REPORT ON TRIPPING OF BOTH SAP PLANT ON 08.11.2012 AT 9:27:19 AM

Dated: 17/11/2012

A committee comprising of following members was nominated by competent authority:

I.	Mr. C N Shah,	JGM (Process),	Chairman
II.	Mr. P K Jha,	DGM (Mech.)	
III.	Mr. A P Tripathi,	Sr. Mgr (SAP)	
IV.	Mr. Sarvesh Kumar Srivastava,	Dy. Mgr (Inst.)	
V.	Mr. S R Garai,	Asst Mgr (Electrical)	

1. To investigate the reasons for tripping of both SAP on 08.11.2012 and
2. To give recommendations / suggestions to avoid recurrence of such trips in future.

1.0 Plant condition during triping of both SAP1 and SAP2

Both SAP were operating normal with SAP-I operating at sulphur firing of 42 t/h and SAP-II operating at sulphur firing of 44 t/h.

In morning shift on 08.11.2012, it was observed by the SAP panel in charge that at 09.27.19 AM, in both SAP trains, with actuation of Blower surge alarm and trip signal, SAP1 blower turine tripped. Trip signal of blower turbine led to trip of both plants sulphur pump at the same time i.e. 9:27:21 AM.

Due to problem in trip block of SAP-II turbine, even after getting trip command from DCS, turbine did not tripped and the same was stopped by the DCS engineer to avoid system cooling as sulphur pump of SAP-II was already tripped. Circulation of acid in DT, IAT and FAT were on with all pumps in operation.

2.0 Trip Incident investigation

To investigate the incident we can use:

a) Sequence Event Recording by DCS (attached as **Annexure – I**).
b) Sequence Event Recording by PLC of surge analyser (not available).
c) SAP shift in-charge's logbook (attached as **Annexure – II**).
d) DCS Trend of various parameters,

In absence of the Sequence Event Recording by PLC of surge analyser, which can have scan time in mille seconds, we have selected / considered the Sequence Event Recording by DCS with scan time of 1 second.
Following points were considered for investigation:

- Reasons for tripping of air blower turbine.
- Reasons for tripping of sulphur pumps and both SAP 1&2.

3.0 Trip Related Sequence Event Recording by DCS

Date and Time		Description	
11.08.2012	**9.27.19 AM**	**10PSL1422AN**	**Surge Alarm for SAP1**
11.08.2012	**9.27.19 AM**	**10PSLI1422AN**	**Surge Trip for SAP1**
11.08.2012	**9.27.19 AM**	**S1TRBTRIPAN**	**SAP1 turbine trip**
11.08.2012	**9.27.19 AM**	**10PSL2422AN**	**Surge Alarm for SAP2**
11.08.2012	**9.27.19 AM**	**10PSLL2422AN**	**Surge Trip for SAP2**
11.08.2012	**9.27.19 AM**	**S2TRBTRIPAN**	**SAP2 turbine trip**

(Due to problem in trip block of SAP-II turbine, even after getting trip command from DCS, air blower turbine was not tripped and the same was stopped by the DCS Engineer at 9.29.24 AM (after 2 minute 5 seconds) to avoid system cooling as sulphur pump was already tripped. Copy of the DCS Operator / Shift In charge logbook is attached **as Annexure-II**)

11.08.2012	9.27.20 AM	10P8301-1 AN	Trip oil Pr. Low ALM
11.08.2012	**9.27.21 AM**	**W1-17 AN**	**SAP1 Sulphur pump Trip ALM**
11.08.2012	**9.27.21 AM**	**W2-17 AN**	**SAP2 Sulphur pump Trip ALM**
11.08.2012	9.27.22 AM	10VE809-1	GB RADIAL BURNER SIDE PV==60.14
11.08.2012	9.27.22 AM	10VE810-1	GB RADIAL PAP SIDE PV==62.9
11.08.2012	9.27.22 AM	10P0160C	Sulphur pump VPT1 PV==25.5 IOP
11.08.2012	9.27.22 AM	W1-6AN	Turbine Trip oil Pr. Low ALM
11.08.2012	9.27.24 AM	10PDSAP-1AN	AIR FLTR DIFF. Pr. Low NR
11.08.2012	9.27.39 AM	10PT074-1	EXHAUST STEAM PR. LOW PV=3.489
11.08.2012	9.27.42 AM	10P0260C	SULPHUR PUMP VPT2 PV=12.2

11.08.2012	9.27.48 AM	10FT1401A	BLOWER DISCH AIR FLOW PV= 400000 Nm3/Hr IOP Recover
11.08.2012	9.28.01 AM	W1-7AN	TUR EX STM PR. LOW ALM
11.08.2012	9.28.01 AM	W2-20AN	SAP-2 BLOWER DISCH PR. LOW ALM
11.08.2012	9.28.12 AM	W2-7AN	TUR EX STM PR. LOW ALM
11.08.2012	9.28.42 AM	10FT1302R	EXP STM FLOW PV=94 TPH HH Rec
11.08.2012	**9.29.24 AM**	**10NAX2400AN**	**TRIP FRM TRBN GOVR. NR**
11.08.2012	9.29.25 AM	W1-7AN	SAP-1 BLOWER DISCH PR. LOW ALM
11.08.2012	9.29.25 AM	W2-7AN	SAP-2 BLOWER DISCH PR. LOW ALM
11.08.2012	9.31.16 AM	10PSL1422AN	SAP-1 SURGE ALARM NR
11.08.2012	9.31.16 AM	10PSLL1422AN	SAP-1 SURGE TRIP NR
11.08.2012	9.31.16 AM	10PSL2422AN	SAP-2 SURGE ALARM NR
11.08.2012	9.31.16 AM	10PSLL2422AN	SAP-2 SURGE TRIP NR

3.0 Reasons for Alarm/Trip of Air blower turbine and sulphur pumps

As per the DCS trend history, both SAP1 and SAP2 air blowers' surge alarm and trip were actuated at 9:27:19 AM leading to tripping of SAP1 blower turbine. Due to problem in trip block of SAP-II blower turbine, even after getting trip command from DCS, turbine for SAP2 did not tripped and the same was stopped by the DCS engineer at 09.27.24 after 2 minute and 5 second to avoid system cooling as sulphur pump had already tripped. The above is also confirmed by the trend of various parameters like turbine speed, blower discharge pressure, Turbine steam exhaust pressure etc. Detailed analysis could not be done as Sequence Event Recording from PLC of surge analyser is not available.

There is a trip interlock for sulphur pumps with MAB turbine tripping (2 Sec delay time after turbine trip). As seen in the DCS trend, both SAP plants sulphur pump tripped at the same time i.e. 9:27:21 AM.

4.0 Observation and Analysis of Trip Incident:

All the parameters of both SAP plants were checked for time just before the SAP plants tripping and all parameters were found steady. Also no alarm was recorded in DCS historical report, which can lead to SAP plants tripping.

The trend graphs of the following important parameters for both the SAP trains, which can lead to surge or tripping of air blower turbine were analysed and no abnormality was observed in these parameters except for the signal from surge monitor for tripping of the turbines of both SAP plants, which subsequently led to tripping of sulphur pumps ant total shutdown of both SAP plants.

4.1 Air blower discharge pressure (trend attached as **Annexure – III**).

Air blower discharge pressure trend for SAP1 was steady at 489 mbar till it got tripped and that of SAP2 was steady at 505 mbar. The trend of blower discharge pressure indicates that blower for SAP2 was running till 9.29.24. There is no sudden increase of the blower discharge pressure, which can lead to surging of the blower.

4.2 Turbine speed (trend attached as **Annexure – IV**).

Air blower turbine speed trend for SAP1 was steady at 12352 rpm till it got tripped and that of SAP2 was steady at 12429 rpm. The trend of turbine speed indicates that blower for SAP2 was running till 9.29.24. As the speed of both turbines was normal, this cannot lead to surge condition of the blower.

4.3 Turbine exhaust pressure (trend attached as **Annexure – V**).

Turbine exhaust pressure for SAP1 and SAP2 was steady in range of 3.9 to 4.0 kg/cm2g till time of SAP1 turbine trip. As SAP1 turbine tripped and SAP2 turbine was still running because of the trip block problem, turbine exhaust pressure reduced to 3.3 kg/cm2g. After tripping of SAP2 turbine, steam exhaust pressure dropped sharply. Both turbines' exhaust pressure was much below the turbine trip set value of turbine exhaust pressure high.

4.4 Lube oil pressure (trend attached as **Annexure – VI**).

Lube oil pressure for blower and turbine in SAP1 was 1.65 kg/cm2g and that for SAP2 train was 1.57 kg/cm2g. Both the above values are higher than the turbine trip set value for low LO pressure of 1.0 kg/cm2g.

4.5 Trip signal from Blower surge control monitor

Surge control monitor unit is common for both the SAP air blowers. Turbine alarm and tripping for surge is set with blower surge (blower discharge pressure 2 pulsation of ± 50 mbar/Sec gradient for alarm and 6 pulsation of ± 50 mbar/Sec for tripping). Both the plant blower surge alarm and trip command was generated at 9:27:19 AM without any pulsation.

As mentioned in point no.4.1, both air blowers discharge pressure trend do not show any pulsation. As mentioned in point no.4.2, both Turbines speed was also constant. Tripping of both SAP trains seems to be due to false signal from surge monitor, which is a matter of great concern. Presently, both SAP trains are restarted and both air blowers are in operation with surge trip bypassed. There is no indication from surge monitor on DCS monitoring station. SAP DCS Operator cannot visualize about the deviation if any being monitored by surge monitor.

4.6 Air blower axial & radial vibration (trend attached as **Annexure – VII**).

Both air blowers' axial and radial vibrations were steady and within specified limit range as given below:

Description	Unit	Value	Lower limit	Upper limit	Remark
SAP1 blower radial vibration					
Burner side	µmpp	18.22	0	200	OK
PAP side	µmpp	18.81	0	200	OK
Burner side	µmpp	8.6	0	200	OK
PAP side	µmpp	9.0	0	200	OK
SAP1 blower axial vibration					
Burner side	mm	0	(-)1.0	1.0	OK
PAP side	mm	0	(-)1.0	1.0	OK
SAP2 blower radial vibration					
Burner side	µmpp	28.11	0	200	OK
PAP side	µmpp	31.40	0	200	OK
Burner side	µmpp	24.08	0	200	OK
PAP side	µmpp	23.01	0	200	OK
SAP2 blower axial vibration					
Burner side	mm	0.43	(-)1.0	1.0	OK
PAP side	mm	0.44	(-)1.0	1.0	OK

4.7 Turbine axial and Radial vibration (attached as **Annexure – VIII**).

Both blower turbines' axial and radial vibrations were steady and within specified limit range as given below:

Description	Unit	Value	Lower limit	Upper limit	Remark
SAP1 turbine radial vibration					
Burner side	µmpp	19.48	0	200	OK
PAP side	µmpp	21.11	0	200	OK
Burner side	µmpp	11.35	0	200	OK
PAP side	µmpp	12.99	0	200	OK
SAP1 turbine axial vibration					
Burner side	mm	0.25	(-)1.0	1.0	OK
PAP side	mm	0.20	(-)1.0	1.0	OK
SAP2 turbine radial vibration					
Burner side	µmpp	29.20	0	200	OK
PAP side	µmpp	32.01	0	200	OK
Burner side	µmpp	56.05	0	200	OK
PAP side	µmpp	71.45	0	200	OK
SAP2 turbine axial vibration					
Burner side	mm	0.20	(-)1.0	1.0	OK
PAP side	mm	0.20	(-)1.0	1.0	OK

4.8 Tripping of sulphur pumps

Sulphur pump for both SAP trains were tripped at 9.27.21 AM, exactly 2 seconds after the trip signal to air blowers at 9.27.19 AM. Sulphur pumps may trip in case of power failure, stoppage of pump due to electrical problem or with trip signal from acid circulation pump trip or main air blower turbine trip.

There was no failure of power or any electrical problem. On checking the drives immediately after tripping, it was observed that all four drives were found in healthy condition & motors were in stop condition due to the stop command from DCS & there was no fault indication in Drives. As acid circulation pumps were in operation, it can be concluded that sulphur pumps had tripped due to surge trip signal from surge monitor turbines trip and leading to sulphur pump tripping.

4.9 Observation from Electrical on Tripping of sulphur pumps

On 08/11/2012 at 09.00 AM, with both SAP plants operating normal, power drawl for SAP plants was 2.78 MW load from TG. At 9.30 AM Panel operator of SAP process Informed that all four number sulphur pump have tripped. Electrical Engineers checked each drive panel and found that all four drives were in healthy condition & motors were in stop condition. It was checked and found that stop command had came from DCS & there was no fault indication in Drive. Except these four sulphur pump motors, all other motors were running at that time. Same was informed to SAP Process Department, Energy center Electrical & DGM (Electrical).

Feeder wise Power distribution of all four number sulphur pump is given below:

P160- New MCC #11 at new substation –Transformer no-14
P161- MCC #10E - Transformer no-13
P260 - New MCC #12 at new substation - Transformer no-15
P261- MCC#10A - Transformer no-13

5.0 List of Trips for Air blowers and sulphur pumps

List of Trips for of SAP trains including that for Air Blowers, Sulphur Pumps and other trips list along with set points is attached as **Annexure – IX**.

5.1 Trip system check

As per the SAP Process, before restart of main air blower, its trips are checked for proper functioning and same is mentioned in the shift in-charge logbook that trips checked and found OK. Please refer copy of the relevant page of the shift in-charge log book dated 04.11.2012 C shift and 16.11.2012 A shift **(Annexure – X)** mentioning that “Sulphur pumps, & MOP, AOP Interlock with turbine checked and found OK”. No separate report for trip / interlock checking with date of checking of each trip for the equipment, actual trip value Vs trip setting etc. is maintained. On verifying the shift in-charge logbook for A shift on 08.11.2012 (**Annexure – II)**, no details about the trip checking for main air blower and sulphur pumps before restart of these machines is mentioned to confirm that all trips are in healthy condition and will actuate as desired for safety of the machine.

6.0 Prossible reason for tripping of both SAP trains simultaneously other than the surge monitor malfunction.

Both SAP plant air turbine tripping at the same time may occur only with the turbine trip due to exhaust steam pressure low / high, as exhaust steam header is common for both the turbines. Both turbines may get tripped in case of LOW exhaust steam pressure less than or equal to 3.2 kg/cm2g or HIGH exhaust steam pressure of more than or equal to 5.6 kg/cm2g.

The trip command for turbine Trip for both SAP plants was not initiated by exhaust steam pressure, which can be confirmed from Sequence Event Recording by DCS (**Annexure – I**) as well as steam exhaust pressure reading trend (**Annexure – V**).

As per the Sequence Event Recording by DCS, trip action was from blower surge control monitor. Blower air flow, blower discharge pressure, blower suction pressure, turbine speed does confirm that blower was running steady and far away from surge limit as is clear from blower characteristic curve.

~~For protecting the blowers from surges, a common surge monitor unit is installed for both the turbines. It may give the trip signal to both the turbines.~~

7.0 Possibility of simultaneous surging of Air blowers

Both SAP1 and SAP2 air blowers and both plants are independent of each other.

It is understood that occurrence of surge conditions in both the blowers simultaneously is impossible as operation wise both the turbo – blowers is isolated from each others and there is no major pressure fluctuation observed in trends of surge monitor unit. (Trend of surge monitor enclosed for reference).

8.0 Action taken after tripping of both SAP1 and SAP2

After tripping of both SAP, the healthiness of surge monitor along with power supply, fuses & pressure transmitters in field were checked by Instrumentation and found everything in line.

Electrical Engineers checked each drive panel of sulphur ump and found that all four drives were in healthy condition & motors were in stop condition. It was checked and found that stop command had came from DCS & there was no fault indication in Drive. All other motors were running normal.

After clearance from Instrumentation and Electrical, both SAP plants were started after bypassing surge control monitor. DCS panel engineer is instructed to closely monitor Blower discharge pressure and air flow indication. Blower discharge pressure high alarm is already set at 500 mbar.

An instantaneous malfunction of surge monitor is suspected leading to tripping of both the turbines. Thereafter signals for Surge tripping in both the turbines are bypassed as per request of SAP operation head and both the turbines are started.

Correspondence has been done with the supplier of surge monitor with intimating the all above occurrence and their reply is also received which is enclosed herewith for reference

9.0 Gist of the Correspondance with the Surge analyser supplier

IFFCO Mail

We have installation of M/s Petrotech USA supplied surge monitor unit (Model : Em-400) which is commissioned by you in our sulphuric acid plant. This one surge monitor unit is used to monitor surge events in two nos. turbo driven blowers. This monitor generates alarm signal on experiencing 2 consecutive pressure gradients of +/- 50 mBar/sec. and trip signal on experience 6 consecutive pressure gradients of +/- 50 mBar/sec.

Yesterday (On 08.11.12) we have faced a problem when both the turbo driven blowers got tripped on same time (09:28 AM) and as per history recorded in DCS the reason for tripping was occurring the surge event.

We fail to understand that why surge event occurred in both the turbo blower simultaneously because operation wise both the turbo blowers are isolated from each others. We also doubt on the malfunctioning of surge monitor. However after tripping we have checked the power supply and healthiness of system and found all the things in order.

You are requested to analyze the problem & suggest us to take the remedial action. If any other protection is required to adopt for safe & reliable operation of surge monitor, pl. suggest.

At present both the turbo blowers are operating at high risk in surge bypass mode. Hence, please take up the matter with M/s Petrotech on emergency basis arrange for immediate remedial action.

Petrotech reply

Hari,

The surge protection of each blower is independent of one another.

A surge event on one machine should not cause both machines to trip.

As mentioned, the surge protection monitors separate dp transmitters for each machine.

If surge is detected, each machine has a separate surge trip contact to the DCS.

In order to confirm individual surge protection for each unit, the customer should verify the following:

- Confirm proper isolation between flow transmitters for each unit by simulating loop signals to the controller.
- Confirm proper shielding of these xmtrs with a single point shield ground. There are two separate shutdown signals for each unit to the DCS. Confirm each shutdown signal is wired independently to the DCS.
- Each shutdown signal is a dry contact. Verify DCS power supply to each of these contacts is independent and reliable.
- Verify that a reliable uninterrupted power supply feeds the surge protection unit.
  Review trend of flow signals to determine if the unit flow was fluctuating.

  We currently have two independent shutdowns wired to the DCS. Please inform us which DCS unit surge shutdown was displayed on the DCS alarm summary.

  Also please inform us of **all alarms displayed on the surge protection hmi** and the desktop pc hmi around the time of the event.

Thank you,

Ryan Curry
Engineering Manager
504-620-5324

IFFCO Mail

We have verified your queries and our point wise reply is as below.:

1. Pressure transmitters installed in outlet duct of both turbo blowers are isolated from each other and they have also been checked by simulating the loop signals to the controllers and found normal.
2. Shielding of pressure transmitters are found connected to the ground at transmitters end.
3. The shut down signals are wired through two separate single pair cables to the separate DCS.
4. Since separate DCS is used for two dry contacts, interrogation voltage is verified for reliability
5. 110V AC power supply is fed to the surge monitor from 25 KVA UPS.
6. Discharge pressure trend of both the blowers and DCS historical reports are attached herewith for your reference.

No recycle to avoid surge

10.0 Possible Risk for SAP tripping

10.1 Possible Risk for SAP tripping due to Surge Trip of Turbines

Signal initiation for Surge tripping in both the turbines at same time is only possible when surge monitor unit gives false signals for tripping of turbines to the DCS.

10.2 Problem in Trip block of SAP2

It has also been observed that when trip command issued by DCS for tripping of both the turbines, SAP-2 turbine was not tripped physically. Since both sulphur pumps in SAP-2 were tripped on receiving the turbine trip command, panel operator has tripped the turbine manually. This problem has also been occurred previously and solved after changing the turbine trip block unit. This is very dangerous situation when SAP-2 turbine is still running with out any protection.

11.0 RECOMMENDATIONS BY COMMITTEE

1. To investigate the reson for false alarm and tripping of turbine signal from surge monitor and rectify the same. Also, the matter shall be taken up with M/s Petrotech, USA to resolve the issue and measures / modifications, upgradation of software for surge monitor etc to avoid problem in future.
2. The provision for Alarm and Shutdown Sequence Recording in surge analyser EM-400 shall be got started / activated (pg 11 of 14 of user manual), which can be useful for analysing the problem in the plant if any.
3. To rectify the problem in trip block of SAP-II blower turbine so that it shall trip with signal from PLC DCS. This will avoid machine operating at higher risk.
4. Presently, both SAP trains are restarted and both air blowers are in operation with surge trip bypassed. Instrumentation shall investigate the reasons for generation of false tripping signal of surge alarm and surge trip and if necessary take help of the surge monitor supplier to find out the reason to solve the problem.
5. There is no indication from surge monitor on DCS monitoring station. The same may be given on SAP DCs to facilitate SAP DCS Operator to check & monitor the deviation reading in surge monitor.
6. For all critical machines like air blower & turbine, there shall be mandatory checking of alarms and trips actual values Vs set values during each restart of machine and same shall be kept as records similar to other IFFCO Plants.
7. There shall be proper logging of all the important events and details of the jobs carried out in the plant with time and action taken etc. during the shift in the Shift in-charge logbook.
8. Log sheets shall be checked / reviewed and signed by Shift in-charge and Sectional Head.

~~9. MODIFICATIONS TO BE DONE TO IMPROVE THE EXISTING SYSTEM~~

~~Instead of common surge monitor, two independent surge monitors equipped with alarm& trend facility to be installed to nullify the possibility of tripping of both the turbine due to false signals It will also improve the reliability of system.~~

10.

12.0 List of Annexures

Annexure – I Sequence Event Recording by DCS
Annexure – II SAP shift in-charge's logbook
Annexure – III Air blower discharge pressure trend
Annexure – IV Turbine speed trend
Annexure – V Turbine exhaust pressure
Annexure – VI Lube oil pressure
Annexure – VII Air blowers' axial & radial vibration
Annexure – VIII Turbines' axial and Radial vibration
Annexure – IX List of Trips for Air blowers and sulphur pumps
Annexure – X Copy of shift in-charge log book dated 04.11.2012 and 16.11.2012
Annexure – XI Details of the EM-400 Anti Surge Monitor
Annexure – XIi Correspondance between IFFCO and Sharman India / M/s Petrotech USA for EM-400 Anti Surge Monitor

Other Points which can be included in the report

- Sulphur Flow – 10FT1201,10FT1206
- Air Flow – 10FIC1401
- Export Steam Flow – 10FT1302
- Turbine Speed – 10ST0762-1
- Turbine Inlet Steam Flow – 10FT1560

SAP-2

- Sulphur Flow – 10FT2201,10FT2206
- Export Steam Flow – 10FT2302
- Turbine Inlet Steam Flow – 10FT2560

Surge Monitoring System Trends

1> Anti surge monitor user's manual
2> Anti surge System Instrument Diagram
3> Anti surge System Wiring Diagram
4> Symbol Sheet for wiring diagram of Anti surge System.

Boiler drum level low

Turbine Trip oil pressure low