ERECTION MANUAL

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1. **Introduction**

1.1 ESTABLISH SITE

When necessary, an introduction meeting will be organised by Client. During such meeting, the Client shall give the following information:

a) Site evacuation procedures.

b) Site Health and Safety Rules.

c) Site Health and Safety Representative.

d) Welfare facilities to be shared.

e) First Aid facilities.

f) Alarm raising procedures.

Erection subcontractor should carry out an inspection of working area and report any anomalies noted to Client for further action / elimination such as:

a) Third working parties in vicinity of operations.

b) Public that could be affected.

c) Compliant location and size of erection working, assembling and discharging areas.

d) Compliance of the ground characteristics for erection:

- Suitable soil compactness for access of mobile crane of 20 tons per axe.
- Drained ground ensure adequate dryness for material storage and erection works.
- Free access around ACC structure will be defined. Site offices, workers

lavatories and bathroom etc. shall be installed within 10m around the area as far as possible Erection subcontractors shall offload the in the working area as agreed by parties.

Client or Erection Subcontractor's shall ensure that water, electricity and communication facilities have been gotten through the offices, at the same time, lumber room shall be set up in the discharging area.

1.2 SITE SAFETY

All work shall be carried out in accordance with Site safety regulations.

All work shall be carried out in accordance with the Vendor Health and Safety manual which is the current edition.

Entering the safety access and working areas shall be by agreed routes as per Health and Safety Plan drawings or local requirements.

Only tested and certified cranes shall be utilised and shall be sufficient for task. Copies of certificates for cranes shall be maintained by the clients & Safety principle and will be checked to use on request at the site.

All lifting tackle shall be tested and certified and suitable for designated tasks. Copies of Certificates have to be available at the site.

The crane driver shall be competent and will have an accredited qualification in conformity with local requirements.

Safety principle shall be responsible for controlling, monitoring and reporting of all safety matters.

The safety principle shall visit site to ensure Health and Safety will be put into practice basing on regulations.

All work shall be carried out in line with Risk Assessments and Method Statements as applicable by competent personal. Training on site shall observe the relevant information as defined from "Health& Safety Plan" by client and instruct the staff in 'tool box' manners.

1.3 PERSONAL PROTECTIVE EQUIPMENT (P.P.E.)

Any of the items listed below shall be compliant with Site Rules, Risk Assessments, and other agreements.

a) Helmet (Welders exempted only whilst welding)

b) Safety Footwear

c) Overalls

d) Ear Defenders

e) Eye Protection

f) Gloves

g) Welding Masks

h) High Visibility Vests (Welders exempted whilst welding)

i) Safety Harnesses

j) Intern Reels

k) Breathing Apparatus

l) Others as identified

1.4 EMERGENCY PROCEDURES

a) Site Evacuation plan shall be submitted by Client.

b) Emergency & contact phone numbers shall be submitted by Client.

1.5 SUMMARY OF ERECTION SEQUENCES OF THE ACC. ACC

The following proposed sequences shall be further detailed in the specific site erection schedule.

STEP 1

Unit will start with the streets 1

Firstly the steel trusses of the streets 1 will be preassembled at the ground level and erected, then the corresponding fan deck supporting, fan screen/fan bell, fan duct and fan deck plates

STEP 2

Erection from the steel trusses of the street 2

Firstly the steel trusses of the streets 2 will be preassembled at the ground level and erected, then the corresponding fan deck infill & fan screen / fan bell, fan duct and fan deck plates

STEP 3

Erection of the motor support bridges of street 1 & 2 with gearboxes & motor & blades & grating and handrails already fitted. (In case of missing parts or late delivery alternative erection PRO will be submitted later)

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Erection of A- frames of the street 1 & 2 above fan deck.

Installation of tube bundles & steam manifold (include the spring hangers & guiding rails for the cleaning ladder and manhole axis platforms & ladders) and condensate header of street 1 & 2.

STEP 4

Erection from the steel trusses of the street 3.

Erection of motor support bridges of street 3 with gearboxes, motor & blades & grating and handrails already fitted. (In case of missing parts or late delivery alternative erection PRO will be submitted later) Erection of A- frames of the street 3 above fan deck.

Installation of tube bundles & steam manifold (include the spring hangers & guiding rails for the cleaning ladder and manhole axis platforms & ladders) and condensate header of street 3

STEP 5

The access of the turbine table area should be available.

Installation of the exhaust ducting at the exit of the TEB (Include the Blank Plate).

Pre-assembling and erection of the horizontal T-section of the main duct for the street 1 & 2 Pre-assembling and erection of the horizontal main duct sections for the street 3

STEP 6

Erection & tack welding the horizontal bellows and butterfly valves at the horizontal distribution manifolds.

STEP 7

Pre-assembling and erection the risers & longitudinal Bellow and this between the main duct and the distribution manifold after welding for steam distribution manifolds.

STEP 8

Preassembled wind wall sections are fixed around the ACC.

Condensate manifolds of each street are welded as soon as the related tube bundles are welded to the steam manifolds and all the tube bundles in the vicinity have been placed into position.

The internal partition will be then installed between fan cells for air seals.

Note: Survey / Topographic report must be performed during installation of the Main Steam manifold sections to verify final placement / vertical alignment to each Riser connection.

Piping will be erected when condensate manifold is welded to the tube bundles and various equipment (pumps and vacuum equipment) are installed. The piping delivery consists of vertical segments with the required elbows and fittings from ACC platform to condensation collector, which should suit HAC piping routing. The erection company will assemble the pieces accordingly.

2. List of Tools & Tackles (capacity, quantity, detail list etc.to be mentioned)

2.1. All lifting equipment for the Contract shall be tested and will have current certificates available. (Test & expiry date and load)

2.2. All plant and equipment shall be suitably maintained and recorded to be kept. 2.3. Principle workload (per unit) (maximum weight of single component)

S.L.	Name	Size^mm^	Weight (kg)	Quantity	Total Wt. (Kg)	Remarks
1	Steam Duct	ĭ9000	150000	2	300000	
2	Steam Duct Tee	ĭ9000	80000	1	80000	
3	Steam Duct Elbow	ĭ9000	80000	1	80000	
4	Steam Distribution Manifolds	ĭ3000 X 15000	18000	10	180000	
5	Current Flow Bundles	11600×2088	5000	1100	5500000	
6	Counter current Flow Bundles	11400×2088	5000	160	800000	

7	Bundle Bellow	ĭ508×11780	1800	40	72000	
8	Condensation Water Tank	ĭ3600×20000	70000	1	70000	Including deaerator
9	Axial Fan Unit	ĭ10974	2200	90	198000	
10	Fan Duct and Screen		5000	90	450000	
11	Motor	200kw	1200	90	108000	
12	Gearbox		1300	90	117000	
13	One Truss Steel	29232	36000	110	3960000	
	Total Wt.				11915000	

2.4 General Construction Arrangement

Road
Storage area for steel structure, fan bridge, A frame Storage area for steam duct, steam distribution manifolds, fan units and other apparatuses. expansions etc.
road 800m X 290m
Road
Road Road
Living area Storage area for ACC Bundles 82.0m X 36.0m
170m X 600m Configuration Area for Big Duct Road
Around 8000 Road

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A. Construction Machinery Arrangement

(1) During the construction for ACC supporting foundation and column, one 25T level jib crane shall be arranged respectively inside per unit of ACC, Turing radius of which shall be set as 70m value for working of column within the radius respectively. Details see general arrangement.

(2) During installation for ACC truss and top thereof, 300t main jib, 64m fly jib and 45m crawler crane shall be respectively arranged inside per unit of ACC for lifting truss, steam distribution manifolds and main steam duct along with the equipment that cannot be lifted by 25t level jib crane. Details see general arrangement.

(3) Two 25t auto cranes and one 20t platform car shall be equipped with per unit for coordinating transportation, loading & unloading of equipment, along with equipment installation on the ground such as steel structure, screen, fan units, A frame, wind wall etc.

B. General Construction Arrangement Management (1) Storage Area 15000m2

Storage area and configuration area should be designated by owner for equipment and big duct that mainly are ACC bundles, steel structure, fan fittings, steam duct etc., which the usage area shall be amount to 15000 around.

(2) Fabrication Area and Tools House

400 m2 Fabrication area should be respectively established on the east and west of ACC for assembling truss, A frame, and fan units etc.

One 40m2 tools house should be established respectively inside the fabrication area of ACC.

(3) Office Area and Living Area 1200m2

Temporary office building shall be set up within the area designated by owner, viz HAC Project Manager department; temporary building shall be set up within the area designated by owner for living. The usage area for the office and living shall be amount to 1200 m^2. **General items of plant and equipment required are as follows:**

a) Mobile Cranes:

350 T Crawler Crane: 65m Main Jib + 41m Fly Jib

25 T Auto Crane: 24.5m Main Jib + 7.5m Fly Jib

25 T Flat Jib Crane: Range of 70m Height of 74m

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b) Welding Plant Z X 7400 500

Contravariant DC manual welder ZX7400 500

c) Generators

d) Compressors，1.0 M³ / Min 1.0Pa

Amount of steam exhausted: 1.0m³/Min

Pressure 1.0Pa, Power，7.5KM/P

Air compressor for site painting

e) Scaffolding including tower and walkway

Scale for each concrete column of ACC

(each ACC unit including 25 concrete columns totally 3 units)，

Barling: 6m – 700 pieces; 4m – 60 pieces; 2m – 400 pieces;

Pedal: 200 pieces; Fastening: 2000 sets

f) Activity cabins 20 M²

Project manager office conference room financial room specialist engineer office, document centre guardian room factory representative office tools crib warehouse of material etc. minimum totally 9 rooms, separated each room 20

g) Angle grinders，100mm

Grinding disk diameter: 100mm, Power，670W

h) Impact wrench + Sockets. M10 M30

i) Torque wrench. M30

Electric Torque wrench used in high strength bolts

Manual torque wrench used in retesting

j) Measuring / levelling equipment.

Theodolite used in measuring

k) Soft Nylon rings + Chain blocks + Pull-Lifts + U shaped shackles.

Nylon sling: 2 M - 2t, 5 M - 10t, 10 M - 20t, Chain blocks 5t, 10t

U shaped shackles 10t, 20t

l) Hand Tools / Spanners etc.: Sledge hammer in 10 psi, hammer in 2 psi, drilling tool in 5-M 30-M, Steel tape in 10-30, box spanner adjustable spanner in 200mm-

maximum opening 25mm, adjustable spanner in 300mm - maximum opening 35mm etc.

m) Safety Harnesses + Personal Protection Equipment: Each person will be equipped with one set according to the number of people in ACC building.

2.5 Recommended storages area for materials

Outdoor Storage

Steel supports structure

Fan Bells

Motor bridges

Grids and checked plates

Railings

Fan screens

Piping

Cleaning ladders

Storage under protective foil

Fin tube bundles

Expansion joints

Air extraction unit (s)

Wind wall & intermediate sheeting / cladding

Fan drive units (complete)

Fan impellers

Gear boxes

Please Note: During unloading, correct lifting equipment / tackle (s) should be used and if necessary additional protection should be done during lifting activities in order to avoid damage to the equipment or material. Good solid timber cribbage / packing should also be placed under the equipment or material before placing onto the ground to avoid damage and contamination with the soil.

Storage in closed rooms

Valves / Fittings

Measuring instruments

Cleaning system (pump, motor and associated material like sprays, hoses, …)

Rupture disks

Connection materials such as screws, nuts, washers, dowels, etc.

ACCESS EQUIPMENT

Erector would normally provide their own access equipment Workings platforms consisting of:

- Top handrail- solid / tubular
- Platform clips
- Floor boards- 3” wide
- Platform bracket
- Mid handrail- solid/ tubular
- Kick/ toe boards
- Ladders
- Site scaffolding
- Mobile scaffold towers
- Or other methods proposed by erecting company

3. **Assembly-wise Erection Procedure**

Erection subcontractors have to check that all materials are delivered against drawing and transport documents, any damaged or missing items are to be reported immediately or ASAP within 2 two weeks so as to replace or repair. If notifications & report of any missing items has not been received within the same time, it would be assumed that all material identified on the delivery / packing list would be correct,

- Any missing / damaged items reported after this time will then become the responsibility of the erection subcontractor to replace & repair.

Site cranes shall be established.

Erection subcontractor’s is responsible for welding consumables that are stored in the correct manner and in line with weld procedures/specifications. A report / record reference about electrode storage & issuance should be submitted each week and inserted into the site records All erection bolts, nuts and washers will be stored in suitable containers.

Crane details will be defined in the method statement (see paragraph 1.7.5).

A method statement for each heavy manipulation shall be issued and will contain following information.

Detailed description of the necessary preparation steps

Necessary crane movements shall be explained and documented on a drawing showing crane radius and working area. Such document is to be prepared by the Erector.

A documented file about crane(s)shall be used, which gives the crane dimensions and load chart. Such document is to be prepared by the Erector.

Per major part and/or heavy manipulations should be having on safety analysis. Such analysis is to be prepared by the Erector.

All hand tools should be in good order and correctly stored in properly container.

MAIN ERECTION SEQUENCES

REFERENCES

Drawing HAC-NKP-J-T01

Unit 1	
Street 1	Between axis (L1-1) -(L1-2)
Street 2	Between axis (L1-2) -(L1-3)
Street 3	Between axis (L1-3) -(L1-4)
Street 4	Between axis (L1-4) -(L1-5)
Street 5	Between axis (L1-5) -(L1-6)
Street 6	Between axis (L1-6) -(L1-7)
Street 7	Between axis (L1-7) -(L1-8)
Street 8	Between axis (L1-8) -(L1-9)
Street 9	Between axis (L1-9) -(L1-10)
Street 10	Between axis (L1-10) -(L1-11)

3.1 Mechanical System

DETAILED SEQUENCES FOR ONE STREET

Lift and erect the ground-assembled steel trusses parts (these assembled structural steel trusses should be safely stabilised by cables and mainly for the first two erected truss).

After erection of the main support structure, Level and dimensional checks plus Bolt Torque should be performed and any correction work should be completed (Max

Tolerance of +/-3mm should be maintained) for TOS. Include being square and aligned and this to avoid problems with other & further parts who have to be erected. One final Topographical placement report will be supplied, after receiving & accepted of the report. The fan deck structural parts (for the current module) can be pre-assembled at the ground level and then installed, the small fan deck structure will be erected with man lift (cherry picker) or by crane. After installation another dimensional check / survey and bolt torque report should be performed & supplied to ensure that the supports are correct – diagonally, elevation & level and central for the installation of the Fan Bell.

Steel trusses of this street will be put on level @ TOS Fan Deck, columns base plates will be fully fastened after alignment meeting HAC requirements. All the bolts will be tight up as supplier's specifications.

3.1.1 Steam Exhaust System

3.1.1.1 Main Steam Duct

Preassembly & erection of hinge bellow & main steam ducting "including blank plate" (following erector statement approved by HAC). Fig 1 & 2 & 3

Pre-assembly and erection of elevated horizontal ducting (following erector statement approved by HAC)

Fig.4.

Fig. 1

Fig 2

Fig. 3

Fig. 4

Welding of the manifold in accordance with WPS and procedures.

3.1.1.2 Steam duct Riser

Preparation & erection & welding of riser at the ground level and erect. Fig 5

Fig. 5

3.1.1.3 Steam Distribution Manifold

After alignment check from top and bottom bundle tubes-sheets and accepted by HAC, erection and tack welding can be start from the Distribution Manifold & Condensate Headers. Fig 6 & 6a.

Fig. 6

Fig. 6a

Start erection of DSM, alignment, welding in accordance with procedures.

(If isolated valve, which should be installed on the ground.) Fig - 7

Fig 7

3.1.2 Tube Bundle System

3.1.2.1 Tube Bundles

Bundle erection can have started when one & two streets are finish completely & bolted up. Prior to lifting bundles, one survey report showing top grinder levelness and straightness would be made by the erection company and submitted to HAC for inspection and acceptance. fig 8 & 8a & 8b

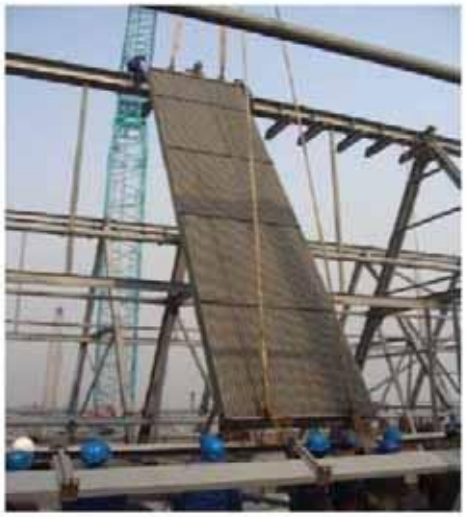

Fig. 8

Fig 8a

Fig. 8b

Preparation of bundles. Fig.9 ACC

Fig.9

Installation of bundles, alignment and welding in accordance with procedure.

Preparation of top steam manifolds (DSM) with access platform and cleaning guiding rails.

.

3.1.2.2 Condensate Header the entire condensate header is welded, remove the bundle jacking supports. Fig.10

Fig.10

Welding of bottom condensate manifold.

Proceed further with the erection of the other streets of the ACC as described above, after under structure is completed.

Continue with piping location and welding.

3.1.3 Air Moving System

3.1.3.1 Fans

Sorting out of fan deck plates can be done at the ground level, and later be placed up the fan deck level. Fig 11 (These plates should be secured against falling down due to wind or others.)

Fig 11

Start with fan deck plate location under the motor bridge. (Before location of the motor bridge)

Prepare 2 temporary supports to assemble the motor bridge and allow access enough for working space &introduction of gearboxes, motor, blade & structural parts such as handrails and grating. (all these parts will be erected in accordance with the crane lifting capacity) Fig 12& 12a

Fig. 12

Fig 12a

Assembling for fittings such as motor briede etc. should be performed at ground level near their final location along each street (fan blades to be installed provisional in max. vertical position)

3.1.3.2 Fan Belt

Start the assembly of the Fan Screen & Fan Bell at the ground level. The assembly of the fan bell should be performed on levelled ground & long timber packing or tables in order to avoid any distortion during assemble of the parts (fig 13 & 14).

Fig. 13

Fig.14

The fan ring and bell should be assembled to its diameter avoiding any roundness and circle deviation.

Recommended Survey / Dimensional Record of each ring and bell will made, the fan ring and bell should be in accordance with the DWG. & records from the supplier.

Lifting operation can have started to locate the whole assembled fan bell & Fan Screen from the ground to its supports onto the Fan Deck level (fig 15).

Fig. 15

The fan bell will be fixed onto the 8 supports plates & fan deck structure with the correct connection bolts. Fig 16

Fig. 16

2.4.1 Continue with the assembly & erection of the other air inlet bells till 2 or 3 streets are completed. Fig.17

Fig

17 3.1.3.3 Gear Box NOTES:

Gearbox shall be filled with lubrication oil, quantity is indicated at the gearbox label &gearbox data sheet (Mineral oil shall be added before commissioning first, and then the mineral oil shall be changed into composite oil as per instruction of gear box.)

3.1.3.4 Fan Bridge

After completion of motor bridge at the ground level, lifting onto the fan deck level (fig 18).

After the basic structure including motor bridges of the whole street is located and erected, a final survey will be performed and recorded for all installed pieces.

Fig 18

Continue and perform the same operation on each adjacent cell.

Preparation & assembly and bolting up for A - frames can start at the ground level. (fig 19)

Fig 19

3.1.4 Structure (Upper)

The Client should officially furnish & show & identify all the site references (Datum Points) such as the main level reference Points^Marked^at different fixed places / locations, the North orientation reference and the main ref. Axes X, Y and Z of the concrete slab & pedestals. All locations should be recorded on one survey report.

The erector subcontractor will check the concrete slab, pedestal before starting any erection of steel parts and confirm the preparation work is in compliance with drawing HAC-NKP-T-T02-02

The client will issue a survey report (Refer to section 2.2.1) which will be verified & confirmed by the Erector Contents of the Report should identify the following:

Indication of the slab level and anchor bolts orientation.

Location of all the concrete slabs following reference axes: X, Y, Z.

All deviation from HAC-NKP-T-T02-02 information's.

HAC-NKP-T-T02-02

Status of concrete construction on the day of site opening.

Above information will be also available after any new concrete slab is installed.

Interface with ACC scope of supply.

3.1.3.1 A Frame Structure A

Pre-assembled A-Frames can be erected (see Fig 14 &14a) followed with the top girders & distance bracings & diagonal bracings & monorails.

Fig. 20

Fig 20a

Make the same operations to erect the adequate streets.

Installation of internal & external doors. Fig.21

Fig.21

Starting intermediate cladding (sheeting) on the internal and external “A” frame of each street. Fig. 22

Fig. 22

3.1.4.2 Winds Wall Structure

Prepare the wind wall structure sections & sheeting at the ground level and erect. Fig.23 & 24

Fig. 23

Fig. 24

3.1.5 Air Evacuation System/Vacuum System

3.1.5.1 Piping and Walls

Installation see the PID drawings.

3.1.5.2 Vacuum Pump and Its Piping

Air take –off lines between secondary bundles and holding pumps.

See the Vacuum Piping drawings of HAC and Installation Instructions of Vacuum Pump.

3.1.6 TANK & DRAIN SYSTEM

3.1.6.1 Drain Tank and Its Piping

3.1.6.2 Drain Pump and Its Piping

3.1.6.3 Condensate Tank and Its Piping

Condensate lines between condensate manifolds and turbine exhaust box

Preparation & prefabrication at site the condensate and air take- off piping. Fig-25

Fig 25

Location of main piping. Fig. 26

Fig. 26

3.1.6.4 Condensate Pump and Its Piping

3.1.7 Other Balance Items

3.1.7.1 Cleaning System Along with Ladder

Erection from valley walkway structure for grating and Introduction of the cleaning ladder. Fig. 27

Fig. 27

2.5.25 Introduction of the cleaning ladder. Fig. 28

Fig. 28

Erection of cleaning system, pump and associated pipe works.

3.1.7.2 Stairs and Elevator

3.1.7.3 Air Conditioning and Ventilation System

Air Conditioning of C&I room for ACC adopt split units, composed of indoor unit and outdoor unit.

Installation of split units should according to the manual for split units.

Installation step as follows:

1. Confirm the installation location

   Indoor unit installation location is in C&I room and nearby the wall; Outdoor unit installation location is outdoor and fix on the wall or on the ground. The distance of indoor unit and outdoor unit should not exceed 5 meters.

2. Installation of indoor unit

   According to the manual for split units.

3. Installation of outdoor unit

   According to the manual for split units.

4. Connection of pipeline

According to the manual for split units.

5. Note

Installation of unit should be grounding, prevent of creep age accident.

3.2. **Electrical System**

Installation see the product design drawings of electrical systems.

Installation instrumentation cables tray and cabling after erection of junction boxes.
Fig. 29

Fig. 29

3.3 **C & I SYSTEM**

Installation see the product design drawings of C & I system.

4.0 Special Precaution to Be Taken During Erection

4.1 Bolting

a. Steel structure supplier will submit bolting torque.

b. Bolts fastening of hub, blades and retaining plates should be fixed following recommendations

given in the relevant procedure and recorded on survey sheets.

4.2 Site welding principles

a. On structure and parts of structure as well as all the items that are protected by paint, welding is forbidden. Repairing and/or adaptation of assembling parts are subject to agreement by client before proceeding.

c. All site-welding assemblies are foreseen and indicated on drawing and all sites welding are associated with predetermined WPS.

c. Welding map: each weld should be itemised with a particular reference number recorded in the welding map drawing and listed on record sheets with location and WPS

d. Erection WPS must be in accordance with HAC recommendations. All additional WPS must be approved. Additional WPS concerning material with thickness above 1”and special treatments should be submitted.

e. In case of bad weather conditions special protection during the welding must be taken to avoid weld failure; such prevention will be listed before starting main welding operation and must follow the general welding recommendations.

4.3 Record of deviations and accepted tolerance on construction

a. The whole construction can be subject to deviations. The maximum and minimum deviations admitted must be recorded and evaluated before construction. Required adjustment will be achieved, if necessary.

b. Recording of deviations

- Under structure fan deck level (with reference to ref. x, y, and z).
- At fan deck level, record of all axial deviations at each top column.
- Top A-Frame level and alignment (with reference to ref. x, y, z).
- A-Frame level: starts at fan deck to top steam manifold level which should be recorded concerning all deviation.

A - Bundle alignment (level, gap between tubes-sheets, etc. see procedures).

- Record top and bottom level and axial / lateral deviation after installation of all bundles of the streets, check compliance with relevant procedure for bundle alignment.

- Clearance between fan bell and blade tip. Blade pitch. Gear shaft verticality and fan bell diameter have to be recorded. Fig 30

Fig 30

c. Value of admitted tolerances is given on each particular procedure.

d. Turbine outlet, main duct, riser, manifolds and bellows are subject to particular surveys and the deviation alignment will be done during pre-erection of parts to be assembled.

4.4 Finish with all remaining interconnecting piping between:

Installation of tubes spacers outside the bundles.

Finalisation of welding riser in accordance with procedures and particular statement Proceed with air leak test.

After leak test, remove the blank plate with the man hole.

Electrical consumption test on motor to confirm fan blade pitch and adjustment of fan pitch on all other fans.

Introduction of hoisting equipment.

Erection of cleaning system, pump and associated pipe works.

Final control of ACC concerning erection.