WORLD-CLASS OUTSTANDING INTERNATIONAL

PROGRAM | EXHIBITION | NETWORKING

OIL CONTAMINATION FOR AMMONIA CHILLER COMPRESSOR 51-C1301A

42nd Turbomachinery
29th Pump SYMPOSIA

GEORGE R. BROWN CONVENTION CENTER
9.30 – 10.3.2013

Sipchem

Reliability
ENGINEERING DEPT.

TEXAS A&M ENGINEERING
TEES
TURBOMACHINERY LABORATORY

A&M

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Area of Expertise: Vibration Diagnostic, Maint. & Overhaul,

Safety Reviews

Equipment Description

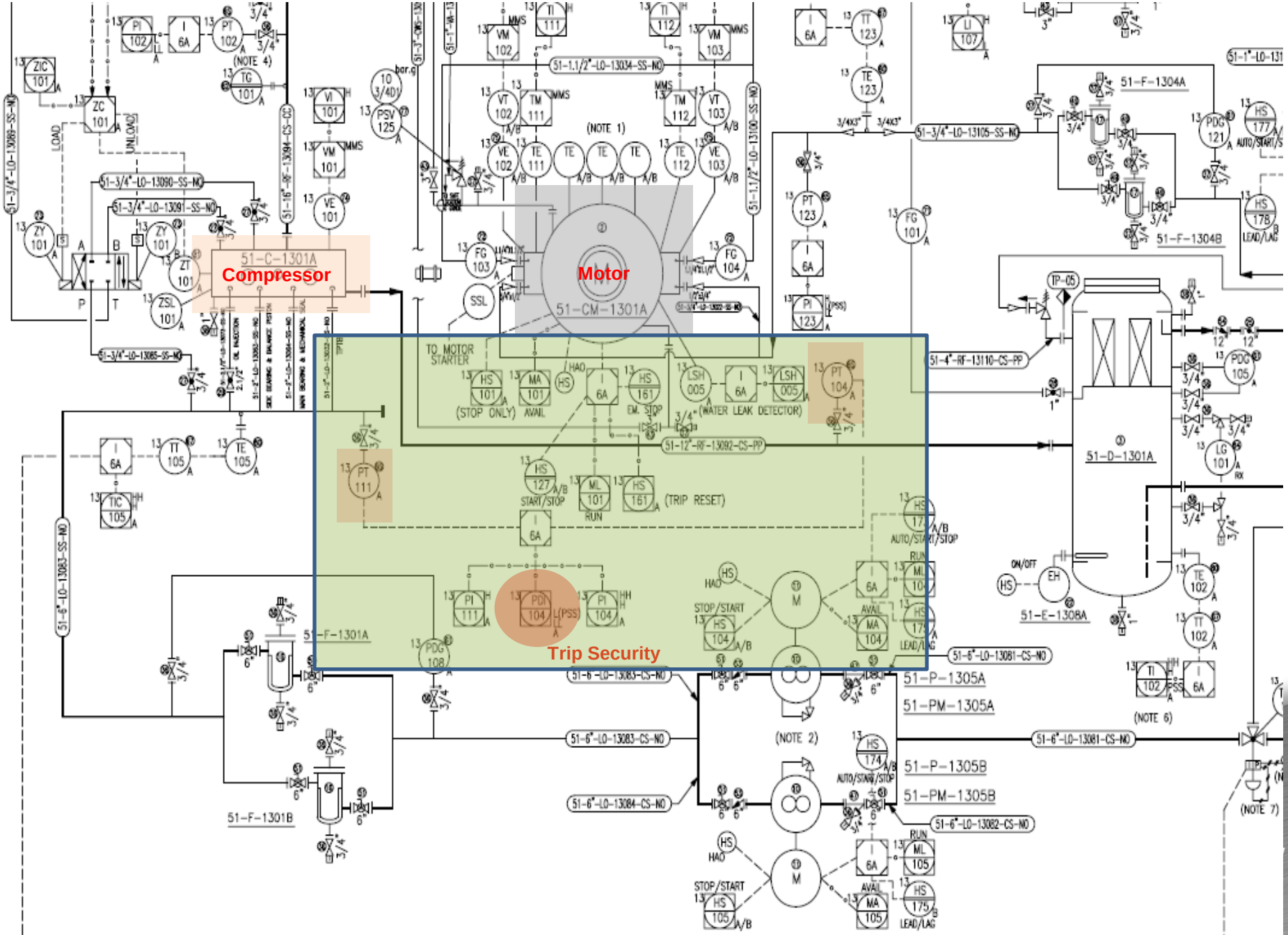
Type	Screw Compressor
Process Gas	Ammonia
Driver	Motor
Flow Rate	41,958 kg/hr
Suction Pressure	5.4barg
Suction Temperature	11C
Discharge Pressure	20.7barg
Power Consumption	3,000 kW
Speed	3,550rpm

What was the problem?

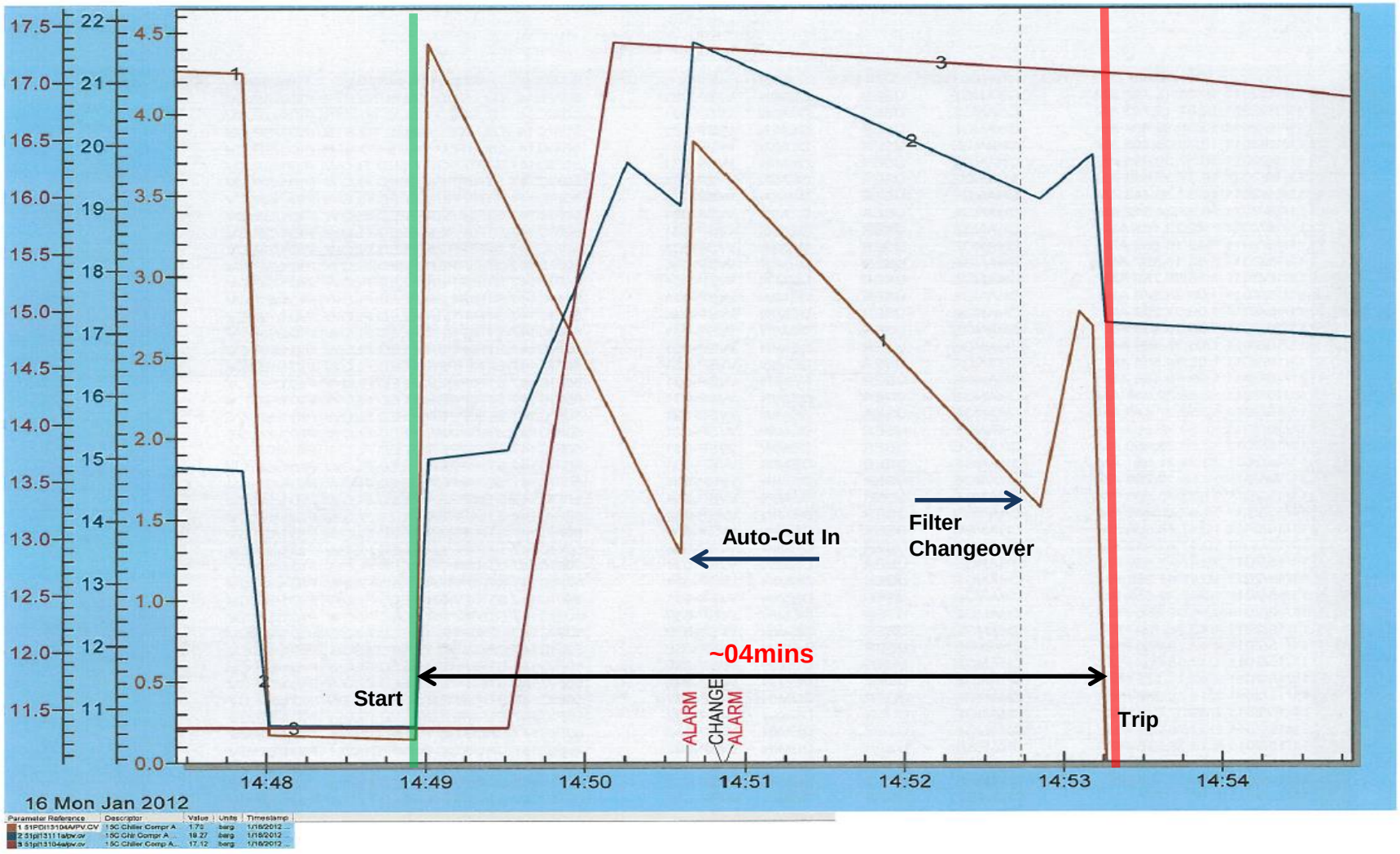
- Recurring trip of 51-C1301A on low value for differential transmitter 51PDI13104.

What does this protection do?

- It measures low differential between lube discharge pressure and process discharge pressure.
- Prevent low lubrication for the bearings and rotating parts.


Compressor
Motor
Trip Security
51-C-1301A
51-CM-1301A
51-D-1301A
51-F-1301A
51-F-1301B
51-F-1304A
51-F-1304B
51-E-1308A
51-P-1305A
51-PM-1305A
51-P-1305B
51-PM-1305B
TO MOTOR STARTER
(STOP ONLY)
(WATER LEAK DETECTOR)
(TRIP RESET)
(NOTE 1)
(NOTE 2)
(NOTE 4)
(NOTE 6)
(NOTE 7)

How was it getting tripped?

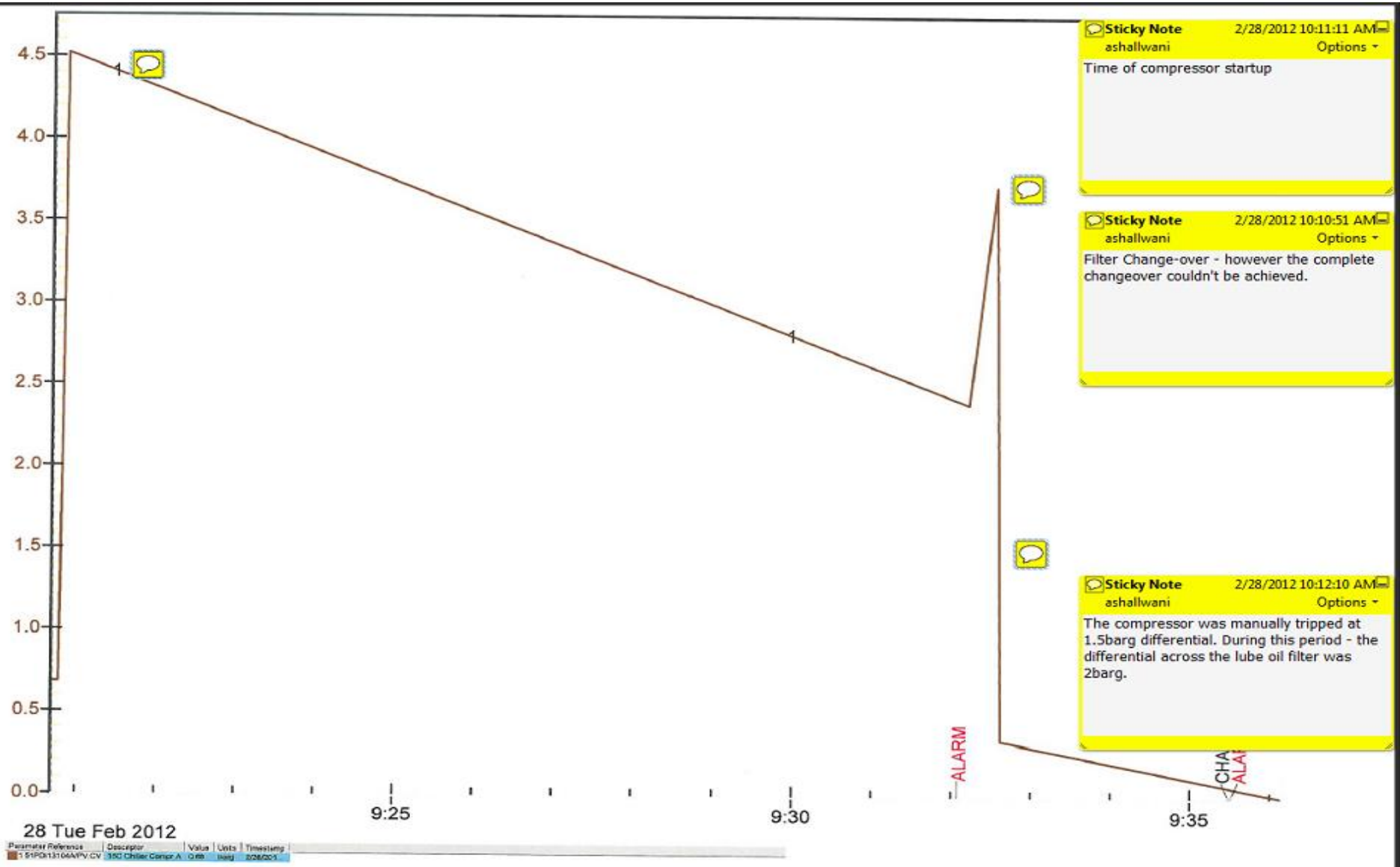


What was it?

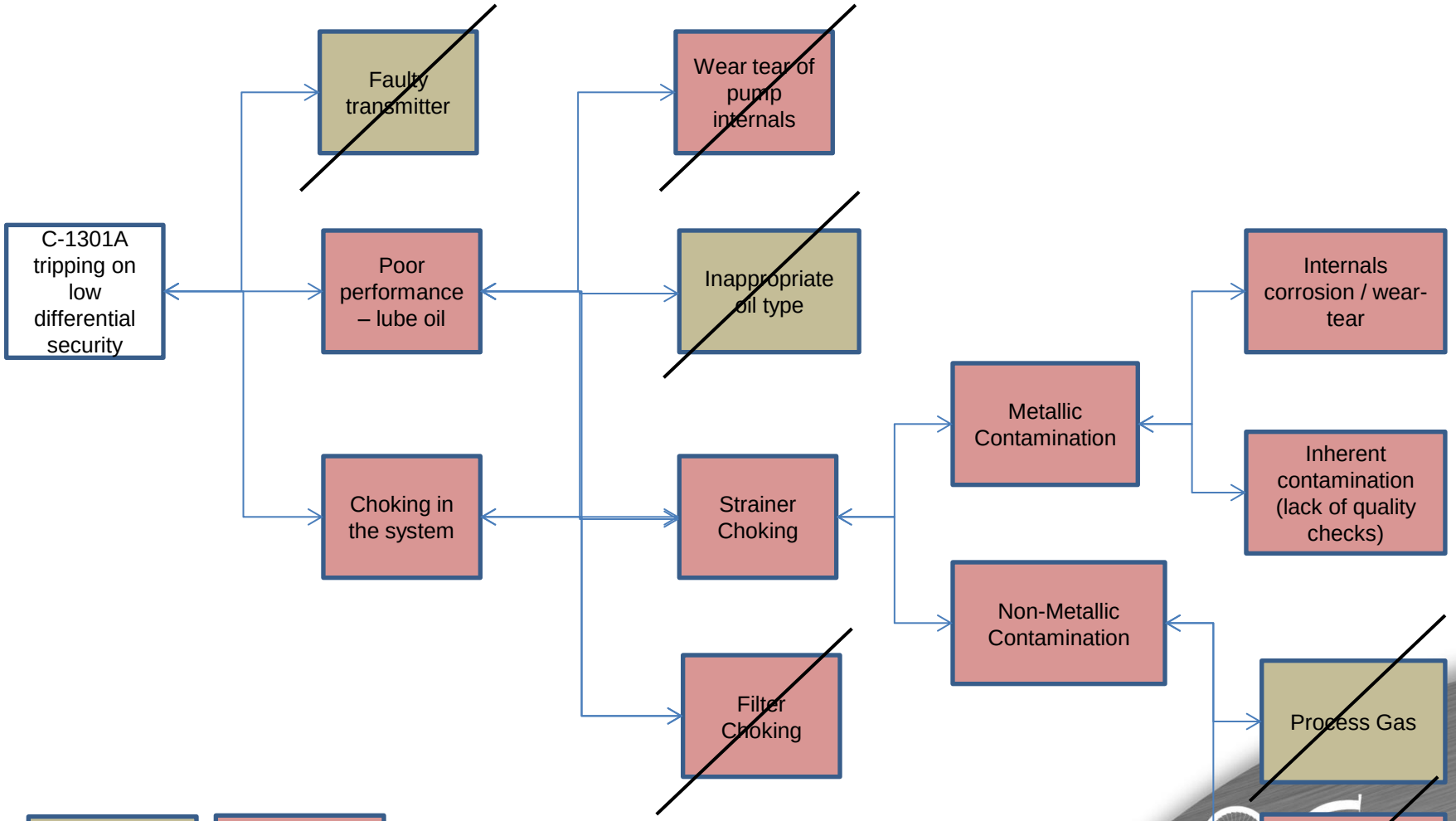
During the run – differential across oil filter was low (<0.20barg).
No alarm / trip on oil filter differential pressure.
Suction Strainer was the next trap – this 20mesh strainer was found choked with blackish material

The strainer size was increased to 40mesh, and lube oil system was operated for period of 3days. During this run, there was no differential across oil filter.

After flushing?



Apollo RCA


C-1301A tripping on low differential security
Faulty transmitter
Poor performance – lube oil
Choking in the system
Wear tear of pump internals
Inappropriate oil type
Strainer Choking
Filter Choking
Metallic Contamination
Non-Metallic Contamination
Internals corrosion / wear-tear
Inherent contamination (lack of quality checks)
Process Gas
Lubricant Handling
CONDITION
CAUSE

Investigation

During the course of investigation following was realized,

1. The traces of contamination were also observed on other identical units 51-C1301 B/C.
2. No quality control document illustrating proper flushing of this equipment was tracked.
3. The equipment was commissioned in Dec, 2009 – but was never under continuous run for years due to gaps related to change over frequency, and limitation of electrical system.
4. Varnish material from internals.
5. While draining the lube oil samples from two different points i.e. oil separator and lube oil cooler – we observed white / milky foam from the drain – this was Ammonia which then vaporized in the open atmosphere leaving behind lube oil in the bottle.

Investigation

Lab tests of particle examination

Physical characteristics				
Organic & volatile @ 550ºC	(on-dry basis)	wt.%	=	74.6
Inorganic matter	(on-dry basis)	wt.%	=	25.6
Chemical constituents after removal of Organic & Volatile @ 550ºC				
Silicon dioxide	(SiO_2)	wt.%	=	0.38
Aluminum oxide	(Al_2O_3)	wt.%	=	0.07
Iron oxide	(Fe_2O_3)	wt.%	=	13.4
Calcium oxide	(CaO)	wt.%	=	0.29
Magnesium oxide	(MgO)	wt.%	=	0.08
Sulphur trioxide	(SO_3)	wt.%	=	0.08
Sodium oxide	(N a_2O)	wt.%	=	0.30
Potassium oxide	(K_2O)	wt.%	=	0.03
Copper oxide	(CuO)	wt.%	=	0.02
Zinc oxide	(ZnO)	wt.%	=	24.1
Manganese oxide	(MnO)	wt.%	=	0.20
Nickel oxide	(NiO)	wt.%	=	LT 0.01
Vanadium oxide	(V_2O_5)	wt.%	=	LT 0.01
Phosphate	(PO_4)	wt.%	=	60.4

- Vogel's Quantitative Inorganic Analysis, 4th Edition, Published by Longman Group Ltd., London, U. K.
- N. H. Furman (Editor) Standard Methods of Chemical analysis, 6th Edition, Published by Robert E. Krieger Publishing Co., Florida, U. S. A.

Lab tests of particle examination

Chemical constituents after removal of Organic & Volatile @ 550ºC				
Silicon dioxide	(SiO_2)	wt.%	=	7.80
Aluminum oxide	(Al_2O_3)	wt.%	=	0.94
Iron oxide	(Fe_2O_3)	wt.%	=	31.0
Calcium oxide	(CaO)	wt.%	=	4.34
Magnesium oxide	(MgO)	wt.%	=	1.90
Sulphur trioxide	(SO_3)	wt.%	=	LT 0.01
Chloride	(Cl)	wt.%	=	LT 0.01
Sodium oxide	(N a_2O)	wt.%	=	0.60
Potassium oxide	(K_2O)	wt.%	=	0.07
Copper oxide	(CuO)	wt.%	=	0.05
Zinc oxide	(ZnO)	wt.%	=	18.6
Manganese oxide	(MnO)	wt.%	=	0.24
Titanium oxide	(TiO_2)	wt.%	=	0.02
Lead oxide	(PbO)	wt.%	=	LT 0.01
Phosphorous pentaoxide	(P_2O_5)	wt.%	=	30.4
Vanadium oxide	(V_2O_5)	wt.%	=	LT 0.01
Nickel oxide	(NiO)	wt.%	=	0.08
Chromium oxide	(Cr_2O_3)	wt.%	=	0.23
Loss on Ignition @ 950ºC	(LOI)	wt.%	=	2.20

Corrosion of Internals

1. The material of construction of piping and other equipment is Carbon Steel. Ammonia isn't corrosive.
2. The lube oil analysis confirmed that the moisture ingress was less then <100ppm.
3. Based on above facts, we inferred that the possibility of corrosion internals is remote.

Inherent Contamination

1. Lack of record to validate and/or negate the possibility of inherent contamination within system.

Overall Performance of Separator

1. The non-satisfactory performance of the separator d/s the compressor was common observation for all the 03 equipment.
2. Traces of oil in Ammonia coolers was observed.
3. Traces of Ammonia in lube oil system was observed.

Visual Inspection







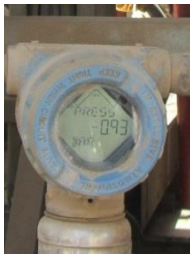


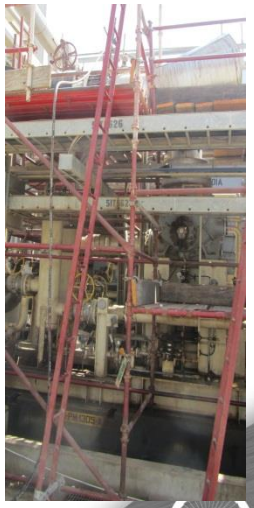
Corrective Actions

thru flushing (Alkyl Benzene)

thru hydro-jetting

thru vacuuming

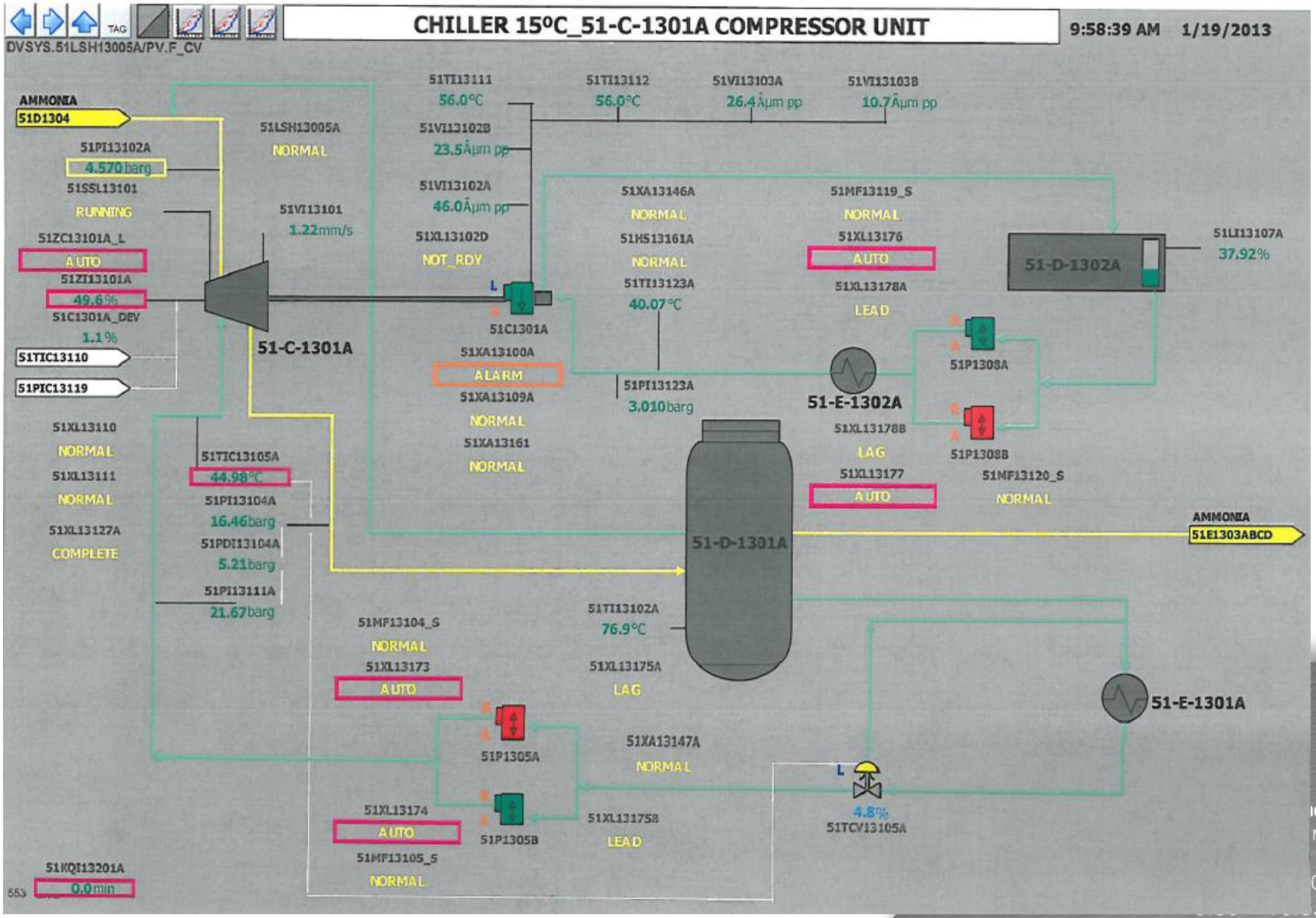




Outcome

1. Post flushing, and vacuum run, the compressor was taken into service.
2. During first two trials, the compressor tripped on low pressure differential protection.
3. During both the trials, the suction strainer was found choked.
4. During third trial, the compressor was operating with stable differential, however the differential across the filter was high (> 2.0barg)
5. Post-filter replacement. The compressor was taken into service.
6. Compressor has been operating smooth since then.

Outcome


CHILLER 15°C_51-C-1301A COMPRESSOR UNIT
9:58:39 AM 1/19/2013
DVSYS.51LSH13005A/PV.F_CV
AMMONIA
51D1304
51PI13102A
4.570barg
51SSL13101
RUNNING
51ZC13101A_L
AUTO
51ZI13101A
49.6%
51C1301A_DEV
1.1%
51TIC13110
51PIC13119
51LSH13005A
NORMAL
51VI13101
1.22mm/s
51-C-1301A
51TI13111
56.0°C
51TI13112
56.0°C
51VI13103A
26.4Âµm pp
51VI13103B
10.7Âµm pp
51VI13102B
23.5Âµm pp
51VI13102A
46.0Âµm pp
51XL13102D
NOT_RDY
51C1301A
51XA13100A
ALARM
51XA13109A
NORMAL
51XA13161
NORMAL
51XA13146A
NORMAL
51HS13161A
NORMAL
51TI13123A
40.07°C
51PI13123A
3.010barg
51MF13119_S
NORMAL
51XL13176
AUTO
51XL13178A
LEAD
51-D-1302A
51LI13107A
37.92%
51P1308A
51P1308B
51-E-1302A
51XL13178B
LAG
51XL13177
AUTO
51MF13120_S
NORMAL
51XL13110
NORMAL
51XL13111
NORMAL
51XL13127A
COMPLETE
51TIC13105A
44.98°C
51PI13104A
16.46barg
51PDI13104A
5.21barg
51PI13111A
21.67barg
51-D-1301A
AMMONIA
51E1303ABCD
51TI13102A
76.9°C
51XL13175A
LAG
51MF13104_S
NORMAL
51XL13173
AUTO
51P1305A
51XA13147A
NORMAL
51-E-1301A
4.8%
51TCV13105A
51XL13174
AUTO
51P1305B
51XL13175B
LEAD
51MF13105_S
NORMAL
51KQI13201A
0.0min
553

Outcome

Database:	Sipchem.rbm	Point:	P1 - 51-C1301A
Area:	51 - Utility Area	Sample:	4768
Equipment:	E18 - 51-C1301-A@15 Degree,Comp	Sample Date:	1/31/2013 1:40:07 AM

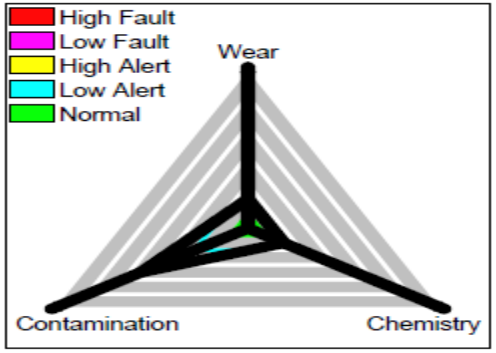
Wear	0
Ferrous Idx	0.0
LCont Ferrous	0
LCont NonFe	0
FW Index	
WDA Severity	

Contamination	30
OilLife Idx	
Contam Idx	9.8
% Water	.0098
LCont Droplet	0
P/MI >4	12,231
P/MI >6	7,677
P/MI >14	873
P/MI >22	163
P/MI >38	15
P/MI >70	5.0
ISO PC >4	21
ISO PC >6	20
ISO PC >14	17
NAS Part Cnt	12
SAE Part Cnt	0

Chemistry	0
Chemical Idx	
Dielectric	2.30
DV Visc 40C	51.6
DV Visc Chng%	12.2
PC Dielectric	
PC Diel Idx	
PC Color Idx	
PC L. Absorb	

Observations
Oil smells like ammonia

Actions



SIPCHEM
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Condition Monitoring Group
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Ref Oil	No Reference Oil