PROCESS INCIDENT INVESTIGATION REPORT

Incident: Flash over in Transformer at Ammonia storage leading to fluctuation in GTG power.

Brief description:

GTG-I was running normal on 03/08/2011 with parameters given below:

Load	:	19.813MW
MVA	:	20.76
MVAR	:	6.11
Voltage	:	11.0KV
Current	:	1086Amp
Frequency	:	50.08HZ
Power Factor	:	0.96

Suddenly at 18:08:27 hrs, load fluctuation occurred due to flash out in ammonia storage 11/0.415 KV transformer. This caused the rise in load of GTG-I and corresponding dip in frequency. Parameters observed just after flash out were as follow:

Load	:	20.183MW
MVA	:	27.22
MVAR	:	9.34
Voltage	:	9.076KV
Current	:	1786 Amp
Frequency	:	Dip could not be captured but might be below 48.6 as it had lead to actuation of LMS.
Power Factor	:	0.74

Following sequence of events occurred due to power fluctuation:

A) Power failure at Ammonia storage (UPS power for control system was available)

B) Tripping of Ammonia refrigeration compressor (K-451) in ammonia-I plant. (Alarm is attached)

C) Tripping of one of the Ammonia feed pumps (11-P1B) of Urea-I plant. (Alarm is attached)

D) Tripping of 21-Unit of Urea-I plant.

E) Tripping of both the units of Urea-II plant.

GTG-I was saved by LMS by throwing off the assigned loads. Load came down to 13.86 MW with survival of Ammonia-I, Ammonia –II and 11-Unit of Urea-I plant.

How did it happen?

Power fluctuation

Earth fault occurred in Insulator of one phase of HT termination in 11/0.415KV transformer at ammonia storage which caused heavy over current on 11KV bus and further caused severe voltage dip, LMS acted to save GTG1. Following incidents took place subsequently after the earth fault in ammonia storage:-

1) **Actuation of load management system (LMS):** Actuation of load management system on under frequency caused the load shedding of all the four stages as defined (Refer Annexure-I). This caused the tripping of 21-Unit of Urea-I plant as defined in 4th stage of LMS along with other loads of stage 1, 2 & 3.

2) **Dip in control power of LT motors:** Dip in control power of LT motors caused the tripping of all the LT motors in complex. This finally caused the tripping of K-451(refrigeration compressor) of Ammonia-I plant and 11-P1B (Ammonia feed pump) of Urea-I plant.

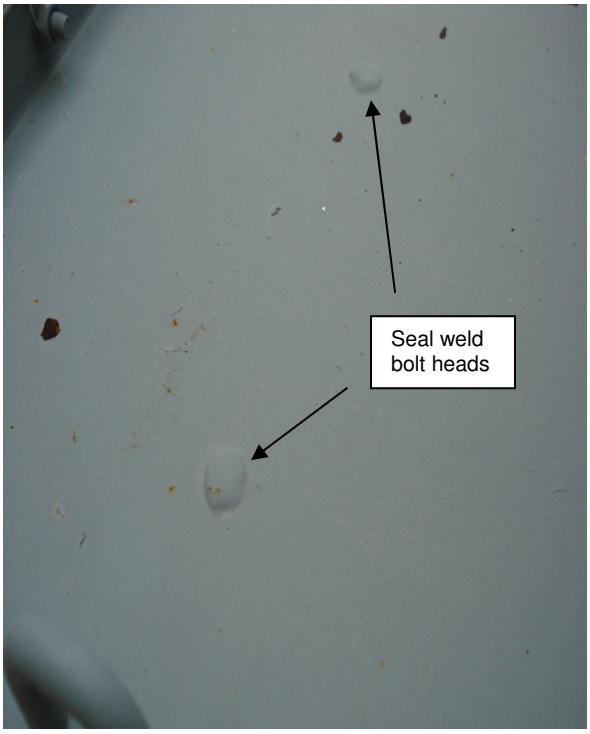
3) **Tripping of one G-2 11 KV feeder on sensitivity earth fault:** This caused the tripping of both the trains of Urea-II plant and all the motors of ammonia-II plant.

Root cause of tripping:

(a) Analysis of tripping in G-I

Ammonia storage transformer 11 KV termination side earth fault occurred through supporting insulators due to moisture ingress through mounting hex head bolt seal welding crack. This bolt is mounted through top from out side the terminal box (Please Refer the Figure below).

This resulted in large current drawl and excess power load on GTG1 which further caused under voltage / under frequency situation. Excess load was shed by LMS to avoid GT under frequency and overload condition. All four stages of under frequency trip actuated as per Load Management System. This caused the **tripping of 21-Unit of Urea-I plant** as defined in 4th stage of Load Management System. EDG Power was available after tripping.



(b) Analysis of tripping in G-II

One 11KV feeder tripped in SPG on sensitivity Earth fault. Second feeder was available but its 3.3KV incomer feeder at G2 SS tripped on under voltage.
Under voltage may be caused by following probable reasons:

1) Voltages dip due to fault current on main HT bus in SPG due to flashover in ammonia storage transformer.
2) Total load on 2nd feeder due to tripping of 1st feeder.
3) Excess current caused by change over of transformers of 1st feeder.

This caused the **tripping of both units of Urea-II plant** along with all the motors of Ammonia-II plant. EDG Power was available after tripping.

(c) Analysis of tripping of all the LT motors

Control power supply 220 VAC for all the LT motors comes from same AC supply line which gives power to continuous running motors. Hence fluctuation in GTG-I load caused the fluctuation in control power of LT motors. This caused the tripping of all the LT motors in complex. All critical LT motors got started with re-acceleration or stand by motor auto start immediately but K-451 (Refrigeration compressor) of Ammonia-1 and 11-P1B (Ammonia feed pump) of Urea-11 train could not be saved.

Tripping of refrigeration compressor of Ammonia-I plant occurred at low control oil pressure (2.0 kg/cm2g). **Low control oil pressure actuated in refrigeration compressor in spite of start of stand by L.O. pump** (probably due to insufficient pressure back-up during changeover time). Same happened for Syn gas compressor in Ammonia-I but low control oil pressure was not actuated due to start of stand by lube oil pump.

Tripping of 11-P1B (Ammonia feed pump) of Urea-I plant occurred at low lube oil pressure (3.0 kg/cm2g) in crank case. **Low lube oil pressure actuated in 11-P1B in spite of start of stand by L.O. pump** (probably due to insufficient pressure back-up during changeover time). Same happened for 11-P1A but low lube oil pressure was not actuated due to start of stand by lube oil pump.

Unlike LT motors, HT motors control power is supplied through separate DC source of 220V. Hence fluctuation in GTG-I load did not result into the corresponding fluctuation in control power of HT motors. This was the reason of survival of all the HT motors in G-I when all the LT motors got tripped.

Note:-

1) LT motors tripping condition cannot be assed because amount of electrical disturbance is not measurable during the fault.
2) Due to earth fault in Ammonia storage 11KV, the feeder was kept isolated and alternate power 415V 3Φ from UPH plant was charged to run ammonia vapor blower.

Recommendations to prevent recurrence:

Recommendations to prevent flash out in ammonia storage:

1. Supporting insulators mounting hex head bolts of all transformers welding will be checked by DP test in Shut down.

2. Rain protection shed over the uncovered transformers shall be provided (No. of such locations- 36).

Recommendations to prevent recurrence like tripping in G-II:

3. G2 11KV feeders (at SPG) sensitive earth fault relay setting to be tested.

4. G2 3.3KV feeders (NG101 & NG102) under voltage relay setting to be tested.

Recommendations to prevent pressure rise in ammonia storage:

5. Separate feeder arrangement for power supply to ammonia storage to mitigate the safety concern in ammonia storage.

Recommendation to prevent tripping of K-451:

6. Actuation of low control oil pressure in K-451 (refrigeration compressor) of Ammonia-I in spite of start of stand by Lube-Oil pump shall be checked in next available opportunity i.e. healthiness of oil accumulator. Necessary setting is to be reviewed if required and further possibility of hardware addition will be explored.

Recommendation to prevent tripping of 11-P1B:

7. Actuation of low lube oil pressure in crank case of 11-P1B (ammonia feed pump) in spite of start of stand by Lube-Oil pump is to be checked in next available opportunity. Necessary setting is to be reviewed if required and further possibility of hardware addition will be explored.