NTPC	LMI	LARA
TITLE	Buchholtz Alarms in Transformers & Reactors	
REF. NO.	LMI 03-R0/ELEC/OGN/OPS/ELEC/001	

LARA SUPER THERMAL POWER PROJECT
LOCAL MANAGEMENT INSTRUCTION

LMI 03-R0/ELEC/OGN/OPS/ELEC/001

Buchholtz - Alarm In Transformers And Reactors

All locations are required to comply with this Directive

Approved for Implementation by .....
HOP(LARA)

Date :.....13/6/18.....

Enquiries to : HOD(Electrical)

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1	TITLE OF LMI	BUCHHOLTZ - ALARM IN TRANSFORMERS & REACTORS
2	DOCUMENT CODE	LMI 03-R0/ELEC/OGN/OPS/ELEC/001
3	REVISION NO/DATE	
4	ORIGINAL/REF. DOCUMENT	COS-ISO- OGN/OPS/ELEC/001 Issue No.01 , 11, March, 1994
5	PREPARED BY	Name: Partha Mukherjee Designation: AGM(EMD) Signature:
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8	REVIEWED BY	Name: R K Rout Designation: GM(O&M) Signature:
9	APPROVED BY	Name: SANJAY MADAN Designation: HOP(LARA) Signature: 13/6/18
10	DATE OF ISSUE	
11	CONTENTS LIST	Enclosed
12	DISTRIBUTION LIST	Enclosed

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Buchholtz Alarms in Transformers & Reactors

1.0 INTRODUCTION

A Buchholtz relay alarm is to be viewed very seriously in any transformer/ reactor which is in operation. The operation of a buchholtz alarm can be caused by the generation of fault gases or entrapped air. The air can get entrapped due to inadequate or improper air release carried out during oil filling, oil filtration or from air leakage through pump suction, gasket joints, etc. The generation of fault gas is usually the first symptom the development of an incipient fault. Serious damage to any transformer/reactor can be avoided if proper attention is given in identifying the contents of the gas. On the other hand, if the gas in buchholtz relay is identified as air, unwarranted downtime to the equipment can be avoided. This document provides guidelines for (1) sampling procedure (2) testing and interpretation of buchholtz gas (3) action based on interpretation of buchholtz gas (4) reporting procedure.

2.0 SUPERSEDED DOCUMENTS - NIL

3.0 SCOPE

All transformers and reactors fitted with Buchholtz protection.

4.0 GUIDELINES

4.1 Sampling Procedure

In the procedure for gas analysis described below. it is essential to take the complete testing apparatus near to the equipment and carry out qualitative analysis of the gas directly near the equipment. This is necessary because if the gas sample is collected by some method and taken to lab for testing, there are chances of collection of air which is entrapped in the connecting pipes and the lab test results may not give a correct analysis. However, in the suggested procedure even though initially air might pass through silver nitrate solution (which is used for qualitative analysis of Buchholtz gas), gases collected inside the transformer/reactor will subsequently pass through the silver nitrate solution and correct analysis will be possible.

Responsibility: AGM(EMD)

4.2 Sampling for qualitative analysis

For sampling and analysis of Buchholtz gas, the aparatus as shown in the Figure 1 should be available in the laboratory. On receipt of a Buchholtz alarm, take this apparatus near the transformer and connect point (4) to the Buchholtz sampling valve (3) using a rubber connecting tube. The qualitative analysis of Buchholtz gas can be carried out by connecting the 3-way stop cock (5) to the gas bubbler (11) and bubbling the gas through the silver nitrate solution by opening gas sampling valve (3). The inflammability of the gas from solution (2) may be checked at the exit point (13). After completion of the test, close sampling valve (3) immediately so that some fault gas remains inside the Buchholtz relay to enable a quantitative analysis of fault gas to be carried out.

Responsibility: AGM(EMD), AGM(Chem)

4.3 Sampling for quantitative analysis

The quantitative analysis of the Buchholtz gases is required only when the qualitative analysis has confirmed the presence of fault gases.

When undertaking a quantitative analysis, the three way stop cock (5), which was previously connected to the gas bubbler, may be turned toward syringe (8) has to be kept as short as possible, so as to minimize the entrapped air in the connecting tubes. Initially keep the plunger of gas tight syringe (8) fully inserted inside the syringe. The connecting tube from Buchholtz gas sampling valve (3) to syringe stop cock (7) is then filled with fault gas. Open the gas syringe stop cock (7) and gas sampling valve (3) slightly and start collecting fault gas in the syringe by slowly withdrawing the plunger. Care must be taken that the plunger of the syringe is not fully withdrawn while taking the gas sample. If oil appears in the syringe, stop withdrawing the plunger. Now close the syringe stop cock (7) and Buchholtz sampling valve (3). The gas collected in the syringe can now be tested in the laboratory using gas chromatography.

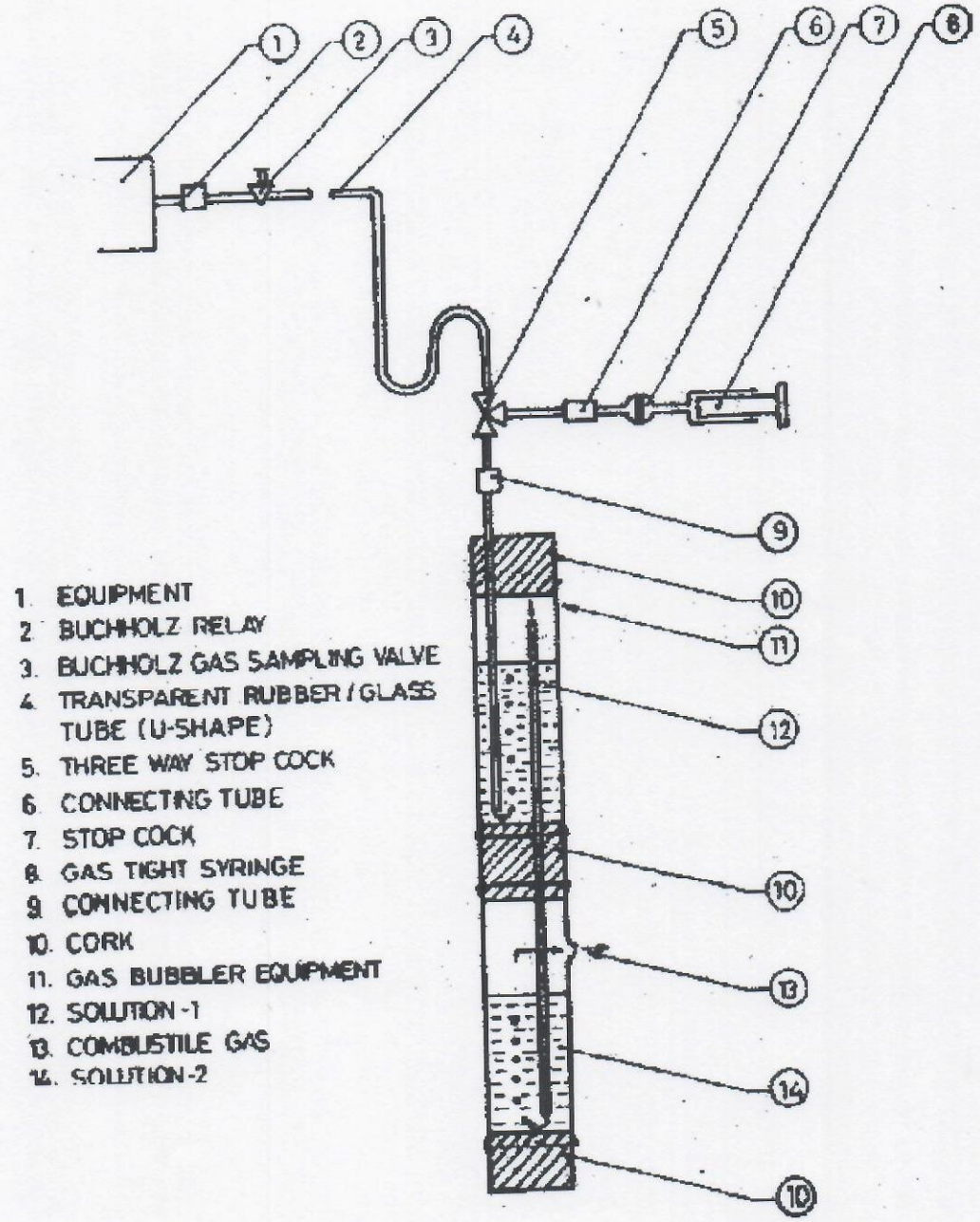
On occasions, the amount of gas collected in the Buchholtz relay may be small and hence care must be taken when passing the gas through the

silver nitrate solution to ensure that some quantity of gas is still available for quantitative analysis

Responsibility: AGM(EMD), AGM(Chem)

FIGURE-I

EQUIPMENT FOR QUANTITATIVE & QUALITATIVE ANALYSIS OF BUCHHOIZ GAS



For sampling, items having the following specifications may be used:

a) Glass gas-tight syringe, 24cc to 250cc capacity
b) Stop cock 3-way, glass.
c) Impermeable oil-proof rubber connecting tube of suitable diameter for different adapters. Glass tube can be used in place of rubber tube.

The gas sampling apparatus described above needs to be transported near to the transformer on receipt of a Buchholtz alarm. However, a permanent arrangement for collection of gas samples is described in annexure (1) and can be installed on all the transformers/reactors. With this arrangement, there is no possibility of mixing external air with the gases released from inside the transformer. this arrangement has already been used on the transformers at Dadri.

4.4 Testing and Interpretation of Buchholtz Gas

The qualitative analysis of the Buchholtz gas is done based on the change in colour of silver nitrate solution through which the Buchholtz gas is bubbled during sampling. The silver nitrate solution used for the testing should be of analytical/guaranteed grade. The gas can be interpreted qualitatively as described below: -

The qualitative analysis of Buchholtz gas can be done by passing the gas from the gas relay relief cock-3 (refer figure-1) first through a solution of aqueous silver nitrate (solution), then through a solution of ammoniacal silver nitrate {solution), both made up in distlled water. The residual exit gas leaving the second solution is tested for inflammability. If, the accumulated gas is air, generally indicating no fault, there is no positive colour change in the two test solutions and the exit gas is not inflammable. If however, the gas has been formed by under oil arcing, or by a bare red hot metallic part under, oil, a white curdy precipitate is formed in solution 1, a yellow precipitate in solution 2 and the residual gas leaving the second solution is inflammable.

Responsibility: AGM(Chem), AGM(EMD)

If on the other hand, the gas has been formed by breakdown of transformer insulation by overheating, a black precipitate will form in both tubes and the exit

residual gas will again be inflammable. A summary of the test indications are given in the table below;

4.4.1 Chemical test indication

SOLUTION 1 (5% SILVER NITRATE)	SOLUTION 2 (5% AMMONICAL SILVER NITRATE)	EXIT GAS INFLAMABILITY	FAULT INDICATED
NO REACTION	NO REACTION	NON INFLAMABLE	NO FAULT, AIR ONLY PRESENT
HEAVY WHITE CARDY PRECIPITATE	YELLOW PRECIPITATE	INFLAMABLE	UNDER OIL ARCING OR HOT SPOT
BLACK PRECIPITATE	BLACK SOOTY PRECIPITATE, SOLUTION OPAQUE	CELLUSE PRECIPITATE	CELLUSE DEGRADATION

In under-oil arcing and under-oil hot metal reactions, the main gas evolved is hydrogen together with acetylene and low-boiling point paraffins. The gas, however, producing the colour changes in both solutions is acetylene, which may be present upto 20%of the airfree volume. In solution 1, a complex of silver nitrate and silver acetylide is first formed and this changes with absorption of more acetylene to silver acetylide. In solution 2, silver acetylide is formed directly, but only after the reactions of solution 1 is completed. As both of these compounds explode violently on heating, the tubes should be thoroughly washed immediately after use.

During the destructive distillation of cellulose, carbon monoxide, carbon dioxide, methane and small quantities of other paraffin are given off. The identifiable gas produced in this case is carbon monoxide which has the property of reducing silver nitrate solutions, under certain conditions, to black metallic silver. Th is is the reaction which takes place in solution 2.

These tests should be done immediately after a fault is indicated by a Buchholtz alarm, as acetylene is very soluble in oil, and on long standing over oil may be totally absorbed. In this case no reaction would take place in either solution, but

the exit gas would be inflammable. Carbon monoxide is relatively insoluble in oil and therefore presents no problem by delay.

For quantitative analysis, gas chromatograph is required which may be available either at site, R & D, Delhi or in any private research institute, like CRPI. The gas sample earlier collected as per the sampling procedure described above, is to be sent to the place where the required facility for testing of the gas is available. The test results will indicate the concentration of various fault gases in gas space. These fault gas quantities are required to be multiplied by Ostwald coefficient (k) to get the concentration of dissolved gases in oil. Ostwald coefficient (k) for various gases in mineral insulating oil is given below (as per IEC 599):

S.No.	Gas	k at 20 Deg. C	k at 50 deg. C
1	N_2	0.09	0.09
2	0_2	0.17	0.17
3	H_2	0.05	0.05
4	CO	0.12	0.12
5	CO_2	1 .08	1 .00
6	CH_4	0.43	0.40
7	C_2H_6	2.4	1.80
8	C_2H_4	1 .70	1.40
9	C_2H_2	1 .20	0.90

After computing the quantity of gases dissolved in oil, further interpretation is to be done as per the guidelines on dissolved gas analysis of transformer/reactors (refer document no. OGN/OPS/ELEC/019).

Responsibility: AGM(Chem), AGM(EMD)

4.5 Action based on interpretation of buchholtz gas

Based on the test results, the Buchholtz gas may be either air or gas. If air is confirmed, the equipment can be kept in service but a thorough physical check of the transformer/reactor should be carried out. Any leakages found should be rectified, even if a shutdown is necessary.

If the reason for air ingress is not detected and the Buchholtz alarm reappears, a shutdown of the equipment may be necessary and a further gas sample taken for analysis. If the sample is confirmed as air, a thorough investigation should be carried out to find out the reason for air ingress in the equipment. This is necessary because air may be entrapped in core/ windings, which in turn may result in local ionization of that area and may impair the insulation. Failure of transformers have been experienced in past because of the ingress of air.

The possibility of air becoming entrapped during oil filling cannot be ruled out and this entrapped air must be released fully before energising the transformer/ reactor. Any oil leakage in the pump suction and pipe flanges etc. will lead to air ingress when the pump is started. Hence, adequate care must be taken to attend to such leakages immediately to avoid failures.

Correct isolation of valves is essential to avoid oil drainage. Air leakage on the suction side ot the oil pumps should be avoided, by replacing the rubber/ neoprene bounded cork gaskets where necessary. In the past, it has been observed that the maximum likelihood of air ingress into the transformer is when the gaskets on pumps suction are damaged. If, after checking air ingress still persists and reason is undetected, the buchholtz alarm will reappear on charging. Under these circumstances, it is advisable to call the manufacturer for rectification. Under no circumstances may the transformer / reactor be energised without rectifying all the suspected points of air ingress.

In case the gas sample indicates that the gases are inflammable and fault gases are present, immediate shutdown of the equipment must be taken and following tests shall be done.

DGA of oil sample collected from main tank must be done and the results shall be interpreted as per the guidelines on DGA. Action must be taken as per the interpretation of DGA results.

Following electrical shall also be done and the results shall be compared with original commissioning/previous results:

a) IR values of windings
b) Measurement of HV/LV ratio at all the tap positions

c) Winding resistance measurement
d) Magnetizing current test
e) Magnetic balance test
f) Impedance measurement test

Applicable only for transformers.

In case of any abnormality, a detailed internal inspection of the equipment may be done to detect the exact fault. Suitable corrective actions must be taken before charging the equipment.

In case no abnormality is found in DGA of main tank oil sample, electrical tests and quantitative gas analysis, the equipment may be recharged.

Responsibility: AGM(Chem), AGM(EMD)

4.6 Reporting

The detailed format for reporting in case of Buchholtz alarm in transformers/ reactors has been prepared and enclosed at annexure-2. The electrical maintenance engineer may obtain the required information for completion the reporting format for record and further communication of Operation Services Division.

The chemistry departments of all sites should ensure the availability of testing apparatus and adequate number of trained persons so that correct gas analysis can be done as and when required. Also they must ensure the availability of silver nitrate (analytical/guaranteed grade and ammonia solution as per the test requirements. It is also suggested that A.G.M. (Chemistry) of each site may periodically check the gas testing facilities.

Responsibility: AGM(Chem), AGM(EMD)

5.0 REVIEW

HOD (EMD – O&M) will review this document once every two years or as necessary.

5.1 Review records

S.no	Date	Reviewed by	Signature	Comments

6.0 DISTRIBUTION LIST

SL NO.	DATE OF ISSUE	ISSUED TO
1		GGM(LARA)
2		GM (O&M)
3		AGM (EMD)
		Lara intranet webpage

ANNEXURE-I

GAS COLLECTING DEVICE

As the Buchholtz relay is always situated close to live parts of the transformer and in order to collect the gases for analysis from conveniently accessible position, a gas collecting device can be used. Present arrangement of gas collecting device for BHEL make transformers at Dadri project is shown in figure-2. These gas collecting devices have been made by M/s Flow Link, Poona and work on following principle :

The gas sampling valve-C, the oil will flow until the pressure exerted by the oil of the conservator has evacuated the gases from the relay housing to gas chamber of the device. The gases will be collected at the top of the chamber. When the gas collection is complete, the Valve C is closed. The gas samples now can be taken by opening Valve-D, for analysis. When all the gases have been evacuated, oil will again start filling the gas chamber completely and the device is again ready for gas collection, after closing the Valve-D. When oil is required to be drained from the Buchholtz relay close the valve before and after the relay. Open the Valve-E and the relay oil will be completely drained. In operation valve-E is to be kept close.

IMPORTANT

When device is placed into service it should be ensured that Buchholtz housing, connecting pipe and the gas chamber of the device are full of oil.

ANNEXURE-2

REPORTING FORMAT

1. STATION
2. NAME OF EOUIPMENT:
3. RATING:
4. MAKE :
5. DATE OF FIRST COMMIS SIONING:
6. DATE OF LAST FILTRATION:
7. DATE OF LAST MAINTENANCE:
8. DATE AND TIME OF BUCHHOLTZ ALARM :
9. DATE AND TIME OF GAS ANALYSIS :
10. RESULTSOFOUALITATIVEGASANALYSIS:

i.	Reaction with Solution 1 (5%silver silver nitrate)	Reaction with solution 2 (5% ammonical silver nitrate)	Exit gas inflammability	Fault indicated air / fault gas

11. ACTION TAKEN IN CASE OF AIR

a. Physical detection of leakages - leakage detected/not detected.

b. In case of leakage is detected indicate the action taken and the time of de-energisation.

c. Time of re-energisation of equipment :

12. ACTION TAKEN IN CASE OF FAULT GASES :

a. Time of de-energisation of equipment:

b. Details of the electrical tests carried out :
(Details of the instruments used may also be specified)

i. IR values of winding (indicate temperature also) :

ii. Measurement of HV/LV Ratio at all the Taps :

iii. Winding Resistance Measurement :

iv. Magnetic balance Test

v. Magnetizing Current Test

vi. Impedance Measurement Test

c. Interpretation Based on Electrical Tests :

d. Results of Dissolved gas analysis :

e. Analysis Based on DGA Results:

i. Result of Quantitative Analysis of Gas :

g. Analysis Based on Quantitative Analysis ot Gas:

h. Final Decision Based on the Tests of step 12 (A) to (G) :

13. OBSERVATIONS DURING INTERNAL INSPECTION (IF CARRIED OUT)

14. DETAILS OF RECTIFICATIONS :
(ATTACH DETAILED INSPECTION REPORT)

15. DATE AND TIME OF RECOMMISSIONING :

I6. DATE AND TIME OF REAPPEARANCE OF BUCHHOLTZ ALARM :

17. DATE AND TIME OF DE-ENERGISATION OF EWUIPMENT :

18. RESULTSOFOUALITATIVEGASANALYSIS

i.	Reaction with	Reaction with solution 1 indicated (5%ammonical nitrate)	Exit gas solution 2 silvernitrate)	Fault inflammability (5%silver air/fault gas

19. ACTION TAKEN IN CASE OF AIR:

a. Method of Detection of Air Leakage :

b. Location of Leakage Observed :

c. Rectification Details:

d. Recommissioning Date and Time :

20. REMARKS, IF ANY :

SIGNATURE