Sustainable Evacuation of Dry Fly Ash at IGSTPP – A Unique Experience

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ABSTRACT

This paper is about the problem faced in Dry Fly Ash Handling System at IGSTPP, APCPL and solution of these problems by Team AHP. APCPL is a Joint Venture Company between NTPC Ltd., Haryana Power Generation Corporation Ltd. (HPGCL), and Indraprastha Power Generation Co. Ltd. (IPGCL) & having total capacity of 3 X 500 MW. Ash Handling System Package is supplied and erected by M/s. DC Industrial Plant Services Pvt. Ltd. (DCIPS), Kolkata. All units are operational since 2012.

Problems Encountered during Initial Phase

- No ash flow from Nuva feeders
- Frequent Choking of Bag filters & Vent Filters
- Frequent outage of AHP system due to passing of Nuva Feeder Valves (Mainly Vent Valve)
- Frequent Pressurization of Fly Ash Transportation lines (FATL)
- High Evacuation Cycle time leading to Ash build up in ESP Hoppers
- Frequent ash leakage from Fly Ash Transportation lines (FATL)
- Fast erosion of Vacuum Pumps Internals & seal water drain lines
- Low Instrument Air pressure 4.0 kg/cm2 with running of all IAC's (3 W + 3 S)
- Fast erosion of Nuva Feeders vent lines
- Frequent pressurization of SILO (PRV pop up)
- Partial choking of FTAL for Main/ FA silo's
- Poor Evacuation from APH Hoppers
- Frequent Interruption in ash Disposal due to failure of Ash conditioner / Rotary Unloader

In the initial phase, the Ash Handling plant dry system had just survived owing to factors like less Schedule Generation & Blended coal, which amounts to an ash loading of 100-110 TPH which is approximately 45% of the rated capacity of the designed system, corresponding to a coal firing of 330-360 TPH. The running Evacuation process slows down & progressively leads to ash build up in ESP hoppers. These Evacuation problems got aggravated to the extent that it led to shutdown of Unit # 2, 3 in month of June 2013.

Then different modifications have been done in phased manner, for sustainable Evacuation the dry fly ash at IGSTPP. As of now, 90% of generated fly has been disposed through bulkers & remaining 10% is through HCSD systems to Dyke.

INTRODUCTION

The unique feature of Dry Fly Ash Evacuation system of IGSTPP is that, it has only Dry mode for ash removal & there is no provision for Conventional wet mode for fly ash removal as stand by system. The Ash Removal system is a combination of vacuum & pressure pneumatic conveying system. The ash removed by this combined pneumatic conveying system is conveyed to Silo's (HCSD or Main) through Ash disposal pipelines inside or outside the plant boundary from where it is ultimately disposed off. For HCSD System (situated inside plant), Ash is disposed through High concentrated Slurry disposal (HCSD) unloading system or in dry mode through Telescopic spout to Ash Carrying Bulkers. For Main Silo, Ash is disposed in semi wet mode through Ash conditioners & in dry mode through Telescopic spout to Ash Carrying Bulkers.

High Concentrated Slurry Disposal System is unique in itself. This is the a first HCSD System in NTPC .The HCSD System Comprises of silos, Rotary feeder, weighing unit, Air slide, AMT(Ash Mixing tank),SCU PLC for maintaining required slurry concentration, booster pump, Mainline piston diaphragm pumps & Main pipeline to HCSD Dyke area.

Conventional Lean Slurry Disposal System and Ash Water Recovery System have limitations/disadvantages on account of higher amount of water wastage/contamination, ground water pollution, potential for ash pond collapse, vast

land required for ash dykes, higher costs for ash pond construction and higher power consumption. These limitations have led to the adoption of new environment friendly ash disposal technologies like High Concentration Slurry Disposal (HCSD) Systems

PROBLEMS OF FLY ASH EVACUATION AT IGSTPP, JHAJJAR

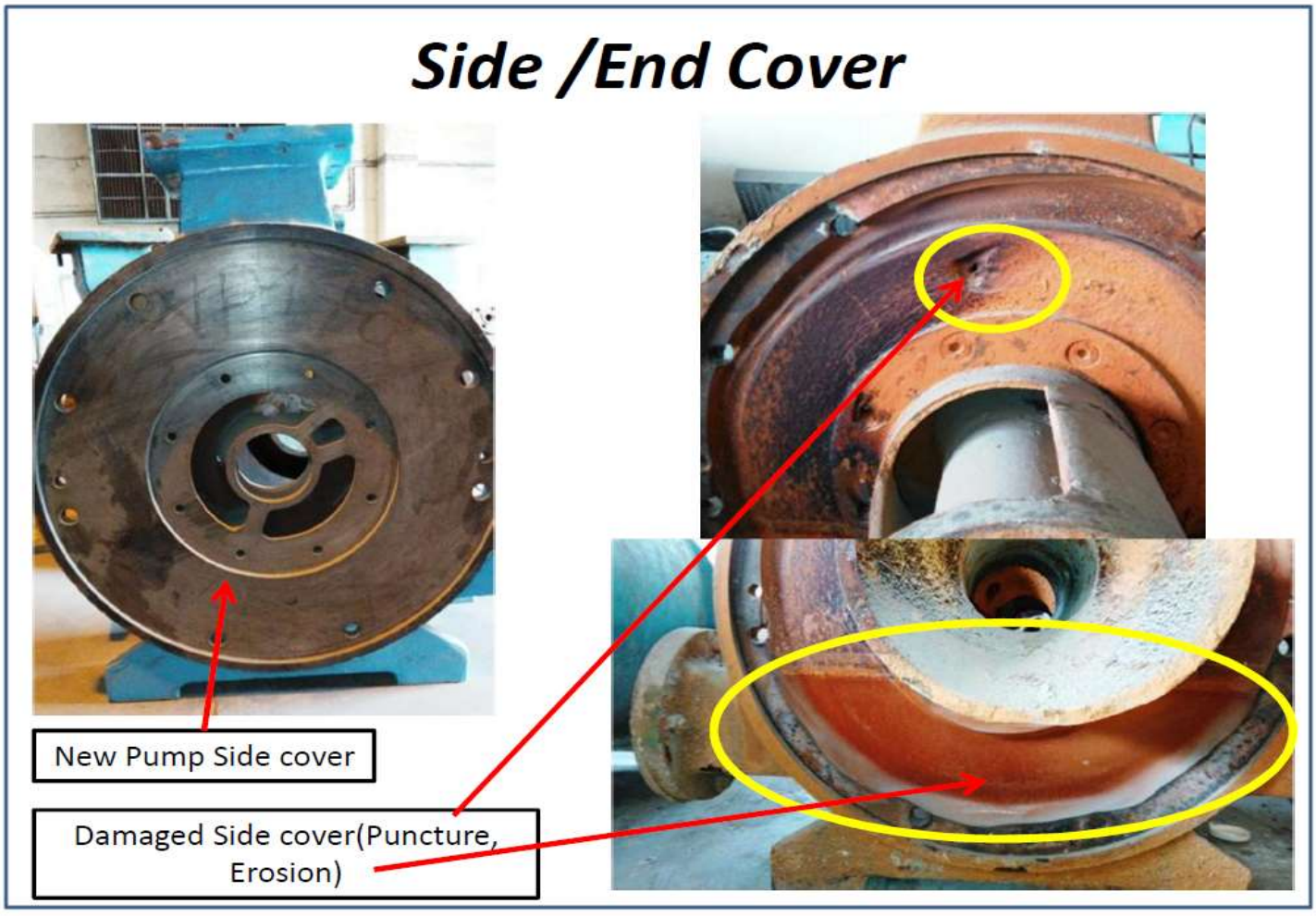
Ash handling plant of IGSTPP had faced a lot of operational Problems since unit commissioning and initial phase of operation. The problems got aggravated to the extent that it led to shutdown of Unit # 2, 3 in month of June 2013. The problems were:

1. Fast erosion of Vacuum Pumps Internals & seal water drain lines
2. Frequent Interruption in Ash discharge from NUVA Feeder to pressure conveying pipelines
3. Poor Ash evacuation from ESP hoppers
4. Frequent Choking and pressurization of Pressure conveying line (Dry Ash Disposal Pipelines)
5. Ash Leakage from Fly ash transportation lines
6. Low instrument air pressure
7. Frequent Interruption in ash Disposal due to failure of Ash Conditioner or Rotary Unloader
8. Frequent Pressurization of Vent filter

1. Fast Erosion of Vacuum Pump Internals & Seal water Drain lines

Root Cause Analysis for Fast Erosion of vacuum Pump Internals & Seal water Drain lines

- ✓ As Hopper becomes empty vacuum pumps extracts Flue gas from ESP hoppers and leads to Acidic seal water



Remedial action taken for elimination of fast erosion of vacuum pump Internals & seal water Drain lines

- ✓ Vacuum pump Internals materials has been changed from CI FG 260 to SS 410. The life has been improved to more than 1 year.
- ✓ Seal water Drain lines material has been changed from CS to SS 410.

- ✓ Silencer Cum Separator tank has been fabricated from SS 410 Sheet, Locally at Site.

2. Frequent Interruption in Ash discharge from NUVA Feeder to pressure conveying pipelines

Root Cause Analysis

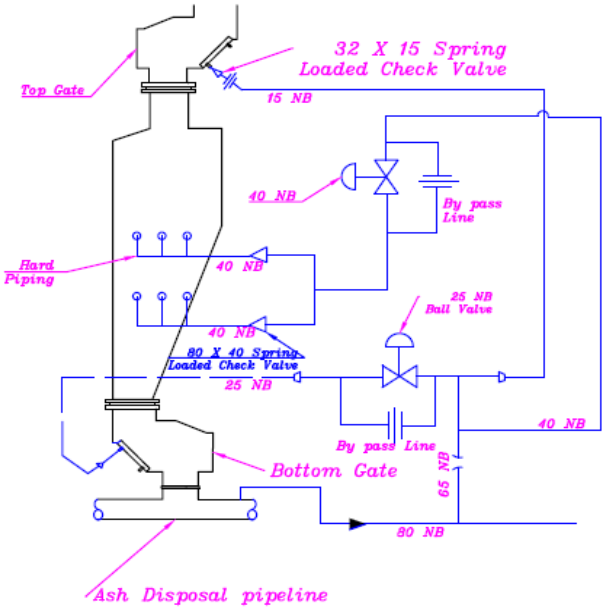
The Nuva Feeder has five valves vent, Top Gate Diffuser Valve, Equalizing, Fluidizing Valve, Bottom Gate Diffuser Valve. These valves operate in a particular sequence of two minute cycle for smooth evacuation of ash from both vacuum conveying as well as pressure conveying system. In case of any problem either passing or abnormal sequence of operation of theses valves vacuum system connects to pressure system for time duration of 48 seconds, after every two minutes in the cycle of operation of Nuva feeder. This causes the disturbance in both Vacuum system & pressure system conveying, which leads to poor Evacuation rate.

- ➢ Nuva Feeder Fluidising pads Arrangement & sealing
- ➢ Insufficient fluidising air for Nuva Feeder Bottom Gate fluidising
- ➢ Nuva Feeders Valves Passing & Nuva Feeders Valve Operation Sequence

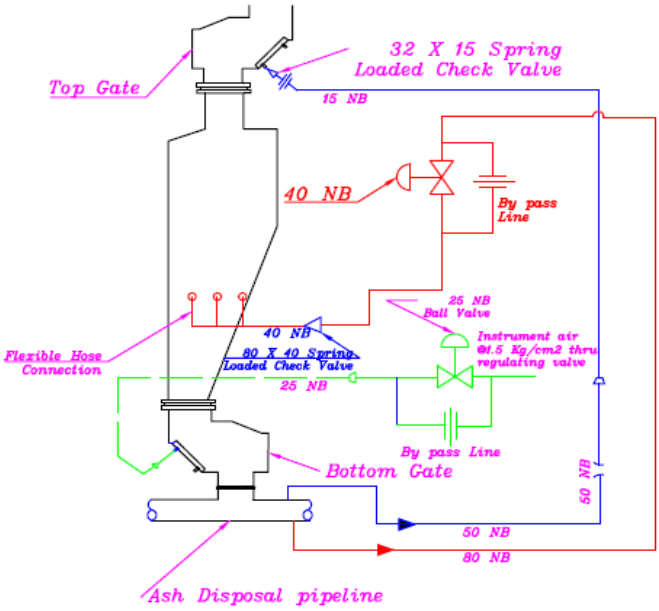
Remedial action taken for interrupted Discharge of Ash from NUVA FEEDERS to Pressure Conveying pipeline

2.1. Modified Sealing Gasket & Arrangement for NUVA Feeder Body Fluidising

Earlier Box type fluidising hard piping scheme has been replaced by fexible hoses with M80 hexagonal adapter. In earlier scheme Champion Gasket & Neoprene Rubber gasket were used for sealing purpose (shown in above figure 2, LH side). Theses Gasket were got damaged as come in contact with high temperature Ash. Now, Silicone Rubber is being used in with M80 adapter (as shown in Fig. 2, Right side).



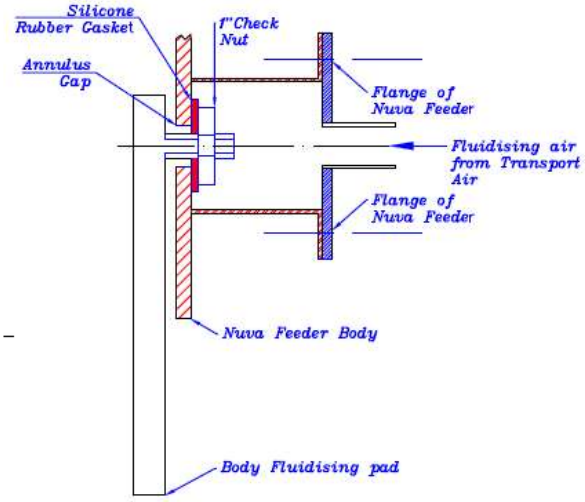
Existing Fluidising Scheme



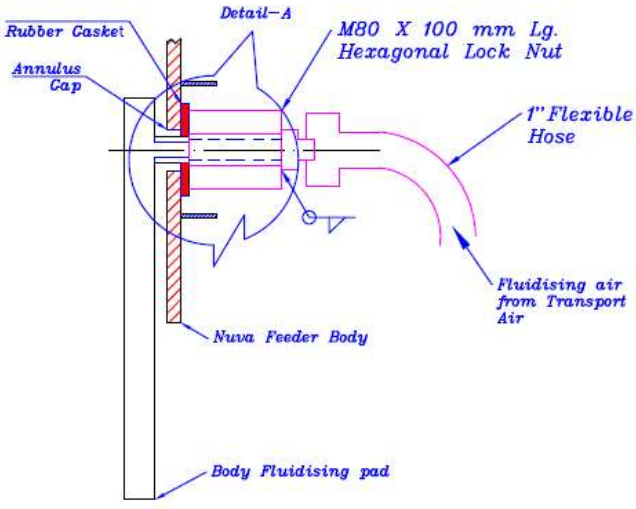
Modified Fluidising Scheme

Benefits:

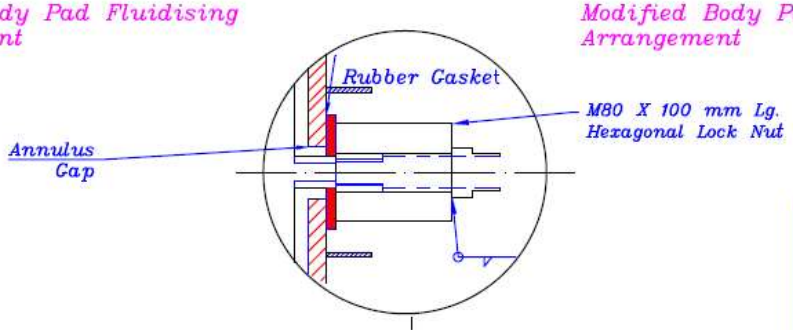
- Un–interrupted Ash flow from Nuva Feeders to Pressure conveying pipeline
- Eliminate the problem of choking of Body fluidising pipeline
- Flexible Fluidising hose leads to elimination of Air leakages, Back Flow of Ash , Erosion of Body pads, Ease in Mechanical Maintenance Activities, MTTF Rises, MTBF rises



Current Body Pad Fluidising Arrangement



Modified Body Pad Fluidising Arrangement



ARAVALI POWER COMPANY PRIVATE LIMITED
(A Joint Venture of NTPC, HPGCL & IPGCL)
Stage–I (3 X 600 MW) ,
Unit # 1, 2 & 3
Modified Nuva Body Fluidising arrangement

Fig: 2

2.2. For Minimising Nuva Feeders Valve passing

- ✓ To address Frequent Passing of Flap Type (Swing Type) Vent & Equalising Valves. Durite Gr IV Seat-Disc has been replaced by Hi-chrome(ASTM A532 CLASS III). These are performing much better than earlier Durite Gr IV Seat-Disc. The life of these HI- chrome Seat & disc is around 3 months.

- ✓ Flap Type Vent & Equalising valves have been replaced by Dual Disc Sliding Valves. These Dual Disc Sliding Valves are also performing much better than flap type valves. With these valves, we are getting a functional life of more than one year.

- ✓ Bottom Gate & Top gate Diffuser Valves Seat & Disc Material Changed from Durite Gr IV to ASTM A532 Gr III. By this we are getting higher hardness so are getting higher life. So Frequent passing problem eliminated.

2.3. Bottom Gate Fluidising

Nuva Feeder Bottom gate Fluidising has been provided from Instrument Air, Pressure of this Instrument air is regulated to 1.5 Kgs. The modified scheme of bottom gate is as per figure 2.

3. Poor Ash evacuation from ESP hoppers

Root-Cause Analysis of Poor Ash Evacuation from ESP Hoppers

The points which causes poor Evacuation are listed below

- ✓ ESP Hopper Fluidising Pressure insufficient
- ✓ ESP Hopper Fluidising Tiles Choking (Back flow of ash to Fluidising lines)
- ✓ Line Vacuum setting & low Shut Off Vacuum
- ✓ Nuva Feeder Problem (Due to Nuva Feeder Valves passing & Nuva Feeder Valve Operation sequence)
- ✓ Bag filter Pulse Jet Timing issue

Remedial action taken for Improvement in Ash Evacuation rate from ESP hoppers

3.1. For improving ESP Blower pressure

- ✓ ESP Blower pressure has been improved by installing orifices at buffer hopper fluidising line (8mm dia.) and ESP hopper Fluidising line (5mmdia).
- ✓ Suction filter being cleaned regularly as maintenance practice
- ✓ Pneumatic Fluidising valves & Fluidising lines purging is adopted as good maintenance practices
- ✓ Checking of Healthiness of ESP Hopper & MHV Fluidising tiles on regular intervals & Corrective action is being taken for maintaining required blower pressure

With above mentioned practices & modifications fluidizing blower discharge header pressure is around 0.25 to 0.3 kg/ cm2. Further improvement of pressure up to 0.3 to .35 kg/ cm2 is required for better fluidisation.

3.2. For reducing back flow of Ash from ESP Hopper to Fluidising Tiles

- ✓ Proper sealing done on ESP Hopper & MHV Fluidising tiles

- ✓ Manual isolation valves erected in each fluidising lines for purging purposes

3.3. Low Shut Off Vacuum

Major cause for low shut off Vacuum was suspected in Vacuum pump. So Vacuum Pump motor pulley dia. Changed from 315 mm to 345 mm which led to the improvement in shut off vacuum from 300mm Hg to more than 400mm Hg. Line vacuum is set at 120 mm Hg.

3.4. For Minimising Nuva Feeders Valve passing

- ✓ To address Frequent Passing of Flap Type (Swing Type) Vent & Equalising Valves Hi-chrome (ASTM A532 CLASS III) Seat-Disc are put in Service in some of NUVA feeders of Unit #2 & 3 on Experimental Basis. These are performing better than earlier Durite Gr IV Seat-Disc.
- ✓ Dual Disc Sliding Valves are also being used in place of Flap Type Vent & Equalsing valves (shown in fig 1 & 3). These valves are also performing better than flap type valves. With Theses valves we are getting a functional life of more than one year.
- ✓ Bottom Gate & Top gate Diffuser Valves Seat & Disc Material Material Changed from Durite Gr IV to ASTM A532 Gr III. By this we are getting higher hardness so are getting higher life. So, frequent passing problem eliminated.

3.5. Bag Filter pulse jet timing setting

- ✓ Pulse jetting is used for dislodging the suspended as stick to the bag filters.
  On time/ pulse duration: 200 msec
  Pulse frequency: 10 pulse/ min.

4. Frequent Choking and pressurization of Pressure conveying line

Root Cause Analysis of Frequent Choking of Pressure Conveying Pipelines

In case of passing of Nuva Feeder Valves or abnormal sequence of operation of Nuva Feeders valves, the pressure system connects to vacuum system for time duration of 48 seconds in each two minutes, of the cycle of Nuva feeder. This connection of vacuum system with pressure system causes flow of pressure conveying (Transport Air) Air from Pressure system to vacuum system, leads to reduction in both air Mass Flow rate & pressure in Pressure conveying system. Due to above mentioned problem the air velocity in FATL reduces, eventually as this Air velocity goes below the minimum required velocity (Pick up velocity) the ash in suspension settles down in pipeline causes choking or blockage of the pipeline.
The point which leads to frequent choking of pipeline are mentioned below.

- ➢ Nuva Feeders Valve Passing & Nuva Feeders Valves Operation Sequence
- ➢ Excess Fluidising Air for Nuva Feeder Bottom Gate Fluidisng
- ➢ TAC Triping & Nuva Feeders Bottom Gate Closing Logic
- ➢ HCSD / main Silo Changeover valves passing

Remedial action taken for Elimination of Pressure Conveying line Choking/ Blockage

4.1. For Minimising Nuva Feeders Valve passing

- ✓ To address Frequent Passing of Flap Type (Swing Type) Vent & Equalising Valves. Durite Gr IV Seat-Disc has been replaced by Hi-chrome(ASTM A532 CLASS III). These are performing much better than earlier Durite Gr IV Seat-Disc. The life of these HI- chrome Seat & disc is around 3 months.
- ✓ Flap Type Vent & Equalising valves have been replaced by Dual Disc Sliding Valves. These Dual Disc Sliding Valves are also performing much better than flap type valves. With these valves, we are getting a functional life of more than one year.
- ✓ Bottom Gate & Top gate Diffuser Valves Seat & Disc Material Changed from Durite Gr IV to ASTM A532 Gr III. By this we are getting higher hardness so are getting higher life. So Frequent passing problem eliminated.

4.2. Excess Fluidising Air for Nuva Feeder Bottom Gate Fluidisng

- ✓ Bottom Gate Fluidising Air Pressure is maintained around 1.5.
- ✓ Bottom gate Fluidising stone/ Tile is being inspected proper sealing on periodic basis.

4.3. TAC Tripping & Nuva Feeders Bottom Gate Closing Logic

A modified Logic is being incorporated for protection of Conveying line from being getting choked in case of TAC tripping on any Fault.

4.4. Modified Logic for TAC speed Regulation/ Unloading

TAC Automatically Regulate speed with line pressure for prevention against line being getting choked.

4.5. HCSD / Main Silo Change over valves Passing

Pneumatic Knife gate Changeover valves has been replaced by Positive Shut off dual disc sliding valves.

5. Ash Leakage from Fly ash transportation lines

Root Cause Analysis for leakage in Pressure conveying pipelines

- Improper Supports & strengthening at Bends
- Improper alignment
- Vibration at pipe rack

Remedial action taken for Minimizing Ash Leakage in FATL

- ✓ Additional channel support has been provided for better Strengthening & Clamping Purpose
- ✓ Realignment of pipe carried out & Pipe Locking done at bends.
- ✓ Pipe locking done at bends against thrust & vibrations

6. Low instrument air pressure

Root Cause Analysis for Low Instrument Air Pressure

AHP have been experiencing low instrument air pressure problem since inception .This was causing problems in MHV and other actuator operation. Also pulse jetting in buffer hopper was not getting adequate pressure (4.3 kg/cm2 against design value of 5.5 kg/cm2).

- Air leakages through fittings of actuators, pneumatic valves
- Compressors cylinders wear out
- Leakage through pulse bars, valve glands

Remedial action taken for Improvement in Instrument air Pressure
For Improvement in Instrument air pressure

- ✓ Therefore to augment instrument air pressure, compressor pulleys have been changed to higher size.
- ✓ Pre-Filter & After Filter cleaning is carried out on periodic basis.
- ✓ ADP servicing carried out.
- ✓ All IAC servicing carried out.
- ✓ Third party air audit carried out. All leakage points attended. On the basis of Audit report DCIPS agrees to give 01 Nos. additional Air Compressor to meet the shortfall in air capacity.

Additional support has been taken from main plant for further improvement in Air pressure. With above mentioned steps IAC pressure Improved to 5.8 ksc with IAC in service

7. Frequent Interruption in ash Disposal due to failure of Ash Conditioner or Rotary Unloader

Root Cause Analysis for Frequent Failure of Ash Conditioner (Rotary Unloader)

- ✓ Frequent Failure of Idler sprocket pin
- ✓ Frequent shifting of Drum & guide rollers
- ✓ High Vibrations at base

Remedial action taken for Elimination of frequent failure of Ash Conditioner

Ash conditioner is replaced by Air slide.

8. Frequent Pressurization of Vent filter

Root Cause Analysis for Frequent pressurization of Vent filter

- ✓ insufficient Instrument Air pressure for pulse jetting of vent filter
- ✓ Silo relief Valve pressure setting issue
- ✓ Insufficient suction to Vent fan

Remedial action taken for Elimination of Frequent Pressurization of SILO's

Pulse jet frequent increased

- ✓ Pulse jet duration increased
- ✓ Additional 400 NB suction pipe attached to vent filter suction pipe