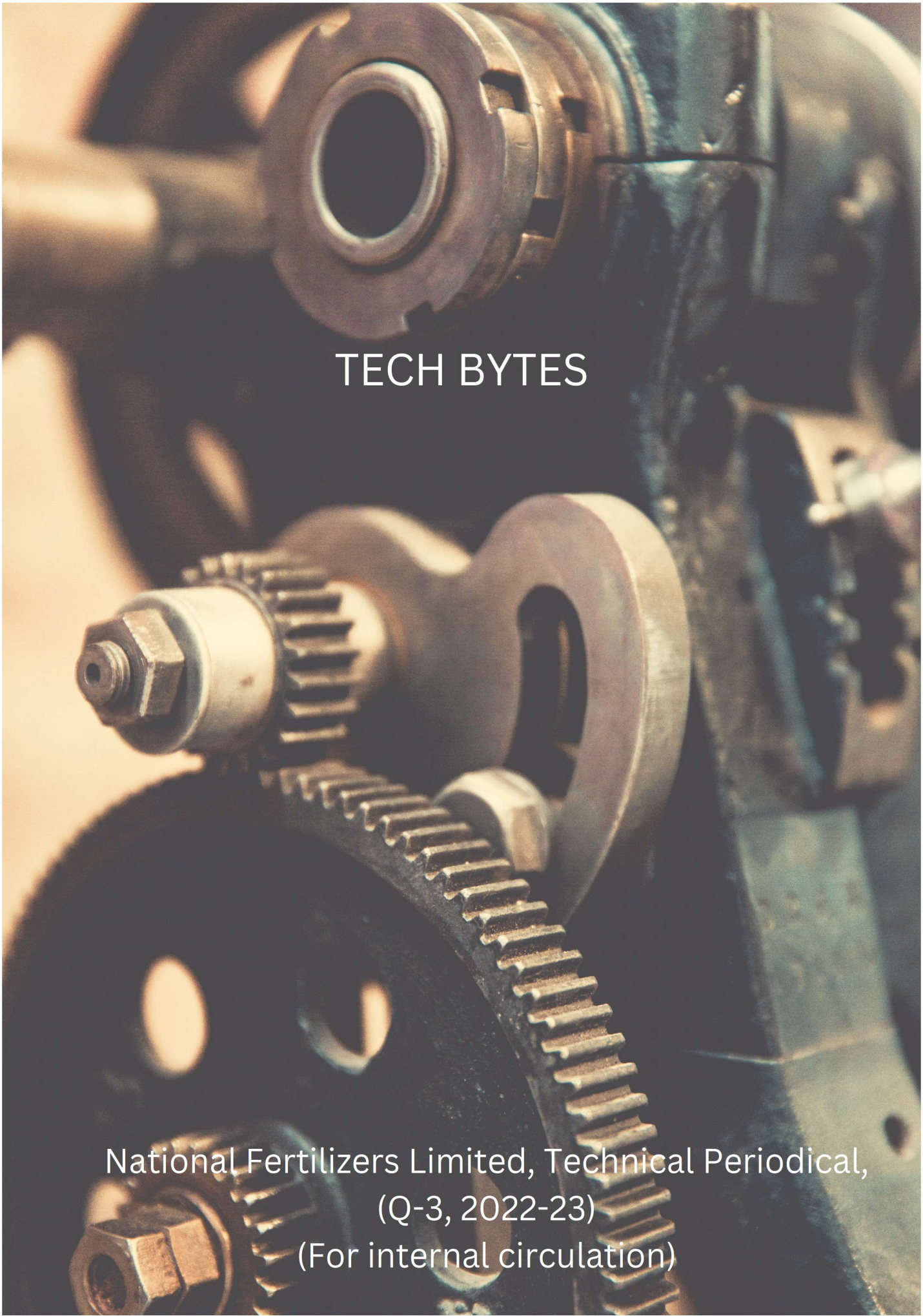

TECH BYTES

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Contents

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Vijaipur Unit

Tripping of Main Breaker of GTG-3 on Stator Neutral Earth Fault Protection at N.F.L. Vijaipur – A Case Study

-By R B J Gautam, DGM-Elect.
Kashmir Singh, SM-Elect.
Rajiv Roshan, AM-Elect.

Introduction:

NFL Vijaipur unit is having three GTG's, out of which two GTG are run in synchronization to cater to the power requirement of the whole complex. Power is generated at 11kv and distributed to different sections of plant at 11kv through ring main system. There is no isolation transformer in-between the Generator and 11KV main bus. In other words, 11kv Generator bus also acts as load bus for 11 KV motors and 11 KV Capacitor Banks.

During Normal operation, Two GTG's run in synchronization & neutral of one of the GTG is connected to earth through NGR (Neutral Grounding Resistance). Generator protection relay is installed on GTGs for isolating the GTGs from 11KV system for any external / internal fault.

Observation:

In the month of October 2022, GTG-2 & GTG-3 were running in parallel at total complex load of 31 MW (Approx). The main breaker of GTG-3 tripped on stator earth fault neutral current protection. Voltage dip of 2 KV was also observed in trend recorder of LMS Panel. No fault relay operated in downstream of Electrical system for identification / localization of fault. There-after, Complete blackout happened due to tripping of GTG-2 on another consequent fault.

Diagnosis & Action Taken:

Generator and its associated cables were tested for healthiness, Insulation Resistance values were observed in the range of 8 to 9 GΩ.

All 11kV feeders, i.e., incomers, transformers, 11kV motors and other outgoing feeder's relay status were checked, but no such electrical fault was observed

All 11kV motors which were running prior to tripping of GTG-3 were noted and clearance to take in line was given after thorough inspection of their terminal box and electrical testing.

Plant and all equipment's were restored after thorough testing and inspection. Only Capacitor bank of 11kv Ammonia line-1 cooling tower was left for Electrical testing.

Although initial electrical testing of capacitor bank along with associated cables indicated IR values 70 MΩ for 1 min and 120 MΩ for 10 min, but during comprehensive testing, an unbalance of approx. 29% was observed (Max Capacitance- 8.54μF and Min Capacitance- 6.007μF).

Detail testing is tabulated below for reference.

Capacitor no.	Insulation Resistance at 5kV (Both plates P-E)	AC Hi-Pot at 7.5kV (Both plates P-E)	Capacitance
R-1	288GΩ and 408GΩ	1.2mA & 1.0mA	8.19 μF
R-2	400GΩ and 462GΩ	1.0mA & 1.0mA	6.007 μF
R-3	572GΩ and 711GΩ	1.5mA &1.7mA	8.54 μF
Y-1	310GΩ and 299GΩ	1.0mA & 1.0mA	7.015 μF
Y-2	564GΩ and 704GΩ	1.5mA & 1.0mA	8.35 μF
Y-3	513GΩ and 657GΩ	1.2mA & 1.2mA	8.29 μF
B-1	442GΩ and 676GΩ	1.0mA & 1.0mA	8.18 μF
B-2	300GΩ and 421GΩ	1.0mA & 1.0mA	6.813 μF
B-3	475GΩ and 673GΩ	1.0mA & 1.0mA	8.135 μF

Unbalance of 29% in capacitance of capacitor bank caused displacement of Generator neutral and flow of earth fault current

Matter was also taken up with OEM of Capacitor units regarding acceptance or replacement of individual capacitor units and concluded that all capacitors' units whose capacitance value if deteriorated more than 10% shall be considered as partially failed capacitor and proposed complete replacement of all those capacitors bank aged more than twenty years to avoid sudden failure of individual capacitor units due to ageing.

Conclusions & Recommendations:

In view of recent incident and findings, followings are proposed to avoid such surprise tripping of electrical system and enhancement of reliability of electrical system

- ✓ Checking of capacitance of individual capacitors during annual turn around to ensure healthiness of capacitor units along with IR values.
- ✓ Checking of crack in porcelain insulators & container of capacitor banks.
- ✓ Capacitor unit shall be replaced, if capacitance value deterioration is more than 10%.

- ✓ Replacement of capacitor banks installed in plant for more than 20 years to avoid sudden failure due to aging.
- ✓ Replacement of existing conventional relays with Numerical relays for enhanced protection and quicker isolation of fault occurred in capacitor bank.
- ✓ Periodic checking of BDV (Breakdown Voltage) of oil in Residual Voltage Transformer and replacement of oil, if required.

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NANGAL UNIT

Fault Diagnosis & Remedial Action in Tripping Problem of Reciprocating HP Carbamate Pump PA-2C/N in Urea Plant

-By Rohan Sharma, AM-Mech.

Introduction:

At NFL, Nangal Unit there are a total of Four Reciprocating High Pressure Carbamate Pumps i.e. 3 Nos. PA-2A/B/R (Old Pumps commissioned in 1978) and 1 No. PA-2C/N (New one commissioned in the year 2001 during Urea revamp) for pressurizing Carbamate Solution for feeding it to Urea reactor. The operating flow of individual Pumps is 50 Nm^3/hr with normal suction & discharge pressure as 70 Kg/cm^2 & 220 Kg/cm^2 respectively. Out of these 4 Pumps, 3 Nos. remain in line while at Full load and 1 No. is kept as standby.

PA-2C/N is a Horizontal Triplex Type Reciprocating pump which is 350Kw VFD Motor Driven through a Gearbox. The normal rpm of the motor is 1480 rpm & 110rpm of the pump.

Pump Particulars:-

MAKE: - M/s Peroni, S.P.A., Italy
MODEL: - PTO/C 190 (125 X 205)

Observation:

The New Carbamate Pump PA-2C/N installed during Urea Plant revamp in 2001 was having Frequent problems Listed as under:-

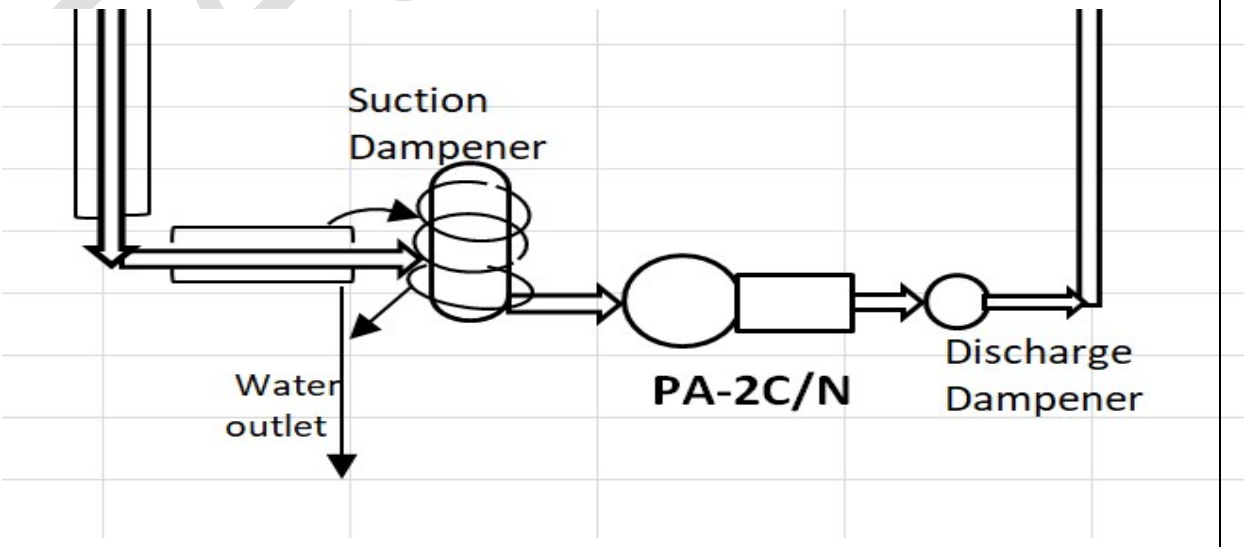
- Not Taking Proper Load/Losing Suction with reduction in Motor Current (Amps).
- Tripping on “Inverter Trip” indication i.e. electrical fault during operation.
- It has also been observed that Valves of the pump are getting damaged after running few weeks.
- Process parameters also get disturbed when pump looses suction/cavitates or trips. In recent past, the problem of loosing suction/cavitation and tripping of the pump had increased.

Diagnosis & Action Taken:

- The First & the Foremost diagnosis is always initiated from cross-checking the Valve bodies condition as being a reciprocating machine as various vibrational forces, variable stresses act on this part causing damage to oscillating parts such as Suction/Discharge Valves, Springs, Seating surfaces. After detailed observations & utilizing NDT methods, the robust assembly of valve bodies was ensured.
- Motor VFD was checked for any abnormality & OEM was also taken in line to rectify the problem; however even after fine tuning of VFD, the pump tripping problem could not be resolved.
- A Technical analysis of the Operating Process parameters was carried out .The operating suction pressure of the pump was observed to be 67-68 Kg/Cm^2 and temperature of carbamate was 118-120ºC. The detailed study of operating manual revealed that the vapour pressure of carbamate at 120 ºC is about 65 Kg/Cm^2. So it was observed that the operating suction pressure is very near to vapour pressure of carbamate at its present operating temperature. During suction stroke of the pump there is possibility that there is a localized vapour formation within the cylinder of the pump causing unloading of the pump, vapors being compressible fluid.

  As the pressure of 1st Stage ($67.7Kg/cm^2$) i.e. suction pressure of pump of could not be increased so it was decided that the temperature of the fluid to be lowered to avoid vapor formation in process. As suction line of the pump was having a jacketed construction, So Raw water injection was provided in these jacketing lines to reduce the inward temperature of suction line of the order 110ºC-112ºC which eliminated the vapor locking in the pump owing to smooth operation of the equipment.

  The schematic representation of the modifications done is as under:-



Conclusion & Recommendations:

The above whole exercise was done in-house and with joint efforts of Mechanical, Electrical & Production the problem of tripping of PA-2C/N was resolved by providing Cooling Water in suction line jacket of the pump. This resulted in increased reliability of the Pump as the machine is in continuous operation since this modification without any tripping and maintenance job of valve bodies/O-rings has also reduced to appreciable extent.

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PANIPAT UNIT

Fault Diagnosis Of 26.5/20 Mva Power Transformer In MRSS

-By Karmandeep Singh, Engineer (Elect.)

INTRODUCTION:

The Transformers are one of the most important and expensive equipment in electrical power network, needing very sensitive and secure protection. Most-common faults in a power transformer are winding and terminal faults. The Restricted earth fault (REF) protection provides sensitive earth faults protection to protect winding of transformers. Mal-operation in REF relays are generally caused by even harmonic components of magnetizing inrush current, odd harmonic components of over-excitation, and CT saturation of severe external fault. However it is evenly important that the stability of REF Relay has been ensured for out-zone faults during any replacements or new work.

At MRSS yard, 26.5/20 MVA, 132/11 kV, Transformer A, B & C caters electrical load requirements of complete NFL Panipat unit. Out of the above three transformers, TRF-B and TRF-C (NGEF make) were installed during inception of the plant (1977) & TRF-A (Schneider Make) was replaced with new one in 2015-16. Plant load is divided into two sections at 11kV MRS i.e. Section A & B that are catered by two of these Transformers with the third transformer kept as OFF load / standby.

OBSERVATION:

On 08th May'22, at around 03.00 am, a L-G fault occurred (Fault current (If) of 184Amps) in the 11kV capacitor banks installed at AFCP. During this event, 11kV Side of TRF-A in MRS tripped on actuation of Restricted Earth Fault (REF) relay (current setting 160Amps) and 132kV Side TRF A tripped on inter-tripping. Since no power was available, this led to tripping of all downstream plant loads of section A. However the load of section B (i.e on TRF-C) was uninterrupted. No relay was found operated at AFCP Feeders, however all the 11kV fuses before capacitor banks were found blown. The effected 11kV bus section at MRS was checked & found healthy. This was again charged by through TRF-B and plant load was normalized with TRF-B and C.

(* Refer figure-1 below)

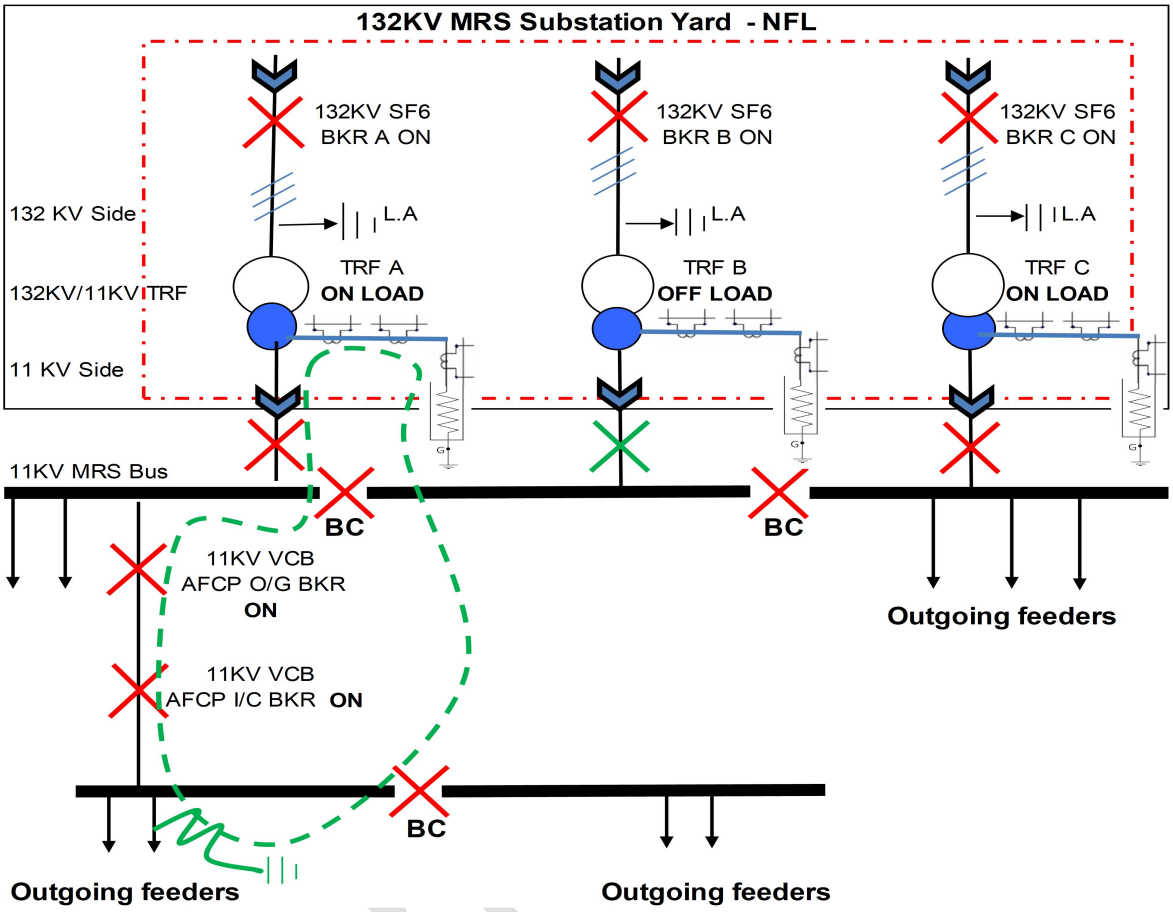

Figure -1

The effected Transformer-A was isolated & thorough inspection/testing of transformer was performed (that included insulation resistance Test(IR), Magnetic Core Balance Test, Break Down Voltage Test of transformer Oil (BDV)) were performed & results were found within the acceptable limits. The REF Relay testing was carried out & relay was found healthy. With above result it was suspected that Unit protection of Transformer (64R) might have given spurious tripping during out-zone fault at 11kV Capacitor Bank of AFCP.

The detailed Standard Scheme testing of Differential (87T) and REF(64R) protection via three phase Primary current injection test was carried out for ensuring system stability for both in-zone & out- zone protection with results as follows:

Type	Fault location	Desired relay operation as per standard protection scheme		Observed Relay operation as per existing protection scheme during testing	
Fault Zone	**Fault Condition**	**REF relay CAG14**	**Differential Relay DTH 31**	**REF relay CAG14**	**Differential Relay DTH 31**
In-Zone	11kV side Phase to Earth Fault	Relay shall TRIP	Relay shall TRIP	Relay OPERATED –OK	Relay OPERATED –OK
	11kv side Phase to Phase fault	Relay shall NOT TRIP	Relay shall TRIP	Relay NOT OPERATED - OK	Relay OPERATED –OK
Out-Zone	11kV side Phase to Earth Fault	Relay shall NOT TRIP	Relay shall NOT TRIP	Relay OPERATED – NOT OK	Relay NOT OPERATED - OK
	11kV side Phase to Phase fault	Relay shall NOT TRIP	Relay shall NOT TRIP	Relay NOT OPERATED - OK	Relay NOT OPERATED - OK

DIAGNOSIS & ACTION TAKEN:

During protection scheme testing, the REF relay was found operating during downstream fault of AFCP. It was observed that the CT of 2000/1 Class- 5P10 installed in Neutral Ground resistor (NGR) of TRF-A was used in the REF protection scheme in-place of the 1600/1 Class – PS Neutral CT available in neutral busing of TRF A. Due to the mismatch in ratios & accuracy class existing between the phases and neutral CT's, the REF relay mal-operated for the Out-zone. The required neutral CT of ratio 1600/1 Class – PS installed at TRF A neutral bushing was connected & again complete scheme testing was carried out. With this correction the electrical protection system stability was found as per requirements. The TRF-A was again charged successfully.

CONCLUSION & RECOMMENDATIONS:

Complete testing of in-zone/out-zone protection scheme with 3-phase primary injection kit should be ascertained during any change/replacement work. The Transformer-A was replaced during 2015-2016 & testing was done with single phase injection kit which was insufficient. So, a comprehensive standard testing procedure is being prepared for such replacement for thorough testing of the new installation at various sites.

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BATHINDA UNIT

Outage of CO_2 Gas Reciprocating KOBE Compressor of Urea Plant due to Lubrication Problem.

-By Pushap Kumar, DGM-Mech.
Saurabh Thakur, AM-Mech.

Introduction:

Kobe compressor (UGB-102) is a critical, single line, two stage reciprocating compressor (Make: M/s Kobelco, Japan, Model: JM-3) which is installed in Urea plant for compressing CO_2 gas from pressure 25 kg/cm2 to 220 kg/cm2 with 25000 m3/hr flow capacity.

On 21.12.2022 evening, lube oil filter started chocking at faster rate. Thereafter, LO delta P was kept under close monitoring. On the morning of 22.12.2022, it was observed that lube oil splashing on 2nd stage cross head window has reduced. The compressor was stopped immediately for inspection/overhauling. Subsequently urea plant shutdown was taken.

Observation and Action:

On 21.12.2022 at around 1700 hrs, pressure difference across lube oil filter of UGB-102 Kobe compressor increased beyond 2.5 kg/cm2 against normal value of 1.0kg/cm2. Immediately, filter changeover was done and stand by choked filter was opened. On checking, fine white metal particles were observed on filter screen. However, no abnormality was observed in operation of machine and the vibration reading was also normal. Choking of LO filter was again observed at 0400 hrs on 22.12.2022 and the frequency of choking increased between 0700 hrs to 0800 hrs [3 times filter cleaned]. During cleaning again few fine white metal particles were observed on the filter screen. At around 0800 hrs, it was observed that LO supply in the crosshead area of 2nd stage had reduced (splashing of oil in 2nd stage crosshead window had reduced), however no such abnormality was observed on 1st stage side [both cylinders]. The machine was immediately stopped for inspection and corrective action.

Following major observation were made, during dismantling and inspection of 2nd stage and crankshaft portion:

- White metal particles were observed in sump of 2nd stage crosshead as well as crankshaft sump. However, oil in sump of both 1st stage cross head was free of white metal.
- After stoppage of compressor, it was observed visually that 2nd stage connecting rod gudgeon pin has shifted axially by almost 40 mm. This caused mismatching of LO supply counter holes in connecting rod and gudgeon pin, resulting in reduced oil supply to cross head bushes.
- Gudgeon pin had minor circumferential scratch marks, but no major deformation
- On dismantling of 2nd stage connecting rod, it was observed that collar given in the gudgeon pin locking bolt has been compressed and flattened due to shifting of gudgeon pin.

- Crosshead along with shoes were dismantled at position. Crosshead and connecting rod were removed. Crosshead shoe, crosshead pedestal and connecting rod big end bearing were checked and found in good condition.

Subsequently, following corrective actions were taken:

- Complete inspection of 2nd stage power end train was done.
- Gudgeon pin to crosshead end bush clearances were found on higher side (0.55 to 0.6 mm) due to scoring marks on gudgeon pin. Hence new gudgeon pin was used for assembly. Clearance of old crosshead bush and new gudgeon pin was 0.3 mm.
- 2nd stage connecting rod was dismantled. Big end bearing was checked and found ok. Damaged Gudgeon pin clamp bolt was replaced with new locking bolt (removed from new connecting rod)
- 2nd stage Crosshead shoe to pedestal clearance were taken and found well within allowable range.

Conclusion and Recommendation:

From observation/findings made during overhauling and inspection of compressor, it was concluded that axial shifting of gudgeon pin occurred due to compression and flattening of the 2nd stage connecting rod small end lock bolt. This shifting caused blockage in oil path to 2nd stage crosshead bush which was observed as reduced splashing of oil on crosshead window. Timely stoppage and subsequent maintenance of compressor saved a catastrophic failure in the KOBE Compressor

.

All connecting rod`s (1st and 2nd stage) small end locking bolt position may be checked during opportunity shutdowns. In case any white metal is observed in the lube oil filter on continuous basis, the machine should be stopped for identification of the root cause to avoid any catastrophic failure of the same.

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