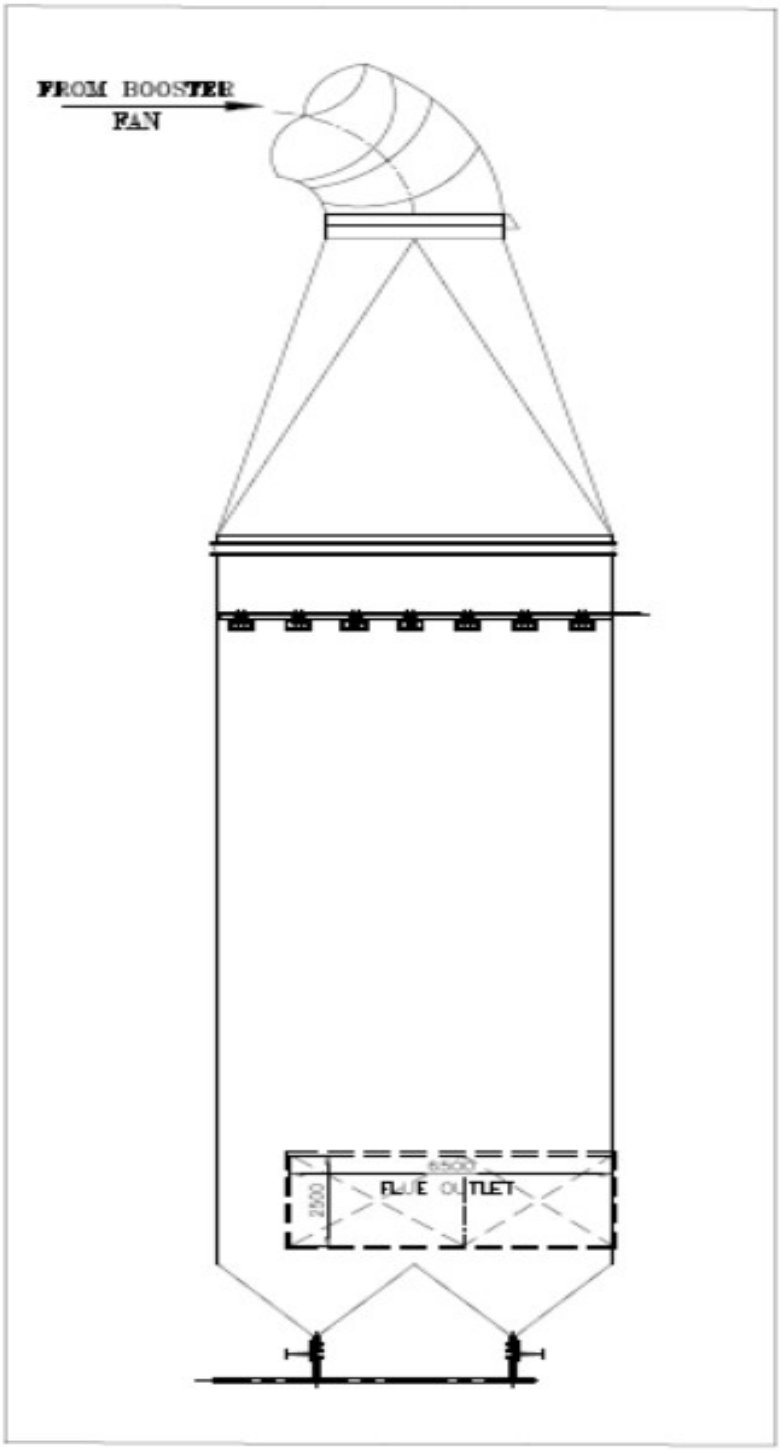

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# FGD & SAC Plant Process & Storage tanks

| **PWT (Process Water Tank) tank storage capacity calculation** | **50GNK13BB002** | |
|---|---|---|
| Design Code | IS | 803 |
| Media | - | 0.25% H2SO4 |
| Storage volume provided | $M^3$ | 50 |
| Diameter considered | m | ~4.50 |
| Height calculated | m | ~3.90 |
| Height provided | m | ~3.60 |

| **FWT (Fresh Water Tank) tank storage capacity calculation** | **50PBL10BB001** | |
|---|---|---|
| Design Code | IS | 803 |
| Media | - | Fresh Water |
| Storage volume provided | $M^3$ | 25.00 |
| Diameter considered | m | ~3.00 |
| Height calculated | m | ~3.90 |
| Height provided | m | ~3.60 |

| **FGTR Effluent Storage tank capacity calculation** | **50HSM34BB004** | |
|---|---|---|
| Design Code | IS | 803 |
| Media | - | 10% H2SO4 |
| Storage volume provided | $M^3$ | 50.00 |
| Diameter considered | m | ~4.50 |
| Height calculated | m | ~3.90 |
| Height provided | m | ~3.60 |

| **SAC Recovered Water Tank storage capacity calculation** | **50GNE10BB005** | |
|---|---|---|
| Design Code | IS | 803 |
| Media | - | 0.25% H2SO4 |
| Storage volume provided | $M^3$ | 50.00 |
| Diameter considered | m | ~4.50 |
| Height calculated | m | ~3.90 |
| Height provided | m | ~3.60 |

| **95% H2SO4 STORAGE Tank capacity calculation** | **50GNE20BB006** | |
|---|---|---|
| Design Code | IS | 803 |
| Media | - | 95% H2SO4 |
| Storage volume provided | $M^3$ | 50.00 |
| Diameter considered | m | ~4.50 |
| Height calculated | m | ~3.90 |
| Height provided | m | ~3.60 |

| **Overhead Emergency Tank** | **50PBL20BB003** | |
|---|---|---|
| Design Code | IS | 803 |
| Media | - | Fresh Water |
| Storage volume provided | $M^3$ | 5 |
| Diameter considered | m | ~2.00 |
| Height calculated | m | ~2.00 |
| Height provided | m | ~2.60 |

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## FGD & SAC Plant Process & Storage Pumps

| **Fresh water Pump** | **50PBL11AP003** | |
|---|---|---|
| | **50PBL12AP004** | |
| Pump capacity calculated | $M^3$/hr | 40 |
| Flow | $M^3$/hr | 36 |
| Head | mmWC | 65 |
| **Process water Pump** | **50GNK14AP001** | |
| | **50GNK15AP002** | |
| Pump capacity calculated | $M^3$/hr | 36 |
| Flow | $M^3$/hr | 29 |
| Head | mmWC | 160 |
| **FGTR Module Wash Pump** | **50HSM11AP005** | |
| | **50HSM12AP006** | |
| Pump capacity calculated | $M^3$/hr | 100 |
| Flow | $M^3$/hr | 71.5-91.3 |
| Head | mmWC | 70 |

| **FGTR EFFLUENT Transfer Pump** | **50HSM21AP009** | |
|---|---|---|
| | **50HSM22AP010** | |
| Pump capacity calculated | $M^3$/hr | 12 |
| Flow | $M^3$/hr | 4.81 |
| Head | mmWC | 50 |
| **PUMP TO CLIENT Services** | **50GNK11AP010** | |
| | **50GNK12AP011** | |
| Pump capacity calculated | $M^3$/hr | 15 |
| Flow- Continuous | $M^3$/hr | 7 |
| Flow- Intermittent | $M^3$/hr | 14.1 |
| Head | mmWC | 35 |