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POWER PLANT COMMISSIONING

Power Management Institute

Noida

CONTENTS

COMMISSIONING PROCEDURE AND DOUCUMENTS

1. INTRODUCTION

The term " COMMISSIONING " is used to describe the activity involved during the latter stage of erection upto the completion of the 72 hours trial run on full load which leads commercial operation.

The commissioning phase is a period of intense activity where many previously unrelated activities start to merge or interact with one another forming a complex sequence of events, with the advent of large generating units, the increased complexity of the plant and the closer limits available on the operating parameters, it is essential to ensure that the plant has been thoroughly tested prior to the normal operation so that initial performance can established and defects and omissions clear.

NTPC has developed an exhaustive commissioning system and philosophy with the consultancy of BEI. This philosophy and system has been accepted by NTPC management and is being implemented in NTPC Projects. The system described in the document is discussed hereunder,

2. THE PURPOSE OF COMMISSIONING

2.1 Target dates should be achieved.

2.2 To check that the plant is supplied and erected as per design.

2.3 Quality of erection and commissioning should be maintained.

2.4 To check that the plant operates reliably, safety and meets the design performance.

2.5 To established the reasons for any failure to achieve the design performance or any other limitation.

3. RESPONSIBILITES

With any “system” or organization it is essential that individuals, groups or departments all know their own responsibilities. The role of each part of the organization must be clear both within its own boundaries and in relation to each other.

Commissioning system sets out the duties and responsibilities of the Corporate Center, the site Erection Department, the site operation & Maintenance Department and the Contactor. The initiative for the setting up the detailed system on the site lies clearly with the Erection Department but in must be emphasized that all activities should be considered jointly by all the above departments.

It is a fundamental requirements that staff from all the above department including the contractor must be made available, full time of placing contracts the contractor is made aware of the significant workload that will be placed on him by the introduction of an organized commissioning procedure.

4. SYSTEM DESCRIPTION

Major committees are formed at least 18 months prior to schedule commissioning of 1st unit: During this period the following activities will be taken up:

i To identify O&M staff.

ii To setup O&M organisation.

iii To collect operating instructions manuals, schematics and drawing etc

iv. To prepare commissioning documents and operating instructions.

v. To train manpower for O&M function.

vi To associate in commissioning.

Vii To prepare plant completion reports.

5. ORGANISATION

The function and responsibilities of the major committees are as follows: -

5.1 Steering Committee

The purpose of this committee is to provide policy and priorities to the activities of the plant erection and commissioning, ensure that adequate resource are available both in material and manpower, to demand and approve programme of work to approve documentation,

The committee would normally be chaired by the site General Manager and consists of the senior officers from the Corporate Centre, Site and also senior responsibilities contractors.

5.2 Commissioning Panel

The purpose of this is to control and progress the day-to-day commissioning activities, to coordinate the activities of the various working parties and test teams and to report progress and receive priorities from the Steering Committee

The panel would normally the chaired by the Chief of O&M and the members would to the take drawn from the test team Leaders, Erection, Department, O&M Department and Contactors Middle Management as well as some staff from operation Services.

6. WORKING PARTIES

Working parties are formed early in the erection phase to carryout a number of vital tasks. The Working Parties are formed for the major plant areas, The objectives of the working party are:

6.1 To promote quick & efficient communication a between members.

6.2 To Support the Erection Department & Contractors in the efficient and safe commissioning of the plant.

6.3 To make clear, operational and safety requirements.

6.4 To be aware of target dates and Contractual requirements to effectively assist Erection Department in putting the plant to work.

6.5 To establish responsibilities and communications with inter plant related Working parties.

Membership of the working Parties is at the senior level in the given plant area and is drawn from the Erection Departments O&M Department, Contractor and operation Services, Chairmanship of the party passes from the Erection Department to the Station Department to the O&M Department phase plant has passed through the station operation phase

In the order to fulfill the objectives of the Working Party, There are a Committee and Commissioning Panel.

i. To implement the policies and priorities decided by the steering Committee and Commissioning panel.

ii To report to the commissioning panel or Steering Committee as necessary, progress, shortage and delays due to staff shortage, safety requirements, plant access, incorrect test procedures, equipments delivery incorrect programmer or the planning.

iii. To define safety requirements in order to preserve plant and personnel's safety,

iv. To define operational practices so that, when plant is commissioned, the operation of its correct.

v. To Define maintenance information required. At the point when NTPC takes over the protection and maintenance clear instructions must be available.

vi To define drawings and manuals that must be handed over prior to the protection and servicing of the plant.

vii. To define, agree and provide the number the type and content of the Commissioning documents required to fulfill the objectives laid out in the paper of the principle.

viii To define an erection and commissioning programme.

ix. To define and progress defects and omissions.

x To define, and issue the necessary certificates which record the stage of the completion of the erection and commissioning, in accordance with agreed procedure.

xi To the established Testing Terms whose members are the working engineer drawn from the various departments and contractors involved in a particular plant area.

xii. To monitor the performance and effectiveness of the Testing Team and to ensure that to ensure that the instructions, policy and procedure set out in the approved commissioning documents are being adhered to.

7. TEST TEAMS

These are made up of the engineers at junior level, who carry out the agreed Plant Testing and Commissioning Procedures. Members are drawn from to the various concerned departments and contractors and will operate under the leadership of the Erection Department Engineers in the case of the plant in the case of the plant testing, the O&M Engineer in the case of the plant commissioning, of the commissioning Department Engineer for both.

The Test Team Leader plays a very important role in commissioning. He provides a dynamic communication link between the engineers in the field and the day-to-day commissioning coordinator, He is responsible for the carrying out the agreed procedures and reporting deviations to the Working party and finally for the preparation of the Test Report and results.

8. DOCUMENTATION

There are five main types Documentation that are used in the system.

8.1 Papers of Principle

The papers of the principles are prepared jointly by the erection Department and Corporate Center. If the O&M Department and contractors are available at this stage of the constriction their to the main inputs should also be included. The Paper of Principle is the first and most vital documents to be produced as it is the base upon which other documents are compiled. Site staff must be made available full time at Corporate Centre to enable the documents to be provided.

The objectives of papers of the principles can be briefly summarized as:

i. Set out the principals & objective of the commissioning.

ii. Established design data against which the plant can be compared,

ii. Define the documentation required.

8.2 Testing and Commissioning Schedules

Testing and Commissioning Schedules are prepared by nominated members of the Working Party to meet the requirements of the Paper of Principle. It should be recognised that there is a fundamental requirement for contractor to be involved in the production of the documents. The documents define the plant to be tested or commissioned and cover aspects such as detailed test method, safety, emergencies, detailed programme, individual responsibility and results.

8.3 Standard Check Lists, Test Producers and Instruments Proving Schedules

Standard Check Lists are intended for use at the completion of the erection to ensure correct erection, testing and to a limited extent, operation, Where items of a similar nature are to be checked, for instance 300 mm parallel slide valves, a simple " standard check list" issued. Test procedures are used to ensure that all tests are carried out in a consistent manner, the test producer may procedure maybe referred to as one step on the standard Check List.

Instrument Proving Schedules are used where a number of instruments interact to from a minor control system which is to be checked, A second use is to hold together the standard Check Lists for a Major plant Auxiliary.

8.4 Design Change Notification

With the increased complexity and diverse nature of the modern plant, it is necessary to device, as early as possible during construction, a system of managing and controlling design changes so that all necessary departments are informed.

8.5 Test Reports

Where commissioning activates are carried out to fulfill objective and to make objective assessment, it imperative that the results of these activities are properly record from and method and of the presenting results will depend on the nature of the activity and may very from a simple calibration with design specification.

The from of the Test reports will decided by the networking by for the plant area concerned.

9. SAFETY

The procedure requires that be tore an item of the plant item of the plant is energized it must come within the scope of the safety Rules and once within that scope be done on that plant item once the requirements of the safety Rules have been met.

It a mandatory that a system of the Safety Rules is established . No plant item may be energized or pressurized until such a Safety Rules systems is an operation, these are statements deigned not to plant, the first being irreplaceable and the second representing a massive capital investment.

10 PLANT CERTIFICATION

As the plant is commissioned, critical stage. both operational and contractual are reached. In the order to the mark events to the ensure that satisfactory procedures are established, certain technical requirement have been met and safety measure have been taken, certificates are issued at different stage e.g.:

i. Safety Clearance certificate – issued prior to exercitation of the equipments / plant.

ii. Record of initial operation Certificate – issued after initial operation.

iii Clearance for the station operation certificate issued after

plant/equipment has reached a satisfactory state of completion.

iv Initial taking over certificate – issued to O&M Department with the intention to take the plant in accordance with condition of contract.

v. Final Internal Contract Clearance Certificate - issued to confirm the completion of guarantee period.

11. PLANT COMPLETION REPORT

When the plant is fully commissioned up to the design intent, a final completion Commissioning report is to be prepared for the plant. It will include plant details, programmer and schedule and achieved, major deviations, etc.

12. Samples of mechanical and C&I standard list.

MECHANICAL

STATION STANDARD CHECK LIST SHEET 1 OF2

PLANT ITEM PIPEWORK-CONSTANT LOAD SUPPORT

PLANT NOMENCLATURE ----------
UNIT ---------- SYSTEM ----------
MANUFACTURER---------- SRL. NO.----------
LOCATION----------

NO	ACTIVITY	WITNESSED NTPC	WITNESSED CONTR	Date
1.	General conditions satisfy the Side standing Instructions as listed In the "Plant Item Commissioning Essential Pre – requisites"(SCL MS1/1)			
2.	The name plate legend agrees with the approved NTPC plant Nomenclature is clearly visible securely fixed, durable and correlates with remote labels.			
3.	The installation is complete and correct in accordance with the latest drawing and specification and support attachments to building Steel work and pipework are secure and satisfactory.			
4.	Access for adjustments maintenance and repairs is a satisfactory,			
5.	Check that support-setting details can be easily read.			

REMARKS

SCL REF: M/4/6

MECHANICAL

STATION STANDARD CHECK LIST SHEET 2 OF 2

PLANT ITEM PIPE WORK ---- C ONSTANT LOAD SUPPORT

NO.	ACTIVITY	Witnessed ---------- Date NTPC CONTR
6.	Check Marinate rings are correctly fitted and undamaged (where appropriate)	
7.	Check hanger adjusted to cold setting according to manufactures figures. Cold Setting ---------- Note for later Check Cold Position datum----------	
8.	All locknuts tightened	
9.	Check hanger setting when system hot. Setting Hot …… Pipe Temp …… Pipe Press…….kg/cm2 Note for following check……..Position when hot .	
10.	Check cold to hot travel is uniform about centre setting.	

REMARKS

SCL REF: M/4/6

CONTROL & INSTRUMENTATION		
STATION	TEST PROCEDURE	SHEET 1 OF 2
INSTRUMENTS PRESSURE GUAGE		TP REF: 1.5.1.
NTPC TAG NO		UNIT
No.	Activity	Remarks

1. Test Equipments Required.

   1.1 Portable Dead Weight Tester, Comparator. Or other similar sure of the vacuum source.

   1.2 Standard Test gauge if not using a dead weight tester, other standard pressure vacuum gauge, dependent on the range of the instrument being tested.

2. Check calibration of the test Equipment.

3. Check the gauge calibration over its entire range 20% steps, increasing and decreasing, Allow for head correction where necessary, Note the results on Standard Calibration sheet 1.15.1.

4. Recheck the calibration of the test equipment.

5. Acceptable errors for pressure gauges, unless otherwise specified in the contract specification are:-

   Standard of Test gauges +_ 0.25% FSD.

DEFECTS & OMISSIONS CONTINUATION OVERLEAF		
REMARKS		
NTPC SIGNATURE	CONTRACTORS SIGNATURE	DATE

CONTROL & INSTRUIMENTATION		
STATION	TEST PROCEDURE	2 OF 2
INSTRUMENT: PRESSURE GUAGE		TP REF:1.5.1.
NTPC TAG NO		UNIT
NO	Activity	Remarks

6. Industrial gauges $\pm$1% FSD between 10% & 90% scale.

7. Industrial gauges $\pm$ 1.5% (1½%) FSD below 10% & above 90% scale.

8. 2nd class Industrial gauges $\pm$ 3% FSD.

DEFECTS & COMISSIONS CONTINUATION OVERLEAF		
REMARKS		
NTPC SIGNATURE	CONTRACTORS SIGNATURE	DATE

Part –1 Boiler & Auxiliaries

A. Commissioning Activities

1. INTRODUCTION

1.1 The commissioning procedure may be broadly divided into the following stages right from the pre-commissioning checks to the reliability run of the boiler with its auxiliaries.

2. PREPARATION –PLANNING VARIOUS ACTIVITIES

2.1 Pre–commissioning check up the pre – commissioning checks are envisaged to the identify the points so that corrective actions can be taken in time so that the commissioning programme can be carried out without unnecessary delays and possible consequent quality deterioration.

2.2 Trial run of equipments: consisting of

a) Safe running the equipment for 8 hours period with all the interlocks and protections, indications etc. to the check the behavior of the equipment and its suitability to put into regular service,

b) Checking the equipment and associated system with the aid of check lists /instructions supplied for the same.

c) In the case of the items like dampers, gates, valves, etc, freeness of movements, full travel, full closure are checked individually and along with drives.

2.3 Pre –commissioning Tests: Gas tightness and air boiler pressure tests are carried out identify and rectify leakage points in the systems,

At this stage the repeat hydraulic test on the boiler pressure parts is also carried

out by to the erection agency.

2.4 Alkali boil out: Alkali boil out is carried out into to remove oil grease and impurities adhering to the interior of the pressure parts of the after erection of the boiler has been completed, the Alkali boil out operation is performed at 40 kg/ cm^2 gauge with 1000 ppm tri-sodium phosphate for 24 hours, the boiler is fired for the process.

2.5 Thermal flow tests: In the order to detect possible chocking in the boiler tubes thermal flow test is carried out. The water wall tubes, economisers and superheaters tubes are normally checked by means of this test.

2.6 Chemical Cleaning of the Boiler Chemical cleaning of boiler generating surface is carried out by circulation method using 4% inhibits HCL Super heaters are excluded.

2.7 Steam Boling: Steam purging of super heaters and critical steam pipe lines is carried out by 'puffing method to remove mill scales weld beads etc. This is achieved in a number of the stage planned to suit the layout of the system, Re heater safety valves are floated at this stage.

2.8 Safety Valve Setting: After steam blowing operations, the safety valves (drum super heater) are required to be set to operate at the desired pressure.

2.9 Commissioning of the Boiler: After completion of the pre – commissioning activities as briefly outlined above, the unit is made ready for rolling of the turbine and synchronizing. Normally this is followed by bearing inspection of turbine and subsequent loading of the unit.

2.10 Reliability run of the boiler: After the Boiler has been commissioned and various automatic put in the operation the boiler is taken for the reliability run. The boiler is operated for a predetermined period as agreed upon by the customer and supplier.

B. Typical Commissioning Schedule

1. INTRODUCTION

1.1 The commissioning team will organise their activities in such a manner that the following jobs are completed to meet the boiler light up requirements:

a) Trial of ID&FD fans.

b) Trial run of air heaters and readiness of AH soot blowing and fire fighting system,

c) Readiness of the light oil systems for firing.

d) Trial run of ignitors fans

e) Trial run of rapping mechanism of E.P.

f) Gas distribution test on E.P.

g) Air load test of EP.

h) Readiness of feed pump

i) FSSS simulation for the bottom elevation.

J Boiler interlock and protection check.

k) Readiness of the bottom ash protection and water seal.

l) Trail run acid circulating system.

1.2 Many of the above mentioned activities are parallel and with various inputs given in time it may take nearly two months to complete the above jobs.

2. Listed below are the various steps (along with tentative time needed to the achieve them) from first light up to Reliability run of the boiler.

		Activity	Time of in days	Total time from from start
2.1	a)	Trial light up	2	2
	b)	Alkali Boil out	5	7
	c)	Cooling down	3	10
	d)	Preparation for Acid cleaning (Removal of Internals, Blanking Flow test comers for the thermal Flow test, putting temporary Piping connection etc,)	7	17
	e)	Thermal flow test of WW/ Eco Wall Plates	3	20
	f)	Removal of the blanks from Orifice or down comers	2	22
	g)	Acid Cleaning & 1st Stage passivation	7	29
	h)	Cooling & inspection	3	32
2.2		Restoration of the drum internals and normal scheme of the Boiler, Hydraulic test and preparation of the Boiler for 2nd stage passivation & steam blowing.	15	47
	a)	IInd Stage passivation	3	50
	b)	Ist Stage steam blowing	5 +	
	c)	IIIrd Stage steam blowing (Including preparation time)	5	60
	d)	Cooling the Boiler	3	63
	e)	Reheater Hydraulic test Including CRH &RRH piping if not done earlier	3	66
	f)	IIIrd Stage steam blowing Including preparation	38	69
	g)	Reheater safety Valve floating	1	70

h)	IV&V Stage steam blowing Including	10	80
i)	HP/LP Bypass system readiness (Welding of valves & connected system operations & checking)	10	90
j)	Drum & Super heater Safety valve floating	3	93
k)	Cooling Boiler	3	96
l)	SH Thermal flow test	4	100
m)	Steam Turbine Rolling & Generator Dry out	10	110
n)	Synchronizing & loading up to 120 MW with coal firing	12	122
o)	Bearing Inspection	10	132

2.3 In the case unit it to be loaded further by coal firing after synchronization (before going for the bearing inspection) then the following systems are also to be made ready before synchronizing (which otherwise needed after bearing inspection)

a) Coal handling system,

b) Ash handling system.

c) Soot blowers

d) Milling system

e) FSSS for mills

f) Availability on the Instrumentation

Controls & Automation

g) Resynchronising after bearing inspection 2

C. Hydraulic Test And Wet Preservation

1. WATER FILLING

1.1 For both drainable and non drainable portions, normally usages of DM water only is recommended.

1.2 All non- drainable parts can be filled with DM water or condensate containing 10 ppm Ammonia as NH3 and 200 ppm of the hydrazene with a solution ph value of approximately 10.0

2. DRAINABLE PARTS

2.1 Economizer, water walls and all drainable portions can be filled with DM water or condensate containing 10ppm Ammonia as NH3 and 200 ppm of the hydrazine with a solution pH Value of a approximately 10.0, If DM water is not available, only the drainable portions can be filled with water free of chlorine and containing to 10 ppm of ammonia as NH3 and 200 ppm of the hydrazine with a solution pH approximately 10.0. Prior to usage, filtered water quality should be ascertained.

2.2 The required quantity of the ammonia and hydrazine should be added into the water of recommended quality and a homogenous mixture should be ensured prior to filling.

2.3 All the drainable parts, (economizer, water walls and the drum) should be filled through their respective bottom drains with vents open. Filling may be stopped vent drum is filled half (this can be ensured by keeping level gauge tapings opened.)

The tank containing clear to the filtered water be drainable and flushed.

2.5 All the no drainable parts (includes drainable super heater) should be filled through their bottom drains with the recommended quality of the water containing 10 ppm of the ammonia as NH_3 and 200 ppm of hydrazine with a solution pH of approximately 10.00. Prior to filling a homogeneous mixture of the chemicals and water be ensured. All the respective vents should be kept opened during filling operation. When water gushes out ensuring free flow from all the air vents including drum, close the air vents. Now pressurise the system up to the working capacity of the filling pump.

3. HYDROSTATIC TESTING

3.1 Water used should be only DM water containing 10 ppm ammonia and 200 ppm hydrazene with a solution pH of 10.0,

3.2 Pressure reading during the tests will be taken from the pressure gauge at the high point of the boiler.

3.3 As a already indicated boiler shall be partially with the aid of fill pump.

3.4 HIGH PRESSURE PUMPS Shall be employed to the obtain test pressure.

3.5 Hydrostatic test pressure shall be as per IBR and contract agreement.

The rate of the pressure rise and rate of the pressure drop for the inspection and draining be as per IBR.

4. GENERAL :

Quantity of the water chemicals required for the one filling.

4.1	Hydraulic	200/210 MW Units
4.1.	Clear filtered water	200 tonnes.
4.1.2	DM water	175 tonnes

4.2 Preservation

4.2.1	DM water	350 tonnes
4.2.2	Hydrazene hydrate (100%)	100 kg
4.2.3	Liquor ammonia (25 to30%)	30kg
4.2.4	Desired water temp	Not less than 21^{o}C

4.3 After successful complain of the hydraulic test, the system may be drained to the as per requirement and kept under wet preservation immediately as per recommended procedure. In the actual practice, it is found that after first to the hydraulic test, closing weld joints are to be made.

5. WET PRESERVATION:

5.1 Ensure to the as a last of to the water kept to the in the boiler used for to the hydraulic test is having a solution pH of not less than 10.0 with a minimum hydrazene content of the 200 ppm.

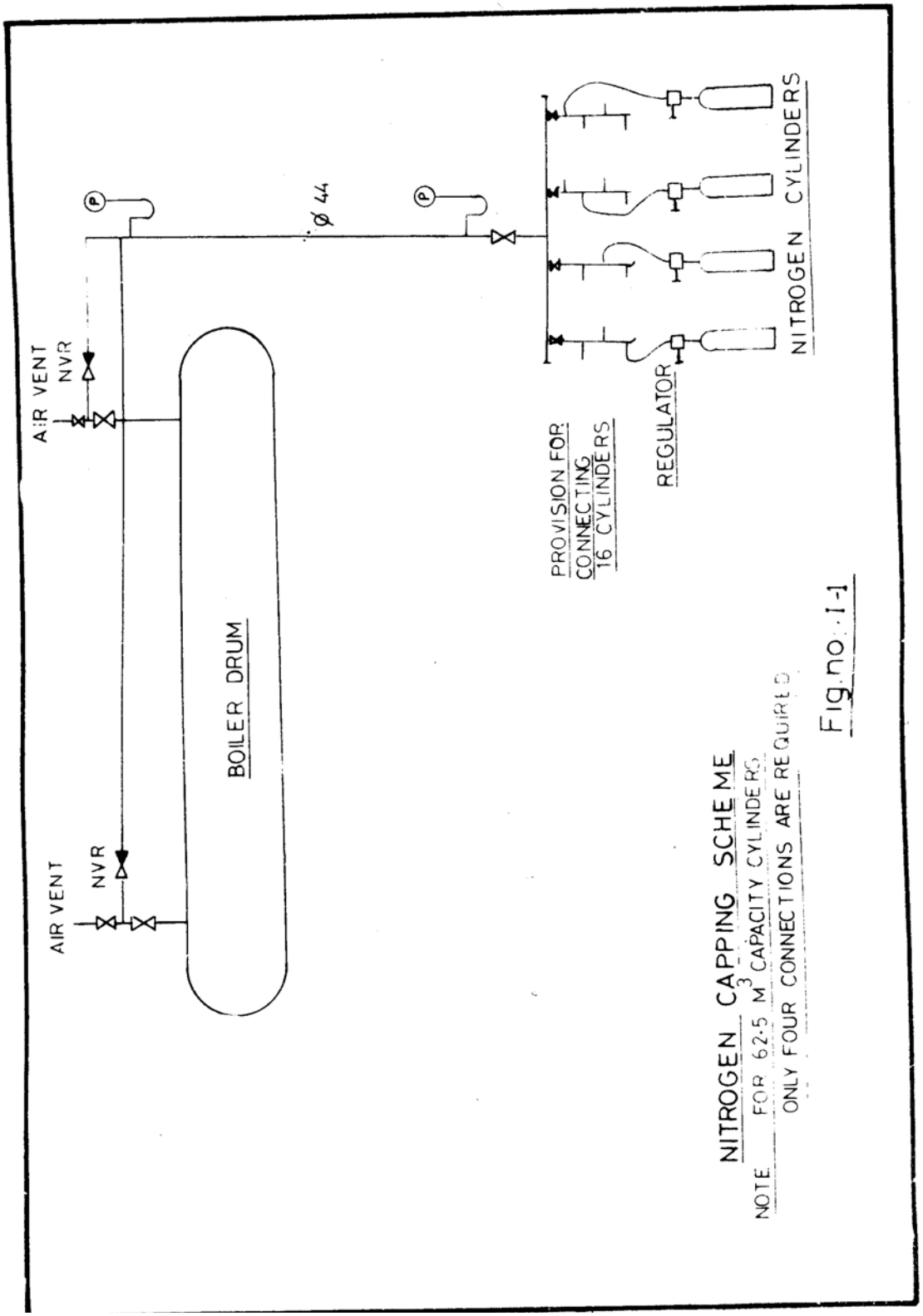
5.2 Keep the under nitrogen blanket at a pressure of 0.5 kg / cm_2 (Refer to fig. No. 1-1.

5.3 Even during cases of the isolated hydraulic test of drainable portion alone, wet preservation under nitrogen blanket should be practiced for the portion tested.

5.4 In the absence of to N2 capping facility, to the boiler can be kept under pressure of5 kg/ cm^2 with the aid of the fill pump.

5.5 Periodical tests are for to the pH and hydrazene content should be done for the samples collected from superheater, As and when the pH goes less

than 9.5 and hydrazene reserve less than 150 ppm.



D. Air And Gas Tightness Test

1 INTRODUCTION

1.1 The smoke generators are used for the easier direction of the air leak and ingress points. The smoke-generator is a sealed cylindrical container having to the chemical in it which produce huge quantity of the smoke when ignited. The specification of the smoke generator used is of type 24 MKS, 40 IBS wt. This is being to the produced from the defense stores.

2 PROCRDURE FOR THE TEST

2.1 Generally to the ignite a smoke–Generator, the seal should to the punctured or removed and it should be ignited with to the help a burning swab, when the chemicals are ignited, they are burnt completely within 10 or 15 minutes and a huge quantity of a smoke is liberated out. the smoke thus the liberated will to the occupy the whole space and the space will be subjected to slight to the over pressure with to the atmospheric pressure. Now the smoke will try to escape into the atmosphere from all known on unknown leakage points (Air ingress points) these points are noted and later on repaired. If necessary the FD or PA fan can be run to slightly pressurise the furnace. The number of the smoke generators required for the test depends on the volume of the space to the tested.

3 FURNACE ZONE

3.1 The furnace zone covers up to goose neck and penthouse 4 Nos of gas generators can be used for this zone. The smoke generators are to be brunt with a burning swab just above the water -seal of the water wall tubes on two sides (Left& right). Manholes are inside the Boiler over a temporarily made platform. All the other Manholes and peepholes are to be a kept closed tightly.

4. SECOND PASS OF BOILER

4.1 This portion covers the area from to the Boiler goose neck to air pre heater. The flue gas inlet dampers to the both air pre-heater are kept closed. In this zone 2 Nos. of smoke generators can be used. These are to be brunt just above to the air pre-heater (above the inlet dampers) where manholes are available.

5. ELECTROSTATIC PRECIPITATOR

5.1 This portion covers flue path after air pre heater M.P., E.P.S. and up to the outer the outlet dampers of I.D fans. The portion is again sub – divided and out of four sections of EP is taken for test at a time. The flue gas dampers after air pre heaters inter – connecting damper and damper in the remaining sections of EP as to be kept closed. The outlet dampers to the of I.D fans are closed are also to be kept closed. Two smoke generator can be used for each section. It is to the burnt inside the EP at the lowest possible point.

6. F.D. FAN DUCTS

6.1 HOT AIR DUCT: It will include duct above air heater and extend up to burner wind box one each side. Totally 2 Nos. can be used for the both sides on one each side. During to the test interconnecting air dampers are to the kept closed.

6.2 COLD AIR DUCT: This portion covers the air duct after the F.D. fan outlet damper and up to air pre heater, the outlet damper of fan F.D. fan the air up to air connecting dampers heaters are to be kept closed.

6.3 One smoke generator can be closed for to the earth side of the duct. Thus totally 2 Nos. of the smoke generators will be required.

7. P.A. FANS DUCTS

7.1 Cold Air Dusts: This will cover cold air after P.A. fan outlet damper and will extended up to mills on each side P.A. fan. One smoke generators can be used in each side. Thus 2 Nos. of gas generators will be required . During this test, outlet damper of P.A. fan, Inter –connecting damper and ho air dampers of mills are to be kept closed.

7.2 HOT AIR DUCTS: It will include the hot air duct after air heater and will extended up to the mills. One smoke generator can be used for each side and it is to be brunt above the air preheater. All the hot air dampers to mills and dampers before air per heater are closed. It will be better to perform this test simultaneously for both sides as enormous volume of the smoke will be available (three is no interlocking damper). Totally 2 Nos. of smoke Generators can be used.

PROTOCOL ON SMOKE GENERATOR TEST
OF THE BOILER

Name of the site:

Unit NO:

The smoke generator test was carried out on the procedure to detect and rectify the leaking portions in the systems. The leakage found has been rectified. Details of the No. of smoke generators used indifferent sections are given below.

Date	Section	No. Of Smoke	Remarks	Generators used
	Cold Air duct			
	Hot Air			
	Second Pass			
	Furnace			

EP LEFT EP RIGHT

Leakages found during the test were rectified and wherever necessary a repeat test was done.

CUSTOMER CONSULTANT

E. Trial Run Of Equipments

1. INTRODUCTION

1.1 All equipments are run independently for a period of at least 8 hours before declaring them available for the regular operation, Firstly the motor is run is accordance with the manufacture recommend actions. After the motor is proven O.K. it is coupled with equipment. Now the necessary checks to the are made as per the checklist for the equipments is run for a period of 8 hours.

1.2 It is necessary to meet the requirements as mentioned in a check list including its related instruments, the inter locks and protections before taking 8 hours trail run is completed a protocol will be singed and a equipment is to the be taken over for the day to day operation and maintenance by the customer's staff.

2. FANS

2.1 <u>Tests</u>

a) Constructional

b) Pre – commissioning

c) Commissioning

2.1.1. Constructional tests: The extent of the test necessary and documentation with checklist to be provided are to be decided and produced by to the commissioning group. (Refer commissioning checklist attached of the ID

fans).

2.1.1 Pre - Commissioning Tests: These tests are will be carried out when construction is substantially complete and will entail the following :

a) Inspections of the fan (Mechanical. Electrical, and Instrumentation action).

b) Ensure tightness of all blots those fixing impeller, bearings, motor as well as tightness of the pressure parts.

c) Lubrication checks on the pump and motors.

d) Checks on the setting on the relief valve (on lub. oil, system)

e) Operational Test on the valves and fittings.

f) Instructions test on all motors.

g) Rotational checks on all motors.

h) Flushing out of oil systems, cooling water system.

i) Finial Inspection of the fan.

2.1.3 Commissioning Tests: These tests will involve the initial operation of the systems to the demonstrate that it is operationally should and conforms to the specification, the test comprise the following operations:

a) The starting and operation of the lub oil

b) Operation of the suction and discharge strainers to the lub oil

heaters, coolers.

c) Operational checks on the inlet vanes, discharge dampers etc.

d) The starting and operation of the fan along with its major components. (Sections chamber, inlet vane control, flexible coupling etc.

e) Operational checks on the bearing.

3. AIR HEATERS

3.1 Tests

a) Constructional

b) Pre – commissioning

c) Commissioning

3.1.1 Constructional Tests : The extent of the test necessary and documentation with check list to be provided ,are to be decided and produced by to the Commissioning group.

4. MILLS

4.1 Test

a) Constructional

b) Pre-commissioning.

c) Commissioning

4.1.1. Constructional Test: The extent of the test necessary and the documentation with check list to be provided, are to be decided and produced by the commissioning group.

4.1.2 Pre-Commissioning Tests: These tests will be carried out when construction is substantially completed and will entail the following:

a) Inspection of the system (mechanical, electrical and instrumentation).
b) Lubrication checks on the bearings.

c) Operational checks and tests on valves, fittings, dampers, and couplings.
d) Insulation test OR motors.
e) Rotational checks on motors.
f) Cooling water lines flushing.
g) Oil(of the lub oil system) flushing.
h) Mill air flow test.
i) Ensure tightness of the ducts connections, lub oil connections.
j) Final inspection.
k) Mill commissioning checks and trial.

4.1.3 Commissioning Test: These tests will involve the initial operation of the system to demonstrate that it is operationally sound and conforms to the specifications. The tests comprise the following operation.

a) The operational functioning of the dampers.
b) The starting and operation of the system.

COMMISSIONING CHECK LIST	PART	SHEET	REF. NO.
INDUCED DRAFTFAN			
STATION	STATION PLANT CODE		
PLANT IDENTIFICATION	UNIT NO I.D. FAN		
	I.D. FAN	PLANT DETAILS	
Manufacture		Type of Lubrication	
Type Capacity		Direction of the rotation on Fan Coupling Method of Control.	
Speed Fan efficiency		Name of Erector	

I.D.FAN MOTOR		
Manufacture		Voltage / Current R.P.M.
Type		Type of Lubrication Class of Insulation
Rating		Service Factor Name of the Erector

S. NO	ACTIVITY	COMMENT

1. Access to the plant & surrounding are satisfactory?
2. Permanent & adequate lighting available?
3. Labeling and identification permanent & satisfactory?
4. Paint mark and identification complete & Satisfactory?
5. Fire – protection available and satisfactory. ?
6. Is plant likely to be adversely affected by to the temperature, liquid or gases?

F. Commissioning Of Electrostatic Precipitator

1. PRE-COMMISSIONING CHECKS - MECHANICAL

1.1 Internal checks: Caution - Use only portable lamp operated by dry cells to avoid electric shocks.

a. Shock bar bolt welding.

b. Free movement of shock bar in guides.

c. Straightness of collecting electrodes rows.

d. Check for- any foreign material between the electrodes.

e. Correct position of gas screen.

f. Correction of collecting electrode guide.

1.2 Concentricity of suspension tube with respect to screen tube.

a. Emitting electrodes in centre of the collecting electrodes.

b. Gap between collecting electrodes and vertical beams.

c. Tension of emitting electrodes.

d. Distance between collecting electrodes and vertical beams.

e. Tack welding of all bolts and nuts.

1.3 <u>Rapping system of collecting Electrode</u>

a. Hammer hitting position on the shock pads.

b. Lateral shift of hammers with reference to shock pad centre max. allowed ± 5 mm.

c. No fouling of hammers with the gables, walls etc.

d. Setting fixing.

e. Tack welding of fasteners on rapping system.

1.4 <u>Emitting Rapping</u>

a. Condition of shaft insulator.

b. Hammer hitting position on the shock beam.

c. Direction of rotation of screws.
d. Tack welding of all fasteners.
e. Set ring fixing.
t. Axial play of shaft insulators 10 mm.

1.5 Check for presence of foreign material and cleanliness of the hopper and walls.

1.6 Check the doors to ensure free swinging easiness to open and close no seizing of nuts.

1.7 Check the gaskets (asbestos rope) on the Inspection door for proper tightness.

1.8 Conduct gas tightness test before the gas distribution test and the insulation work is done.

1.9 Gas distributor screen.

Conduct gas distribution test and ensure following:

a. Check for the positioning and locking of deflection elates and throttling plates on the screen sheets.

b. Check for removal of all temporary arrangements (rounds of ladder etc.)

c. Check for minimum distance of 100 mm between the bottom screen and the front cable to prevent dust deposits in the inlet dust of EP.

1.10 Gas distribution wall - bottom gaps and provision of inspection doors.

1.11 Top of EP Insulator Housing

a. Condition of support insulators.
b. Heater location and fixing.
c. Tight fixing of bare conductors.
d. Plugging of lifting tool inlet.
e. Check earthing cables.
f. Proper closing of housing cover.

2. PRE-COMMISSIONING CHECKS - ELECTRICAL

2.1 Geared Motors

a. Check insulation value. Note down the value.
b. Check winding resistance 40 to 50 ohm equal in all 3 phases. Note down the values.
c. Check oil levels.
d. Check cable connection from panel to motors.

2.2 Heaters

a. Check heater continuity and resistance - Note the values.
b. Check insulation - Note the values.
c. Check thermostats and its connection.
d. Check cable connection from panel to heater and thermostats.

2.3 Auxiliary Control Panel :

2.3.1 Precommissioning

a. Check insulation value. Megger R.Y.B. of incomer, outgoing cable and main switch between phases and phase to earth values greater than 2 Megaohms acceptable.
b. Check fuses.
c. Check wiring and components.
d. Clean by air blowing.

2.3.2 Commissioning of Auxiliary Control Panel

a) Disconnect heaters, motors from panel.

b) De-couple motors from rapping mechanism.

c) Remove programmer from the module.

d) Switch on supply to panel. Supply on bulb should glow.

e) Press rapping mechanism start button.

g) Keep the switches on the programmer module in continuous operation.

h) check all protections for motors and heaters. In case of motor check fault indication.

i) Switch off panel.

j) Press start push button for rapping motors.

k) Connect out going terminal for motors and heaters.

l) Check direction of rotation of motor. Ensure proper rotation before coupling to rapping mechanism.

m) Check if all motors run for 1 minute before stopped by the timer.

2.4 Testing of transformer rectifier set: Open circuit test (at partial loading) should be carried out by authorised engineers.

In this case, the results of the test should be tallied with (he results in the test certificate. Equipments and instruments required for this purpose are :

a) Voltmeter 0- 500 Volts AC

b) Ammeter 0- 5 amps (C.T. ratio 50:5)

c) Suitable cables and leads for instruments.

d) Air cooled portable type single phase, 50c/s, 28 amps. 0-470 volts variable auto transformer.

3. BEFORE THE FIRST LIGHT UP OF THE BOILER

a) Civil work of control room for EP should be ready in all respects like inside plastering, white washing, lighting, with proper ventillation as agreed upon.

b) Electrical power supply should be availed to put at least all rapping, motors into operation. It is preferable to make available the total required power.

c) Pre-commissioning check - Mechanical is done.

d) Pre-commissioning check - Electrical

i) Electrical motors are done.

ii) Rapping motors are put into trial run and continuously thro' Auxiliary control panel during oil firing.

4. GAS DISTRIBUTION TEST

4.1 Test is conducted preferably before first light up.

4.1.1 Gas Distribution Test of E.P.

The E.P. being in the gas path, is not available for mechanical adjustments once the boiler is lighted up. Its satisfactory performance from the very beginning ensures a long life of ID fan and hence it is desirable to commission E.P. in a systematic way in all respects before the first light up of boiler. It is recognised that it would be possible to commission E.P. before first light up of boiler by proper scheduling the jobs from the beginning. Gas distribution test, normally called as G.D. test, is one of the tests to be conducted after interval erection of EP is completed in all respects.

The purpose of the gas distribution test is to check and correct the gas flow inside E.P. chamber by fixing deflection plates on the distribution screen at suitable locations. The best time to conduct CD test is prior to first light up of boiler. Ensure erection of E.P. internals is completed and availability of I.D. & F.D. Fans. To start the G.D. test, ID AND FD fans are kept running and gas flow is adjusted with the inlet vane control of fan,

such that average air velocity obtained is m/sec. in one of the panes. The velocity readings are to be taken by an anemometer in the rear end of first field. Where first field is a dummy, these readings are to be taken in the second field. Each field is divided into number equal zones and velocity measured at various heights in each zones. The velocities and flow pattern are to be studied to determine to fix the deflector plates in the gas distribution screen. These deflector supplied by Trichy can be easily hooked . in the zones very high velocities are noted. Velocity measurements are to be repeated after fixing the plates to calculate the efficient of variations which is limited to 20%. The GD test as described above for one path is to be repeated in on the remaining three paths.

4.1.2 Air Load Test of E.P.

Air load test of E.P. is also to be conducted prior to first up of boiler to indicate the alignment of internal healthiness of insulators and the transformers/rectifiers. As the test is conducted in the medium of air prior to first light up, the test is called as air load test. Detail checks to commission EP rectifier transformer and control panels are separately given. All the electrical equipments are commissioned and available for air load test. To conduct air load test, ID/FS fans are kept in service and all the E.P. zones are charged. Volt-ampere characteristic of each field is tabulated.

Steam coil Air Preheater should be put into operation to obtain flue gas temperature at the inlet of EP to 105°C during initial operation.

FEED BACK DATA SHEET ON EP PERFORMANCE

1. DAILY LOG SHEET.....OF.....

1.3 HOPPER EVACUATION TIME GAS PATH .....

DAY	FIELD 1		FIELD 2		FIELD 3		FIELD 4		FIELD 5	
	1 HOPPER	2 HOPPER	3 HOPPER	4 HOPPER	5 HOPPER	6 HOPPER	7 HOPPER	8 HOPPER	9 HOPPER	10 HOPPER
1.										
2.										
3.										
4.										
5.										
6.										
7.										
8.										
9.										
10.										
11.										
12.										
13.										
14.										
15.										
16.										

G. Fuel Oil System

1. INTRODUCTION

1.1 As a result of long storage and exposure to atmosphere for a' long period the oil lines are normally filled with mud. muck and attacked by rust etc. This calls for a thorough cleaning and removal of rust, millscales etc. to the extent possible. Failing to do so may result in frequent choking of filters in the lines resulting in a number of interruptions in the initial stages of operation of the boiler. Also the choking of oil gun tips resulting in poor combustion and carryover of oil to the air heater, and hence a cause of air heater lire.

1.2 Field experience shows that these oil lines, if blown with steam at a pressure around 10-12 Kg/cm 2 at the rate of 5 to 10 T/hr for a period of 4 to 6 hours continuously, gives a good cleaned surface.

2. FLUSHING OF H.S.D. LINES WITH OIL:

2.1 Inspite of the due care taken for cleaning the oil lines it is observed that during initial stage of operation the filters provided in the lines particularly before igniters, and the igniters, atomisers get choked very frequently causing interruption in the process. It will be a worth exercise to make some temporary connection for recirculating the H.S.D. back to the storage tank and keep the oil pumps running for a period of one week or so before first light up of the boiler.

3. TESTS

a) Constructional

b) Pre-commissioning

c) Commissioning.

3.1 Constructional Tests: The extent of the test and documentation with check list to be provided, are to be decided and produced by the commissioning group.

3.2 Pre-commissioning Tests:

These tests will- be carried out when construction is substantially complete and will entail the following;

a) Inspection of the Pump (mechanical, electrical & instrumentation)
b) Ensure tightness of the pipe lines.
c) Checks on settings on relief valve (on oil system)
d) Operational test on valves and fittings.
e) Insulation test on motor.
f) Rotational check on motor.
g) Hydraulic test.
h) Flushing out of the pipe line.
i) Inspection of supports, drains.

3.3 Commissioning Tests : This tests will involve the initial operation of the system to demonstrate that it is operationally sound and confirms to the specification.

The tests comprise the following operation:

a) The starting and operating of the pump.

H. Preparations For First Light Up

1. SYSTEM

1.1 In order to prepare the boiler for light up the checking can be started system wise. Broadly the boiler can be divided into six systems. They are;

1. Air System
2. Gas System
3. Water System
4. Fuel System
5. Steam System
6. FSSS

1.2 These systems are to be thoroughly checked for their mechanical completion, cleanliness and it should be ensured that the related test on them i.e.Gas tightness, Air tightness, Hydraulic test etc. have been carried out.

1.3 Trial run of all auxiliaries excluding milling system should be completed.

1.4 Check availability of instrumentation, interlocks and protection needed for light up and alkali boil out.

1.5 Check refractory and insulation work has been completed.

1.6 Check availability of proper quality and regular supply of D.M. water.

1.7 Ensure that communication between all-important areas of operation is available.

1.8 Ensure sufficient illumination in Boiler house and other working area.

1.9 Ensure that chemical laboratory is functioning. Ensure Fire fighting arrangements are available. Ensure sufficient stock of fuel oil, lubricants & Commissioning spares are available.

1.10 The commissioning engineer should prepare working instructions for light up and alkali boil out based on operating instruction manual received from manufacturing units and distribute sufficient copies to operating staff of customer and consultant. This procedure shall be explained to the staff in two or three lecture sessions to be organised by the commissioning engineer where he shall try to make them conversant with the schemes.

2. CHECKING OF IGNITOR SYSTEM

2.1 Check on Ignitor Air System Layout :

a) The erected ignitor air system layout must be as per design.

b) Check for leakage of air in the system especially in all the flange joints starting from fan outlet to the wind box. Ensure that there is no gap between ignitor horn supporting plate and its flange.

c) Check the system resistance when the fan is operating at the optimum point. Ensure that there is no abnormal pressure drop exist in the critical sections (like elbows, toes and bends). If so the concerned Engineer may be consulted and the defect (if any) is rectified.

d) After ensuring that the layout is as per design and there is no leakage of air in the system and there is no abnormal pressure drop in the critical sections and the ignition air is passing out through free flow area inside the horn. still if the farthest ignitor wind box is not-getting the minimum prescribed wind box furnace differental press-ure (75 mm in the case of 2 million BTUH and 10" mm in the case of 6 million BTUH) the ignitor air fan must 'be checked for its

performance in the following manner.

e) Run the fan with its suction opens to atmosphere and take the following measurements:

1) R.P.M. of the motor/impeller shaft.

2) Power consumption of the motor.

3) Total pressure just at the fan at various quantities delivered. The quantity delivered can be throttled by using the outlet damper and the delivered quantity can be measured by using a pilot tube.

4) A graph is plotted between the quantity and the total pressure. This characteristic is compared with the specification/characteristic available in the instruction manual. Any abnormality either in the characteristic or in the power consumption and in the RPM must be immediately informed to Engineering for corrective action.

2.2 Check on the mounting of the Ignitor

a) Check the ignitor windbox dimensions and it must be as per design.

b) The flange welded in the ignitor windbox to mount the front plate must be checked for its verticality.

2.3 Check on Ignitor Parts

a) Check vertically of the Eddy plate inside the horn using the No. Go and Go gauges.

b) Keep the front plate on the ground and place the ignitor gun in position, now check the verticality of the ignitor gun tip slot opening. A variation of appr. _j_ 1 mm can be allowed. Otherwise modify the tip seating plate in the eddy plate so that the gun tip slot opening is vertical.

c) Check the tightness of the tip lock nut.

d) Check for leakage of oil/air in the tubes. If the leakage is not arrested by changing the gaskets '0' rings etc. reject the gun & replace with another one.

e) Check the relative distance between the spark plus centre wire and the gun tip as given in drgs.

f) Check the leakages of the flexible hoses. If it is leaking reject the same and replace with a new one.

g) Check the continuity of the ignitor wire, ensure that the insulation is not damaged. Damaged wire should not be used.

h) Ensure that the other end of the ignition wire is positively connected to the transformer in the control cabinet.

i) Ensure that the earthing is proper.

j) Ensure that the high pressure (HP) and low-pressure (LP) tappings are clean and there is no leakage.

3. CHECK ON OIL CHARACTERISTICS

3.1 The oil provided for the ignitor by the customer has to be analysed in the

laboratory. If laboratory facility is not available at site. send sufficient quantity of oil sample to Trichy-labortory. The characteristics must be as per the customer's commitment in the contract.

4. CHECK ON EQUIPMENT IN OIL/AIR LINES

4.1 Ensure that the pressure gauges provided are calibrated and are in working condition.

4.2 Check all the equipment in the line are as per the Engineering drawing.

4.3 Check the leakage of all the valves in the line and the strainers.

5. PRE-CHECK BEFORE LIGHT-UP

5.1 Connect the test box to me control cabinet close the oil/air stop valves before the control cabinet and check the following:

a) Check the Motor operated valve (MOV) operation and the limit switch engagements by operating the test box.

b) The spark plug is kept on platform so that the tri^ is not touching the platform the intensity of the spark is checked by operating the test box. If the spark is not strong check the spark plug inner connections and earthing.

c) Now open the oil and air stop valves before the control cabinet, replace the spark plug in its position. Now give command to the control cabinet by operating the test box. Don't keep the ignite command more than 10 sees.

d) If the ignitor is not starting with 6 set atomising air pressure, it could

be throttled down during start up, but it should be brought back to set pressure aft"r starting for better.

6. TESTING FURNACE PROBE

6.1 Furnace prob is installed to measure the gas temperature in the furnace one prior to reheater bank. The operation of furnace probe for advance and retract is tested from the control room. It is prohibited to advance the furnace probe to measure the gas temperature at load. This is to be used only at the time of start up till reheater steam slow is established. Furnace probe must be commissioned fully in all respects before light up of the boiler.

7. FIRST LIGHT UP OF THE BOILER

7.1 Here we will confine ourselves to a few general requirements which may not form a part of the check lists.

a) Remove all loose construction material around boiler and also cut off temporary supports, construction platforms etc. not envisaged in the drawings.

b) Mark all valves in the Boiler by tag no. and identification plates usually supplied from Trichy. In the absence of identification plate this information can be painted.

c) All lines to be identified by painting by colour code as well by lettering such as:
   - Fed line from Feed pump.
   - Line to Econorniser.
   - Hot air to Mill.
   - Attemperator line to S.H. No.

d) On all equipments it is predent to paint prominently the lubricants to be used.

e) Inspect water walls, superheaters, Reheaters economisers and air S.eater, ducts.

f) Seals particularly at hopper portion require attention.

g) Retractable soot blowers must be -in withdrawn position.

h) Instrument tapping point valves must be open (By Instrument Engineer).

i) Drum level signalling and instrumentation should be made operational.

7.2 After making the above preparations and completing the necessary checks the mock testing of Boiler interlocks should be carried out.

8. EXPANSION MOVEMENT OF BOILER

8.1 Calculated Values. It is needless to emphasis the importance of insuring the free movement of thermal expansion by pressure part components and the potential damage that may *be* caused to the pressure parts due to any restriction in the free movement.

For measuring these movements, a pointer is to be attached to the various components for which expansions are to be measured. Against these pointer a target plate is to be placed on the permanent steel such as platform girders or columns steel etc.

I. Alkali Boil - Out

1. CHEMICAL CLEANING OF BOILER

1.1 Chemical cleaning of boiler water & steam system will be carried out to remove loose foreign materials, oil, grease, rust, mill scale, silica in the form of silicates in order to obtain steam of high purity.

1.2 After chemical cleaning operation the bare metal surface is obtained. Since bare metal is more prone to oxidation/corrosion, the chemical cleaning is followed by passivation in which a thin uniform layer of protective magnetite is formed on the metal surface exposed to water/steam water mixture.

1.3 Chemical cleaning of Boiler is divided into following stages :

Stage I Water Washing Alkali
Stage II Alkali Boil out & Rinsing Boil - out
Stage III Acid cleaning of Boiler Acid
Stage IV 1st stage Passivation Cleaning
Stage V 2nd stage Passivation & Passivation

2. WATER WASHING

2.1 It is necessary to remove loose dirt and water soluble ingredients on the circuit by mere filling and dumping method as much as possible prior to alkali boil out. Temporary acid cleaning pumps, chemical mixing tank 5c temporary pipings will be used for the purpose of water washing. Circulating water pumps take suction from mixing tank <5c pump the water into boiler drum through economiser & superheaters. From the drum water drain back to mixing tank. Recirculation flow is established through

boiler steam &. water circuit. Circulation of water is continued till the conductivity of inlet &: outlet samples show equal values. Water is then dumped through w.w. drains. The dumping & refilling is to be repeated till the conductivity of washing water levels with that of fresh filtered water. For water washing filtered water may be used.

3. ALKALI BOIL OUT

Alkali boil out will be carried out by actually firing the boiler at 40 Kg/Cm (g) for 16 to 20 hrs with the following chemicals predosed in boiler water.

1. Trisodium phosphate 1000 PPM 0.1%
2. Do Deca Hydrate
3. Hydrazine Hydrate 200 PPM 0.02%

3.2 Boiler will be filled upto - 180mm level with D.M. water using acid cleaning pumps or B.F. Pump. A strong solution of about 20% concentration will be prepared in a tank located at Boiler drum elevation floor. This chemical suction will then be charged into drum through manhole by suitable means &: the drum manholes will be closed.

3.3 Boiler will be lighted up within AB elevation warm up oil guns & gradually pressure in the drum will be raised to 40 Kg/Cm (g). During pressurising period boiler expansions shall be regularly monitored as indicated by the expansion markers.

3.4 The 40 Kg/Cm drum pressure will be maintained for 16 to 20 hrs.,with hourly blow down lasting one minute each time to remove substantial quantities of impurities collected in water wall header. Blow downs will be given through w.w.ring header drain values. During blow down operation the feeding shall be maintained to keep drum level normal. Oil guns may preferably be cut out during blow down period.

3.5 Samples of each blow down & drum water shall be taken & analysed.

3.6 At the end of blow down operation boiler will be boxed up and hot drained when pressure has come down to 1.5 Kg/Cm2-

4. RINSING

4.1 Boiler will be filled to normal level with water by acid cleaning pumps or B.F.P. and then will be drained. Rinsing will continue till the Phosphate/NaOH concentration is reduced to nil and conductivity of Boiler inlet and outlet water becomes equal.

COMMISSIONING PROTOCOL FOR ALKALI BOIL OUT

PROJECT---------- CONTRACT NO ----------

UNIT NO ---------- RATING ---------- MW. CUSTOMER----

Alkali Boil Out Boiler was carried out from----------(date)
To----------(Date).

The following chemicals were changed:

TRISODIUM PHOSPHATE --------- Kgs (--------- ppm).

The boil out was carried out at 40-kg/cm2 pressures for a period of ----------

Hence and the process was declared completed----------

-------at ---------- Hrs----------(date).

The end point values are as follows:

Ph	po_4 ppm	Oil ppm

REMARKS:

Manufacturer Customer Engineer

J. Acid Cleaning & Passivation

1. PROCESS

1.1 Acid cleaning of Boiler Steam and Water circuit covering economiser, water walls, Boiler Drum and excluding superheaters, re-heaters and associated piping will be carried out to remove iron oxides, mill scales and silicates from the system (Refer fig.1-2)

1.2 Acid cleaning will be done by circulation method for effectiveness of the cleaning process. Acid cleaning will be followed by passivation, so that the uniform protective coating of magnetitie is formed on the metal surface and further corrosion/oxidation damage to metal surface is prevented.

1.3 Acid cleaning process will be carried out in following stages.

Stage I - Acid Washing
Stage II - D.M.Water Rinsing after acid washing
Stage III - Citric acid Rinsing
Stage IV - D.M. Water Rinsing
Stage V - Neutralising with Sodium Carbonate
Stage VI - Passivation 1st stage
Stage VII - Inspection
Stage VIII - Passivation 2nd stage.

2. ACID CLEANING

2.1 Chemicals to be used for acid washing are:

a. Hydrochloric Acid 4-6% concentration
b. Ammonium bifluoride 1% concentration
c. Rodme 213 special 0.1% inhibitor
d. Lime

e. Nitrogen gas.

2.2 Drum downcomer openings will be fitted with temporary orifice plates to restrict the flow through down comers. Superheater steam openings from the drum will be plugged by the temporary rubber plugs and superheater will be kept pressurised at 5 Kg/Cm pressure with Hydrazine dosed water using hand pump.

2.3 Drum internal will be removed from the drum. Nitrogen capping and vapour venting temporary arrangements will be made before acid cleaning process.

2.4 HCL of 30% concentration will be stored in rubber lined acid storage tank. Suitable arrangements will be provided for charging concentrated acid into the mixing tank. Mixing tank is provided with steam heating arrangement and D.M. water/filtered water make up arrangement.

2.5 D.M.Water will be filled in the boiler upto the drum top venting out air completely. For this purpose acid cleaning pumps will pump the water from mixing tank to the economiser through temporary piping. Through economiser water wall enter the drum and flow through down coiner and water wall tubes into bottom ring header. From bottom ring header water will flow through temporary drain lines (Welded to hand hole plates openings) and normal drain lines back to the mixing tank.

2.6 Chemicals other than HCl will be stored on the platform above; mixing tank for charging through mixing tank manholes. Express Laboratory will be set up near mixing tanks for quick analysis. Arrangements will be made for neutralising the acid dump in the neutralising pit using lime powder.

2.7 Having filled the boiler with water, circulation flow of 400t/hr will be established through the above circuit. Heating steam will be turned on to

get water temperature of 65°C. When 65°C temperature is achieved inhibitor will be charged into mixing tank. Then half the quantity of ammonium bifluoride will be charged. After added chemicals have been dissolved, hydrochloric acid dosing will start. The dosing of Hydrochloric acid ar^d other chemicals should be spread over a span of time but within one hour. Care should be taken to see that Hydrochloric acid concentration does not exceed 6% at pump suction.

2.8 Sampling points will be provided at Acid cleaning pump suction and discharge header, acid return from boiler drain header and superheater drain header.

2.9 During acid washing concentration of HCl in the system and temperature will be frequently checked. The temperature of system shall be kept below 70°C as the inhibitor becomes ineffective at higher temperatures.

2.10 Due to the chemical reaction during washing process, the concentration of HCl decreases rapidly at first and slowly afterwards, then it stabilises at a constant value. Similarly iron value increases and attains a steady value. The constant values of HCl concentration and iron content denote the completion of acid washing. After this stage is attained cleaning solution will be drained through neutralising pit. During the acid washing process hydrogen gas is produced. This gas will be continuously vented through the temporary drum vent header and through the vent values to the vent/drain collecting tank.

3. RINSING AFTER ACID CLEANING

3.1 Having drained the acid, the system will be filled up with water, heating steam will be turned on simultaneously. Circulation will be established through the system and temperature of water will be raised to 65°C. After attaining the uniform temperature through out the system. D.M. Water will

be dumped under nitrogen capping at 0 - 0.75 Kg/Cm pressure so that by no chance active bare metal surface is exposed to oxygen.

3.2 Second Rinsing will be done as above.

4. CITRIC ACID RINSING

4.1 Chemicals to be used are :
Citric Acid - 0.2% by weight Ammonia to get PH value of 3.5 to 4.

4.2 System will be filled with D.M. Water heated between 50-60°C and put on circulation. Citric acid and ammonia will be charged in the mixing tank and circulation will continued till uniform concentration of citric acid is obtained at all places. After this, citric acid will be dumped under nitrogen capping.

5. D.M. WATER RINSING

5.1 Citric Acid rinse will be followed by D.M. water rinse at 6^° as discussed in first D.M. rinsing. D.M. water will be dumped under nitrogen capping.

6. NEUTRALISATION

6.1 Chemical to be used.
Na_2CO- = 1% OR 10 KG/M^3 of Circuit Volume.

6.2 System will be filled with D.M.water, heating and circulation will be done. When temperature of system has reached 80°C NaCO- will be charged in the mixing tank and recirculation win be continued.

6.3 As the neutralising reaction will take place alkalinity will progressively decrease and finally when reaction is completed it will stabilise. When reaction is completed solution will be dumped under nitrogen capping.

7. PASSIVATION

It is a process in which a uniform layer of magnetitie will be formed on the bare metal surface obtained after acid cleaning* Formation of completely protective layer will begin with 1st stage passivation & develop further in 2nd stage Passivation & continue during normal operation of boiler in the safe regime of water quality.

7.2 1st Stage Passivation t The system will be filled with D.M.Water put on circulation and heated to 85°C. Hydrazine will be charged in mixing tank to give concentration of 300 ppm and ammonia will be added to get pH value of 9.6. Since the reaction of hydrazine at low temperature is a slow process the solution will be left to circulate for about 24. hours at a temperature of 85 - 90°C. In case the hydrazine concentration drops below 150 ppm at the end of ten hours concentration of hydrazine will be increased to 150 ppm by further dosing. After passivation is over solution will be hot dumped but under normal atmospheric air capping and boiler air and flue gas path will be set for natural draft cooling.

7.3 Inspection :- When boiler has cooled down substantially drum internal surface will be examined for cleaning and magnetite *tilm* formation. Hand hole plates will be cut and bottom ring header will be inspected internally and will be cleaned mechanically or flushed by water if deemed necessary. Once the inspection is over drum internal will be reinstalled. Temporary pipings will be cut, hand hole plates will be welded, drum safety valves will be reinstalled, super heater plugs will be removed, H->- vent pipe will be removed and boiler water and steam system will be normalised for steaming.

7.4 2nd Stage Passivation :- Chemicals to be used.
Hydrazine = 300 ppm Ammonia to get PH value of 9.6

200 tonnes of solution of Hydrazine and ammonia will be prepared in condensate storage tank and will be recirculatcd tor about 20 hrs using boiler fill pump for 200/210 MW units. Solution will be analysed for Hydrazine concentration and pH value before starting boiler filling. Boiler steam & water circuit will be lined up for normal steaming and solution prepared will be filled up to normal operating level using boiler fill pump. Boiler will be lighted up with AB elevation oil guns; pressure will be slowly raised to 40 Kg/Cm and maintained at this value for about 20 hrs. Regular sampling of boiler water will be done to fine out Hydrazine concentration and pH value. When Boiler water temperature drops to 90°C the water in the system will be drained. If 2nd stage passivation is followed immediately by steam blowing boiler water need not be drained

8 PUMPS, TANKS, AND MISCELANEOUS ITEMS

S.NO. DESCRIPTION (2000/210 MW UNITS) QTY. REQUIRED

8.1 ACID Transfer Pump.

(Centrifugal) with motor	2 Nos.
Specification – Capacity	20 T/ Hr.
Head	30 meter
Fluid	Hydrochloric Acid
Temperature Ambient	
Construction Hastilloy - C Material	

8.2 <u>Acid Storage Tank</u>

Fiberglass of F.P- Lined Of Rubber lined MS- tank	2 Nos.

Capacity 15 tons- Cylindrical

With 50mm discharge flanged end.

8.3 Acid Circulating Pump

Specification –	Capacity	150 H/br	5 Nos.
	Head	150- 180 Mwe	
	Type Single stage centrifugal		
	Temp.	95C	
	Medium to be Water Handled		
Material	Body- Cast Steel.		
	Impeller---------- do— Carbon steel.		
Type of Construction	Bank pull – out type with horizontal or Vertical split casing		

8.4 Dissolving Tank

Of rectangular shape construction of the mild steel Capacity 20 M^3

8.5 Pressure gauge range 0 to 20 kg/cm 4 Nos

8.6 Dial gauge thermometer (MOO°C 2 Nos

8.7 Super heater plugs as per transfer tubes in boiler

8.8 Orifice for down comers.

9. SPECIFICATIONS OF CHEMICALS

Chemical with	Specification	Quantity
a) Tri Sodium Phosphate	IS 573 – 1973	
b) Soda Ash	IS 252 – 1972	
c) Hydrochloric Acid	IS 265 – 1962	
d) Liquor Ammonia	IS 799 – 1955	
e) Bleaching Powder	IS 1065 – 1971	
f) Nitrogen Gas	IS 1747 – 1972	
g) Rodine 231 special		
h) Citric Acid	IS 5464 – 1970	
h) Hydrazine Hydrate 8		
k) Burnt Lime (Commercial) CaO More than 80%		
l) Ammonium bifloride (100%) Commercial grade		

COMMISSIONING PROTOCOL FOR EACH CLEANING

PROJECT---------- CONTRACT NO----------

UNIT NO ----------RATING ---------- MW. CUSTOMER----------

Acid picking was started with inhibited Hydro Choric acid to the acid (Hcl) on ----------Date)following by to the citric rinse,, D.M. rinse , Soda ash neutralization and culminating in the first stage passivatioin , It was Completed on ----------(date).

The following Chemicals of the quantities mentioned against each were used :

1) HCL----------tons
2) Inhibitor(Rodine 213)----------Lts.
3) Ammonium biflouride ---------- Kegs
4) Citric acid ---------- Kgs.
5) Ammonia ----------Lts.
6) Sodium carbonate ----------Kgs
7) Hydrazine hydrate----------Lts
8) Nitrogen----------Numbers of f Cylinders

The drum and test is capons were inspected, the following observations are made:

REMARKS:

Manufacturer CUSTOMER ENGINEER

K. Thermal Flow Test Of Economiser, Water Walls & Superheater

1. INTRODUCTION

1.1 After the alkali boil out has been completed the boiler will be shut down for making temporary connections and arrangements for acid cleaning. For this, drum internals are to be removed, orifice plates to be put in position in the down comers and superheater plugs to be placed 'in position from inside the drum in the superheater connecting tubes.

1.2 In the past, tube failures has been a major contribution cause for Boiler downtime. Our analysis reveals that a Major percentage of the Tube failure, at least during commissioning and initial operational stages of the Boiler is due to internal blockage of the tubes. A small tube failure in a Boiler under operation, if not detected in time can lead to Major Repairs to the unit.

2. INSTRUMENT

2.1 Thermal flow meter is an instrument used for detecting chokes in water wall circuitry superheater sections, Economiser coils and terminal tubes of a boiler.

3. PRINCIPLE OF OPERATION

3.1 The Thermal flow meter works on the following principle. The time taken for a heated tube to cooler depends upon the rate of flow of fluid passing through the tubes. The tubes are heated and the time taken for the temperature to drop from 10°C to 30° above the ambient at that place

indicates the rate of cooling.

3.2 This cooling period is compared between all the tubes wherever the detection is to be made. If there is a blockage inside any particular tube, then the cooling period for this tube will be much higher compared to the flow meter period of all other tubes in that section. The accuracy of the flow meter is good for a fluid velocity inside the tube of 0.15 m/sec. to 3.0 m/sec. There would be about 2 to 3 times greater error if the velocity of the fluid is less than 0.15 m/sec.

4. FOR WATER WALL AND ECONOMISER

4.1 The ideal period of testing of waterwall

4.2 7 Econo. would be after the acid cleaning metal debris inside the tubes could be cleaned by the acid in circulation. For conducting the test after second stage passivation, the temporary connections may not be available as the boiler has to be lighted up for second stage passivation. It is also not advisable to conduct the test after first stage passivation as circulating water for a continuous period .during the test can dislodge the thin film of magnetite coating created during first stage passivation.

5. FOR SUPERHEATERS

5.1 The ideal period for testing superheaters sections would be immediately after steam blowing. Establishing flow through superheater surfaces may require temporary pipe connections from superheater outlet of Deaerator tank. In units equipped with bypass system the HP/LP bypass stations or the existing pressure reduction station lines can be utilised.

5.2 Testing of Super Heater Sections ; As mentioned earlier, the ideal period of testing of superheater surfaces would be immediately after steam

blowing. During steam blowing there is a good possibility of blowing out debris and other foreign materials from inside the tubes, thereby avoiding unnecessary cutting and welding of superheater tubes due to choking.

COMMISSIONING PROTOCOL FOR THERMAL FLOW TEST

PROJECT_____CONTRACT NO._____
UNIT_____RATING_____MW, CUSTOMER_____

_____

Using acid to the cleaning system / circuit the flow test for the water walls and economizer was conducted from (date) _____ to _____
before /after acid cleaning, the flow test for the super heater section was from (date) _____ to _____

Stage –1 Water Wall and economizer

1) Number of Tubes found Chocked:
2) Economizer (Counting from front):
3) Left side water wall (counting from left side):
4) Right water wall (Counting from the front):
5) Rear water wall (counting from to the left):
6) Water wall (platen) (Counting from front):
7) Whether Chocking was removed or not:

Stage-II Super heaters, Steam cooled Walls, steam cooled spaces

1) Number of the tubes found choked:
2) Low temperature super heater (counting from left):
3) Platen super Heater (counting from left):
4) Final super Heater (Counting from left):
5) Steam cooled wall (counting from left)
   a. Left :
   b. Rear ;
   c. Right :
   d. Front :
6) Steam cooled spacers:

REMARKS:

_____

MANUFACTURER CUSTOMER ENGINEER

L. Commissioning Of Valves

1. INTRODUCTION

1.1 The correct and efficient operation of valves in a power plant leads to efficient operation and saving in make up DM water in the system. The valves are to be kept in good condition as the boiler is being operated. The following precautions are to be taken before installing control valves in water and steam line.

a) The control valves in water line should be installed after flushing the line thoroughly.

b) The control valves in steam line should be installed after blowing the up stream lines with steam.

2. CHECK LIST OF VALVES

2.1 During hydraulic test check tightness of flange joints if provided.

2.2 Check for gland and bonnet leakage.

2.3 Check for passing valves and attend.

2.4 Check the opening and closing of all the valves manually. If it is hard to operate, service the valve.

3. MOTORIZED VALVES

3.1 Check for correct lubricant filled in the gear box to the required level.

3.2 Electrical circuit to be checked before engineering.

3.3 Insulation resistance valve should be measured for motors and recorded.

3.4 Set the position and torque switches by manually operating the valve.

3.5 The valve should be brought to middle position and impulse should be given to check the direction of valve opening/closing.

3.6 After checking the correct direction, the valve should be opened and closed for the full stroke.

3.7 Operate the valve from remote and check for correct indication at the desks.

3.8 The valve can be connected on interlock and checked correct operation.

4. PNEUMAHC OPERATED VALVES

4.1 Check tie proper erection of pneumatic tubing particularly with a view to maintenance of valve.

4.2 Check the pneumatic tubing layout as per the drawing.

4.3 Purge all airlines before connecting them.

4.4 Set the correct air pressure in the pressure regulator as recommended in the O&M instructions.

4.5 Check fill opening & closing of the valve by local operation.

4.6 Switch over to auto operation and check for the correct operation of the valve.

4.7 If airlock device is provided, initiate simulation of air failure and check the valve for stay put condition.

4.8 Check the full operation of the valve from remote manual.

5. CONTROL VALVES

5.1 Before erecting the control valves.

a) The upstream line to the control valve to be cleaned by blowing steam, compressed air or by flushing with water depending on the duty of the control.

b) All the impulse lines connected with the control valve should be blown by air/steam, before connecting.

5.2 Check the control valve plug for correctness with respect to 0&-M manual.

5.3 Check for actuation of the valve.

5.4 Do not try to tightly shut the valve, as it is not meant for that duty.

6. SAFETY VALVES

6.1 Check erection of safety valves wit'-i respect to drawing. The set pressure is marked on the outlet flange of the safety valve and it should match with the location in the drawing.

6.2 Check all the flange bolts arc tight.

6.3 Check the seal of upper and lower rings are intact.

6.4 Check the hand-popping lever is properly fixed and does not interfere the closing of valve after hand popping.

M. Steam Blowing

1. INTRODUCTION

1.1 Steam blowing of Main Steam lines, cold reheat lines, Hot Reheat lines, Superheaters, Reheaters and transfer pipe lines of turbine will be carried out in order to remove welding slag loose, foreign material, iron pieces, rust etc. from the system. These undesirable materials, if not removed completely from the system during steam blowing, will be loosen and carried over to the turbine with the steam, in course of operation and will cause severe damage to the turbine. Also the valves in the steam system will get damaged resulting into improper functioning or failure of valves.

2. BASIC TECHNIQUE USED

2.1 The technique employed in puffing method of steam blowing is to give a thermal shock to the contour being purged, to dislodge the scales etc., which will be subsequently cleared by the expanding steam. The procedure _is to raise the boiler pressure to a pre-determined value, shut off firing and at the same time open the electrically operated temporary valve, thus allowing the steam to escape to atmosphere with high velocity carrying with it the loose debris* To prevent undue stresses, on account of the sudden temperature variation, the pressure drop allowed in drum i& limited to corresponding saturation temperature change of .40°C (75°F) maximum. The electrically operated temporary valve is closed immediately. The abrasions on the target plates fixed in the exhaust piping indicate the effectiveness of blowing The steam blowing process is then repeated. The standard practice is to limit the no of' blows per day to 6 to 8, at an interval of 11/2 hrs. with overnight cooling (Refer fig.No.I-3).

3. SCHEME

3.1 Steam Blowing is done in different stages depending en one type of turbine & its Steam Oil circuit. In case of 210 Mw &-MW turbine the Steam blowing is accomplished in six stages (refer to fig. No. 1-4). Since there are no isolating valves in the HP & LP bypass upstream lines, it becomes necessary to blank these lines at some stage of blowing and to be removed afterwards. In order to minimise the extra work of putting and removing of blanks, the sequence of blowing has been selected as under:

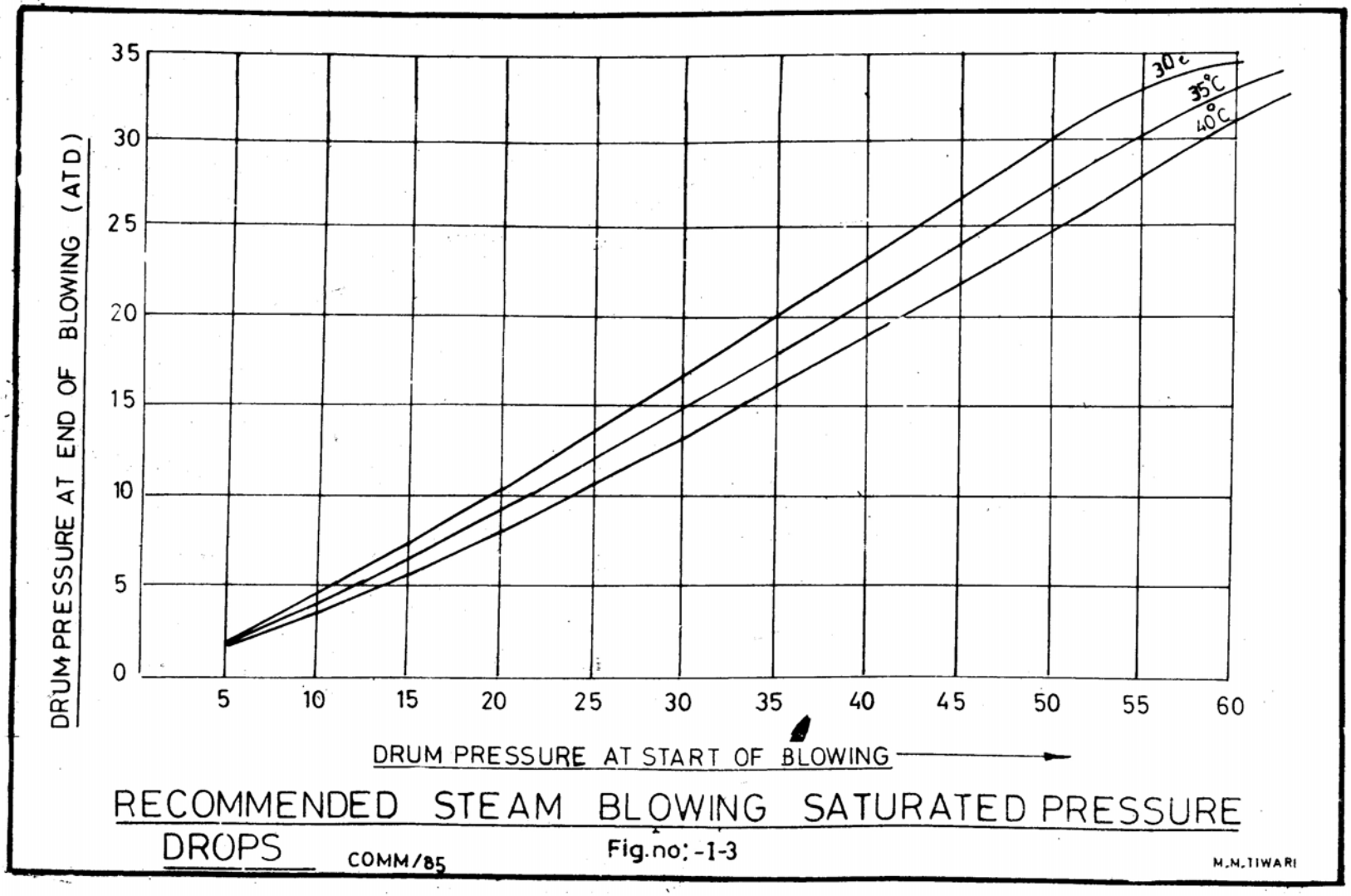
Stage I (a)

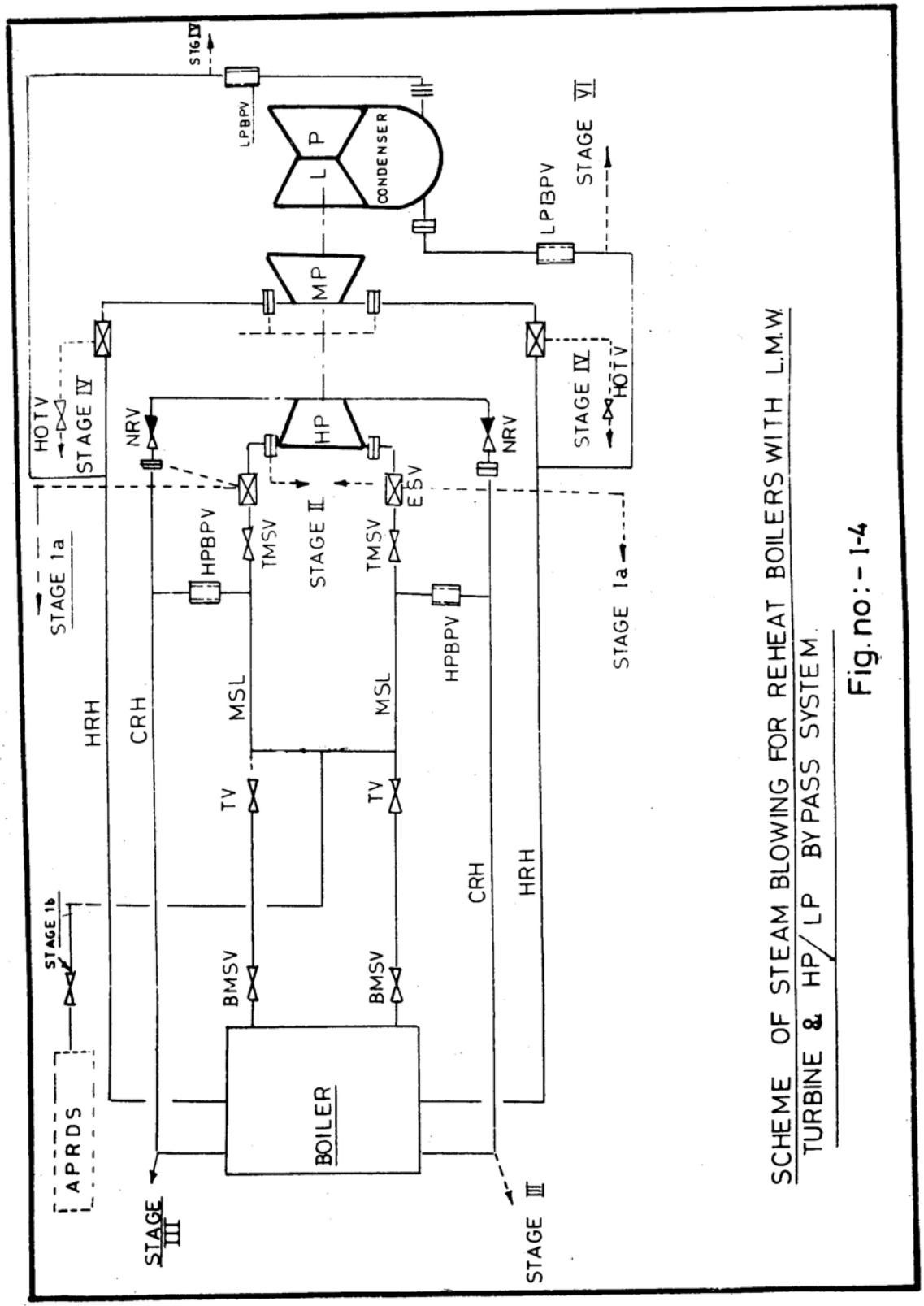
The Super heaters, Main steam lines and Auxiliary PROS are covered in this stage. The Super heaters and main steam lines upto the Turbine emergency stop valve are included in this stage of blowing. Temperature lines connected to ESV are suitably reputed to atmosphere. The main steam stop, valves at boiler and turbine ends are kept fully opened and the isolating valves of the Auxiliary PRDS Steam' line are kept fully closed.

Prior to start of this stage of blowing, suitable blanks are provided in upstream line of HP bypass valve.

Stage I (b)

The stop valves of the main steam line at the turbine end are kept fully closed. The Auxiliary PRDS steam line upto the pressure control valve is cleaned in this stage of blowing.


DRUM PRESSURE AT END OF BLOWING (ATD)
0
5
10
15
20
25
30
35
5
10
15
20
25
30
35
40
45
50
55
60
30c
35°C
40°C
DRUM PRESSURE AT START OF BLOWING
RECOMMENDED STEAM BLOWING SATURATED PRESSURE DROPS
COMM/85
Fig.no:-1-3
M.M.TIWARI


STG IV
LPBPV
L P
CONDENSER
LPBPV
STAGE VI
MP
HOTV
STAGE IV
NRV
HP
NRV
STAGE IV
HOTV
ESV
STAGE Ia
HPBPV
TMSV
STAGE II
TMSV
STAGE Ia
HPBPV
HRH
CRH
MSL
MSL
TV
TV
CRH
HRH
STAGE 1b
BMSV
BMSV
APRDS
BOILER
STAGE III
STAGE III
SCHEME OF STEAM BLOWING FOR REHEAT BOILERS WITH L.M.W.
TURBINE & HP/LP BYPASS SYSTEM.
Fig. no:- 1-4

Stage II

The main steam transfer piping from ESV to HPT control valves are steam blown in this stage. Temporary piping are suitably routed to atmosphere from the HPT control valves. At ESV the connections are suitably made for this purpose.

The upstream of HP bypass line remains blanked.

The HP transfer pipelines remain blanked at the ESV end during the further stages of steam blowing.

Stage III

The cold reheat lines and the HP bypass lines are covered in this stage.

Stage III (a) :

Temporary connection are made from E.LSV to the flange in CRH line, provided at the down stream of NRv. The exhaust piping is led to atmosphere suitably at the boiler end of cold reheat line.

The upstream as well as the downstream of HP Bypass line remains blanked. Also the isolating valves in the extraction lines from cold reheat lines are kept closed.

Stage III (b)

The blanks of upstream and downstream lines of H!' 1'iypdss are removed and a specially fabricated spool piece is introduced in place of HP Bypass valve. The stop valves in main steam line at the turbine and are kept closed during this stage of blowing.

The steam enters the CRH lines through HP Bypass lines thus ensuring the cleaning.

After this stage of blowing, the stop valves in main steam lines at the turbine end are kept opened, thus allowing steam to flow to CRH lines parallely through these lines and HP bypass lines.

Stage IV

The hot reheat lines are covered in this stage of blowing.

The cold reheat line is connected to the reheater and at turbine end temporary lines are suitably routed to atmosphere from the Interceptor valves. Two hand-operated valves are introduced in the exhaust piping from IV to facilitate reheater safety valve floating at the enc stage IV blowing.

At IV suitable blanks are introduced to prevent steam entering the transfer pipelines. Also the LP bypass upstream is kept blanked.

During Stage IV blowing the hand operating temporary valves are kept fully open.

4. REHEAT SAFETY VALVE SETTING

4.1 At the end of Stage IV blowing, the boiler firing is continued and pressure is raised by regulating the hand operated temporary valves in the exhaust piping. The reheater Safety valves are then floated one by one.

Stage V

The reheat transfer piping from Interceptor valves to IPT control valves are steam blown in this stage.

Temporary piping are suitably rounded to atmosphere from IPT control valves. The blanks provided during Stage IV at IV are removed. The LP bypass upstream remains blanked during this stage.

Stage VI

The LP bypass upstream lines are covered in this stage.

The blanking in the line is removed and temporary piping is routed to atmosphere suitably. During this stage of blowing, the hand operated temporary valve in the exhaust piping from IPT control valves are kept closed so that the full quantity of steam is flowing through the LP bypass upstream lines.

5. PRECAUTIONS

5.1 In the puffing method of steam blowing, the water level in the drum swings beyond visible limits at the start of blowing, during blowing and at the end of blowing. During steam blowing there are chances of water carry over to saturated steam lines and low temperature superheaters. This can possible be minimised by keeping the water level in drum at the lowest visible limit at the start of blow. It is recommended that the water feedings to drum may be started when the drum level starts falling towards end of the blow and drum level is to be brought to normal level for subsequent light up of boiler.

5.2 The time for opening as well as closing of the electrically operated

temporary valve should be as short as possible to match the pressure drop in drum. Arrangements should exist in control room for simultaneous opening/closing of the temporary valves.

5.3 The temporary discharge piping should be well supported to withstand the reaction forces during blowing.

5.4 The boiler pressure during blowing out operation should be kept within the design pressure of reheater and related piping, temporary piping, fittings and flanges.

5.5 The boiler pressure during blowing out operation should be kept within the design pressure of reheater and related piping, temporary piping, fittings and flanges.

5.6 The gas temperature at furnace outlet will be restricted to be within 535°C (1000°F) to safeguard reheater tubes.

5.7 Water level in drum will be subjected to a very high degree of fluctuation. Special care is to be given to this aspect.

5.8 Sufficient storage of demineralised water should be ensured and the rate of make up water to feed tank is to be matched taking into account the capacity of feed tank.

5.9 Internal boiler water treatment to be carried out with NH^ and N-H. only to maintain a pH of 10 in boiler water and in feed water 5 to 25 ppm of N-t-L to be maintained.

5.10 Communication between operating levels and control room, necessary instruments and controls and boiler protections should be ensured before steam blowing.

5.11 Hot tightening of flanges studs/bolts is to be done wherever such connections have been made at 5kg. /cm.

5.12 All the drains of connecting piping are to be left open to atmosphere and not to be connected to drain vessels, to ensure proper draining.

5.13 After completion of steam blowing, permanent drain piping can be routed and tig welding adopted to avoid welding slag and subsequent problem in draining the system during operation.

N. Safety Valve Setting

1. INTRODUCTION

1.1 A safety valve is used principally to save the boiler pressure parts from being unduly stressed in excrement cases of mal-operation. It is installed as near to the Boiler or superheater or Reheater outlet headers as possible to be put into effective use.

1.2 Test

1) Constructional
2) Pre-commissioning
3) Commissioning

2. CONSTRUCTIONAL TEST

2.1 The extent of the test necessary and the documentation with check list to be provided, are to be decided and produced by the commissioning group.

3. PRE-COMMISSIONING TESTS

3.1 These tests will be carried out when construction is substantially complete and will entail the following:

1. Inspection of the valve.
2. Ensure correct welding of valves to pipe line.
3. Piping works complete after steam blow.
4. Proper support for safety V/V exhausts.
5. Tightness of bolts on valves.
6. Drain from safety valve body and exhaust Tray properly laid.

7. Insulation provided wherever necessary.
8. Silencer being fixed.

4. COMMISSIONING

4.1 The commissioning of the safety valves are TO ne done on The separate activities viz.

i) Re Heater safety v/vs floating.
ii) Boiler drum and superheater safety valve floating.

4.2 Reheater Safety Valve Floating :-, The floating of Reheater safety valve will be done after the 4^{th} stage of steam blowing i.e. When cold Reheater and Hot Reheat steam pine line are steam blown. The drum pressure after the 3rd stage steam blowing should be maintained at 20 Kg/Cm^2 to facilitate salon valve floating. The floating is to be done from the -highest pressure safety valve and then proceed to the tower ones.

a) All safety valves should be gaged except the one to be floated.

b) Pressure in the line is to be raised steadily and as pressure reaches about 80.85% of the set value the valve should be popped by hand (operating the lever) 4-5 time so that the valve freeness may be ascertained.

c) Raise steam pressure in line slowly and note the lifting pressure of the valve and also note the setting pressure.

d) If lifting pressure is not as per rated value the valve should be gaged after pressure has dropped considerably and then ring adjustments made to acquire the wanted value.

e) Once adjustments have been made remove the gag and slowly start raising pressure and observe the floating and setting of the valve.

f) Continue this process till rated set pressure is achieved.

g) Once valve has been floated it is to be left as it is.

4.3 Safety Valve Floating Of Boiler Drum & Super Heater: - The safety valve floating of the boiler drum and super heaters will be done after the 5th stage of steam blowing. Boiler shall be lighted., up and pressure raised slowly at the rate of 0.6 - 0.8 Kg/Cm /minute. ~At pressure raising above 30 Kg/Cm after every 10 Kg/Cm ' pressure rise the boiler pressure is to be held at this value for 30 minutes to ensure proper expansions of boiler at various points. The valves are to be floated in the descending order i.e. The drum safety valves from the highest pressure are to be floated first followed by superheater safety valves which are set at a lower pressure. The safety valves are then to be floated as explained for Reheater safety valves.

4.4 Electromatic Safety Valve: - This valve is fitted on the superheater header and has the lowest set pressure. It also has the additional advantage of being able to be operated when impulse is given from the U.C.B. Its pre-commissioning test includes the checking of the electrical wiring necessary to and from the UCB Control Board. During commissioning the knob on the U.C.B. must be set to remote during lifting of valve in progress and then set on Auto for self" lifting at the set pressure. It should also be tested from U.C.B. When knob is placed on manual for its operation. For safety valve floating .the procedure as described for Reheater safety valve floating, is to be followed.

PROTOCOL ON SAFTY VALVE SETTING

PROJECT: -

UNIT:-

STEAM PARMENENTS AT MCR:-
FLOW:-
TEMPERATURE :-
DRUM PRESSURE:-
SUPER HEATER PRESSURE: -
RE HEATER PRESSURE:-

SAFTY VALVE SETTINGS

NO	DATE	Location	Lift		RESET		BELOW DOWN
			Designation	Actual	Design	Actual	%
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

CONSULATANT CUSTOMER

O. Commissioning Of Soot Blowers

1. MECHANICAL CHECKS TO BE DONE

1.1 Inspect for breakages and other damages that could happened during transit and erection.

1.2 Erection of blower according to the marking on the blower and completion of erection including pipelines as per drawings.

1.3 Mechanical clearances with regard to blower drop, adjacent tubes, projection inside the furnace when in retracted condition, movement during expansion of boiler, should not be restricted - Check as per drawing.

1.4 Lubrication of moving/rotating parts.

1.5 Check for- proper hanger supports for steam piping as per drawing.

2. READINGS FOR OPERATION WITH STEAM (MECHANICAL)

2.1 After completion of Hyd. test, the blanks provided in each blower should not be removed.

2.2 Open the drain valve .and charge steam slowly. Any leaks in the blank to be attended.

2.3 Keep the Electrical isolating valve and control valve in full open position for blowing of lines.

3. CHECK UP OF ELECTRICAL SYSTEM

a. Check for breakage/damage/rusting of motor and limit switches, if any breakage is found the component to be replaced.

b. Check for healthiness of limit switches and wiring done between the terminal box and the switches.

c. Check the I.R. valve of the motors if .it is found to be low then rectify.

d. Check for breakage/rusting of components, and replace if any.

e) Check for shortages (for bulbs/switches etc.) in mounted component and make good the shortage.

4. COMMISSIONING OF BLOWERS WITHOUT STEAM

4.1 Switch on the power supply to the panel after by passing the interlocks (like the inlet valve open, drum valve closed pressure of steam).

4.2 Rectify if any defect is noticed on switching the supply.

4.3 Select the local mode of operation of the blower.

4.4 Operate the blower individually and check the proper functioning of relays, limit switches and indications.

4.5 Rectify, defects, if any, noticed during (4)

4.6 Select the remote manual operation of the blower at the control panel.

4.7 Operate the blower one by one from panel and check for the operation of the relays, proper forward and retract travels of the blower. During this check, locally one should ensure that the blower is OK and rectify the defects noticed.

4.8 Auto Sequence Operation

a) Local remote selector switch on Remote.

b) Sequence cu* off switch in 'ON'.

c) Soot blowers in 'Auto' position.

d) Start the sequence operation.

e) Check for the automatic operation of the blowers, check relays, indicating lamps etc.

f) Check for the completion of sequence.

g) If any blower is bypassed in between then check that the next blower operates, when in Auto sequence.

h) Check for the audible and visual alarm when the sequence is complete.

Part – II Turbine & Auxiliaries

A. Acid Cleaning Of Oil Pipelines

1. INTRODUCTION

The Turbine oil used in the 200/210/500 Mw Turbo-sets is used for lubrication of the bearings, for Hydrogen seal system, as well as for governing system of the turbine. Therefore, the cleanliness of the oil is of utmost importance. To achieve this, it is necessary that all the oil pipe lines must be thoroughly cleaned form inside so as to free them form rust particles, mill scale, grease, protuding welds, etc. as otherwise the oil may get contaminated while flowing through the system. Following steps are observed in the cleaning of the oil pipe lines.

a) Mechanical cleaning and flange preparation.
b) Acid cleaning.
c) Passivation & Drying.
d) Final erection in position.

1.1 Mechanical-Cleaning and Flange Preparation : After the oii pipes are assembled and erected in position, it must be ensured that final complete welding of all the joints is done. All tapping points for gauges etc. must be provided to cut or weld these pipes, at any point, after they are cleaned with acid. Mechanical cleaning of all the oil pipes is to be done in following manner.

a) Chipping and grinding of all the protruding welds sticking inside the pipe lines to be done by using files, chipper or flexible shaft grinder. Points which are inaccessible otherwise have to be cleaned with the

help of flexible grinder.

b) Round wire brushes tied with steel chain/wire are pulled through the pipes. The process is repeated 8-10 times to remove all the rust, welding splatters mill scale etc.

c) Pipes of smaller diameter are to be cleaned with steel chains as wire brushes cannot be passed through.

d) All the joining flanges of the pipe lines are to be scrapped and colour matched with the surface plate.

e) After all the pipes are mechanically cleaned they are blown by compressed air to remove the rust and dust and ensure that there is no blockage in the pipe line. Thorough inspection of the pipe lines from inside with the help of mirror and light is done, so as to check the proper cleaning of the pipes.

f) Pipes are now ready for acid cleaning.

1.2 Acid Cleaning : Apart from the mechanical cleaning, the acid cleaning of oil pipes is a must, and should not be left over on the pretext that the mechanical cleaning has been perfect. During the treatment of the pipes with orthophosphoric acid, the sulphur which accelerates the corrosion of metal is removed from the surface of the pipes alongwith the mill scales.

1.2.1 Requirement of Materials for Acid Cleaning for 200/210 MW Units.

a) Mixing tank of acid capacity - 10,000 litres
b) Hot air blower.
c) Temporary pipes, reducers, flanges, dummies etc.

d) thophosphoric Acid - 10,000 Kg.

e) Thermometer - 1 No

f) Acid pump capacity and pressure - 100 cu M/hr at 5 Kg/Cm

g) Rubber gasket of various sizes - 10 M

h) Flexible hose pipe PVC
100 mm dia - 16 M

i) Auxiliary Steam at 8 to 10 Kg/Cm and 300°C.

1.2.2 Six to eight number of pipes, depending on their sizes are assembled in loops at the place where the acid cleaning is to be undertaken. In erecting the loops, normally pipes of the same dia. should be used.

1.2.3 The delivery end of the acid pump be connected with one end of the loop by flexible pipe. The other end of the loop is connected to the return pipe of the tank.

1.2.4 Fill the acid tank with 15% solution of orthophosphoric acid and the temp. of the solution must be raised to 30 to 40°C. In the other tank make 2% solution of orthophosphoric acid for passivation of the pipe lines.

1.2.5 The loop is flushed with 15% solution of acid for 2-3 hours and then one of the joint is opened for inspection. For strongly corroded pipes it is recommended to the first flush the loop for 3 to 4 hours and then stop the pump and the loop is kept filled with acid solution at 0.5 to 1.0 Kg/sq.cm. pressure for 6-7 hours and then again the pump is started and circulate the acid for 2-3 hours. Thus by this process even the strongly corroded oipes are cleaned.

1.2.6 At the return line of acid to tank, all suspended rust particles should be collected by providing some stainless steel mesh or by some other arrangement.

1.2.7 The cleaning of the front pedestal inner oil pipe lines of the governing system is not done by acid. They are only mechanically cleaned.

2. PASSIVATION & DRYING

2.1 After the loop is flushed and cleaned with *15%* Acid solution, the passivation of .the surfaces so cleaned is done by circulation 2% solution of orthophosphoric acid in the loop. The circulation is done for i to 1&1/2 hours.

2.2 After passivation cycle is over the acid solution from the loop drained and the loop is dismantled for drying and inspection.

2.3 Dry hot compressed air is blown through each pipe separately. The temp. of the hot air should be 50 to 60°C and should be blown at a pressure of 3 to 4 kg/sq. cm. The duration of blowing should be 30 to 40 minutes. The drying of each pipe has to be done individually and not in loop. The air is blown from one end, and is exhausted from the other end.

2.4 Clean dried pipes are subjected to through inspection. The clean dried surface has a dark steel grey colour, which shows that the acid cleaning is of required standard.

2.5 After the inspection, the ends of the pipes should be covered with clean new cloth or with wooden blanks, and must be tied properly to as to ensure that no foreign matter goes inside the cleaned pipe.

2.6 In case the cleaned oil pipe lines are required to be stored for some time, and 1-2 months, after cleaning and passivation the oil flushing is undertaken, it is recommended to cover the cleaned surface of the pipes with a layer of turbine oil & properly cover the ends with cloth or blanks.

2.7 The pipe lines are to be stored in clean dry place on sleepers and not on the floor. All the precautions should be liken that no dust, moisture or foreign matter enters these pipes during storage.

3. FINAL ERECTION IN POSITION

3.1 The packing of the correct size, thickness and material should be used. The details given in the drawing in this regard should be followed. While making the gasket it must be ensured that the inner bore of the gasket must always be more than the bore of the pipe.

3.2 It is prohibited to cut or weld these pipes after acid cleaning. Cleaning by jute is not allowed and during final inspection IT must be checked that no traces of fibres are sticking on any place of the cleaned surface.

3.3 The cleaned pipe lines should be erected in position, taking all the precautions that nothing falls inside them cr they become dirty during assembly. The ends should be uncovered only just prior to tightening of the joints.

3.4 All the tappings for the instruments must be temperarily plugged till the connections to the instruments are done.

4. SAFETY

4.1 Orthophosphoric acid is not poisonous but may cause skin burning and hence all the safety 'precautions must be taken during acid cleaning.

a) Smoking is strictly prohibited in the area where acid cleaning is being done. No fire should be lit around the area.

b) The operators must use rubber gloves and eye protecting glasses while handling the acid.

c) Even for the inspection of inside of dry cleaned pipes for illumination, candle or match should not be lighted. Electric lamp and mirror may be used for the purpose.

d) Due precaution must be taken while tightening the joints of the loop, so that they do not leak on starting of ac id pump, thereby leading to acid being sprayed through these joints.

B. Lubrication And Governing System

(OIL FLUSHING & HYDRAULIC TESTING)

1. INTRODUCTION

1.1 Oil flushing is meant for guaranteed cleanliness of Oil Pipe lines, bearing housings, elements of governing systems etc.

1.2 All the pipelines must be acid cleaned prior to their final erection in position.

1.3 Before starting the flushing ensures that all the oil pipes, pumps, centrifuging machine, oil tank with injectors and filters etc. have been assembled and Installed at their proper places.

1.4 Flushing should be carried out with Turbine Oil IOC-14, which is the working fluid for the governing and lubrication system. During flushing the temperature of oil should he maintained at 50 to 55°C.

2. PREPARATION FOR OIL FI-LING IN MAIN OIL TANK:

2.1 Before oil filling the following points are to be checked.

2.1.1 All the flanges in the system should be checked for proper tightness with correct gaskets and orifices if any.

2.1.2 All the permanent supports should be checked for proper erection and tightening. Check that all temporary support are removed. Check the slope of the pipelines.

2.1.3 Oil tank should be thoroughly cleaned and inspected before oil filling. Check the paint applied to MOT for proper application.

2.1.4 Emergency drain from the oil tank should be properly erected as per requirement, wherever provided.

2.1.5 All the work on the impulse lines of instruments should be completed and the instruments erected or local and remote indications is with compensation for location.

2.1.6 Check the oil level indicator of MOT for correctness.

2.1.7 Check whether injector unit overhaul is completed.

2.1.8 Check that the centrifuge connections are completed it is ready for oil filling.

2.1.9 The oil to be filled, should be tested in the laboratory before filling.

2.1.10 Suction and discharge valves of all the oil pumps should be kept closed.

2.1.11 All the valves in the oil coolers should be kept closed prior to the oil filling. Afterwards the oil coolers may be charged.

2.1.12 Valves of seal oil injector suction lines should be kept closed.

2.1.13 A gang of workers should be ready with all the necessary tools to attend the oil leakages, if any. In the event of any leakage, stop the further oil filling at once.

2.1.14 Ensure proper lighting in the area.

2.1.15 Arrangement of compressed air should be made for cleaning the oil tank strainers.

2.1.16 Adequate quantity of Turbine Oil should be kept ready.

2.1.17 Inspect the oil tank strainers for any damage to the mesh.

3. CHARGING OF OIL SYSTEM (Refer Fig. No. II-3) Oil Flushing Circuit of a typical 200/210 MW Turbine Lub. Oil System.

3.1 Filling up of oil tank must be done through the oil centrifuge.

3.2 While filling up check whether any of the following flanges fitted externally are leaking.

3.2.1 Suction line of starting, stand-by and emergency oil pumps.

3.2.2 Drain to centrifuge, dummy, emergency drain sludge drain and differential monometer connections of oil tank.

3.2.3 Suction line flanges of seal oil pumps.

3.3 While filling up, if no external leaks are observed, fill the oil tank upto 520 mm. from the top of the oil tank, which corresponds to zero of the indicator.

3.4 Further fill up the oil tank and check whether the indicator reading corresponds to that of actual measurement.

3.5 Fill the tank upto 140 m-n from the top of the oil tank which corresponds to 38 cm of the level indicator reading and check that the oil level is below the strainers.

3.6 Adjust the low level, high-level indicator so as to give alarm at 30cm and 10 cm for high and low respectively.

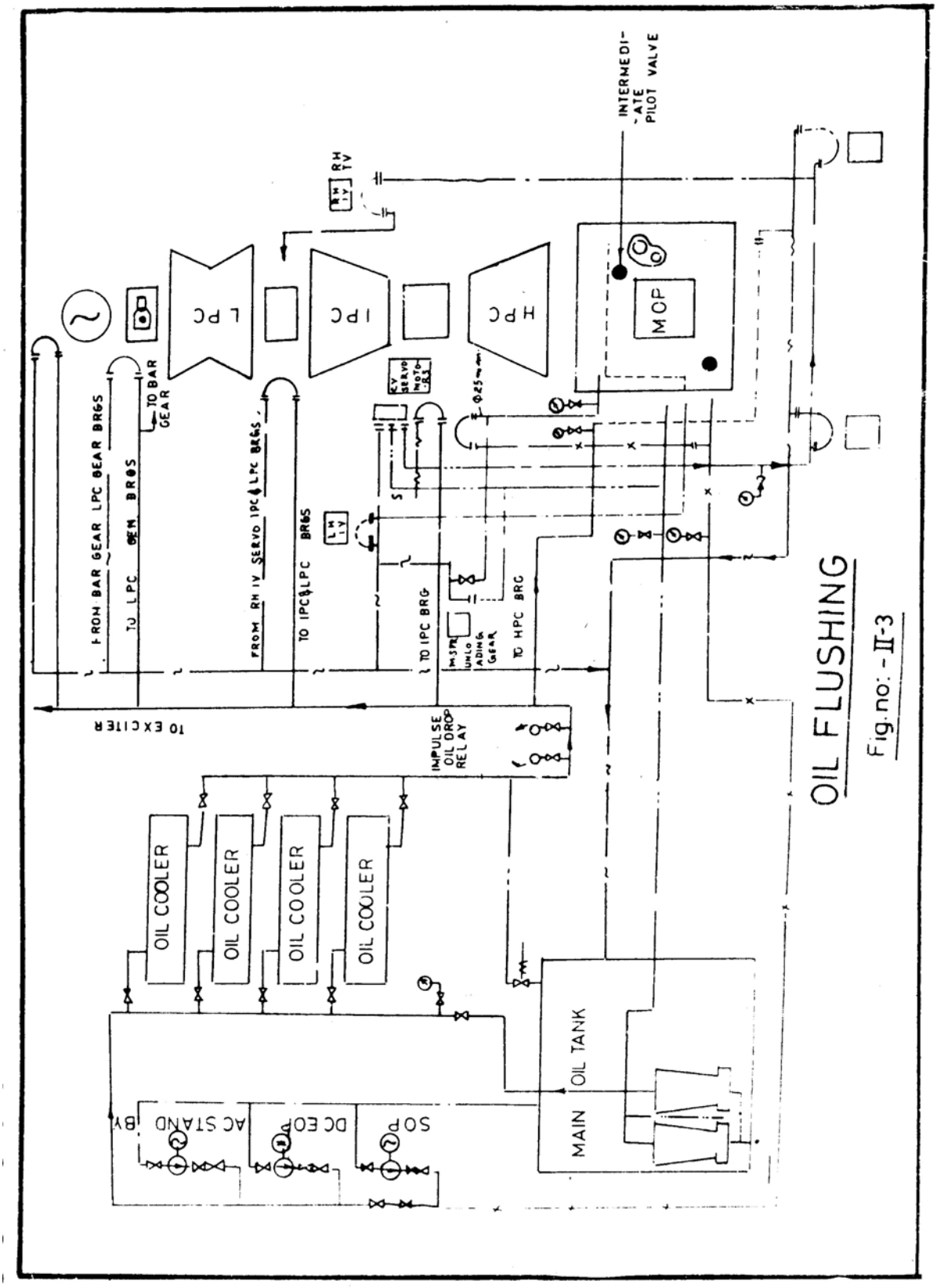
3.7 Open the suction valve of stand by oil pump for charging the pump and check for any leakages.

3.8 Open the delivery of the standby pump and check for any leakages.

3.9 Charge one by one the coolers as follows:

3.9.1 Keep open tie oil cooler thermo-well pocket at the outlet before outlet valve.

3.9.2 Open, a little, the inlet valve of the oil cooler.


OIL FLUSHING
Fig. no: - II-3
INTERMEDI-ATE PILOT VALVE
RH TV
LM LV
KV SERVO MOTORS
Φ25 mm
MOP
HPC
IPC
LPC
TO BAR GEAR
FROM RH LV SERVO IPC & LPC BRGS
TO IPC & LPC BRGS
TO IPC BRG
TO HPC BRG
IMPULSE OIL DROP RELAY
TO EXCITER
OIL COOLER
OIL COOLER
OIL COOLER
OIL COOLER
MAIN OIL TANK
SOP
DC EOP
AC STAND BY

3.9.3 Check whether air is being pushed our through the thermo-well pocket. In case of air lock the AC standby oil pump may be pumped for removal of air lock.

3.9.4 Keep open the inlet valve fully.

3.9.5 Open the outlet valve gradually to the full open position.

3.10 Check each oil cooler drain by opening a little and observing whether oil comes out.

3.11 Charge the other coolers as mentioned above.

3.12 During filling up of oil cooler check whether high-level annunciation disappears if the level falls below 30 cms, and low-level annunciation appears if the level falls below 10 cms.

3.13 Check whether annunciation appears at control room when the difference in level before and after the filter is 700 mm.

4. OIL FLUSHING

4.1 After filling oil upto the correct level in the main oil tank start the oil flushing of a 200/210 MW & MW turbine is done as the following stages :

4.1.1 First Stage Oil Flushing:

a) All the bearing, of TG are by passed in the first stage of oil flushing. For this, loop the inlet and outlet lines of the lubricating oil lines suitably at each bearings. Only these lines will-be included in the first stage of oil flushing and all other lines should be blanked.

b) Also blank 20kg/c'n~ line at front pedestal MOP suction, CVS.M and also suction line to MOP at CVSM, to by pass governing system in the 1st and Und stage flushing. Lub oil line to Barring

Gear is to be disconnected near barring gear and connected to the L.P. rear-bearing pedestal.

c) Check whether the pressure gauges are fixed for all the oil pumps.

d) Check that the drain valve of the lube oil header is in closed position.

e) Check whether the oil pumps are coupled with their respective motors after the completion of the motor trial runs.

f) Oil temperature measurement thermo-meters must be fixed at the inlet and outlet of each oil cooler and the return line of each bearing.

g) Open the suction valve of AC standby oil pump and close the discharge valve.

h) Check that cooling water for the bearing of the pump is available and is sufficient.

i) Check that the level of oil in the thrust bearing of AC standby oil pump is normal.

j) Rotate the pump at the coupling for checking its freeness.

k) Start the vapour exhaust fan.

l) After ensuring provision and working of emergency tripping system of AC standby oil pump, and giving signal to persons standing at different places for watching leakages, the pump should be started.

m) Note down the starting, No-load, Normal-current and shut off-pressure.

n) Open the delivery valve a little for charging the system and check for

any leakages.

o) After everything is normal open the discharge valve to the extent such that tie discharge pressure is not below the rated value and also the motor does not got overloaded.

p) Watch the oil tank level and in any case it should not drop below 15 cms. If necessary fill the tank and maintain a value of 20 cams. at the indicator.

q) Ensure that centrifuging machine is in service.

r) Check oil level is normal in the starting oil pump bearings.

s) Open the suction valve of starting oil pump for charging the pump by opening the air release and close it after completely charging the pump.

t) Start the starting oil pump and note down starting current, no load current and closed delivery pressure.

u) Open the delivery valve a little for charging the system and check for any leaks-

v) If everything is normal, open the delivery valve to the extent such that the delivery pressure is maintained to the rated value and the amperage well within the rated value.

w) Stop the standby oil pump. Watch the oil tank level if necessary fill the tank upto 15 cms.

x) Watch the differential level meter. If the differential shows about 200 mm or the level drops to 50 rnm. as per the level indicator clean the

oil tank tiller. Keep a record of cleaning of filters to decide the effectiveness of flushing of the system during complete process of oil flushing.

y) It is advisable to keep minimum number of oil coolers, in such a way to maintain the oil pressure before the cooler between 2.5 to 3.0 kg/cm^2. The oil coolers which are not in service, are to be put into service once in 8 hours, by changing from the running coolers.

z) Increase the lub. oil temp. and maintain between 0 to 55°C with the centrifuge in circuit. Control the oil temperature by admitting cooling water to the oil cooler.

za) Once in an hour tap the welded joints lightly on the lub. oil inlet and outlet pipes to remove the welding slag.

zb) Once in 20 hours of continuous operation during flushing at 60°C drop the oil temp. to about *WC* and Then raise once again to 60°C.

zc) Oil sample should be sent for analysis after every 8 hours to compare the PH value, iron content etc. at the lub. oil drain header and the suction of SOP.

4.1.2 Second Stage Oil Flushing:

a) The temporary connections from bearing inlet pipes to outlet pipes (drains) are removed.

b) All the journal bearings of the TG are properly tightened after putting their respective upper halves on them. Then these bearings are turned by 20° to 25° so that: their oil supply lines to babbit are cut off and the oil does not go to the babit portion of the bearings. In such

position of the bearings the' oil falls in the bearing chamber without entering the journal babbit area of the bearing.

c) For Radial Thrust and other spherical seated bearings remove the top halves of the bearings and then insert tightly a few layers of clean muslin cloth along the journal of the rotor and in the side oil clearances, so that during oil flushing the oil does not enter the journal babbit area of the bearings.

d) Wrap clean cloth around the rotor at all the places where it extends immediately out of the bearing chambers so that the oil does not spread. Normally no oil should leak through these areas.

e) Close the bearing housings by putting the covers and tighten the horizontal joint so that the oil does not leak through.

f) Lub. Oil line to the Barring gear is to be disconnected near Barring gear and left to the read' bearing pedestal of L.P.

g) Complete the oil flushing as described earlier.

4.1.3 Third Stage Oil Flushing:

a) All the TG Bearings are normalised & flushing is done through the bearings. Ensure that orifices of correct sizes are installed at the bearings as per the drawing for each bearing.

b) Front bearing pedestal is to he cleaned thoroughly including the casting holes and all the governing parts removed.

c) Main oil pump unit is to be removed completely.

d) Main Oil Pump suction & delivery ,pipe is already dummied at

bearing pedestal before first stage oil flushing.

e) Servomotor return line to suction of MOP to be connected to drain point with a temporary connection.

f) The control oil line and the secondary sensing line near servomotor to he looped together with an orifice of 25 mm as shown in figure.

g) Take a temporary connection on the secondary sensing line of the intermediate pilot valve base and connect to the ESV & IV servomotor oil line which tapped out from the emergency governor pilot valve inside the front bearing pedestal.

h) Dummy the control oil feeding to intermediate pilot valve (next to secondary sensing line).

i) Dummy the connection which leads from intermediate pilot valve to suction of MOF.

j) Connect the lub. oil distribution pipeline from front bearing which leads to lubricating the MOP bearing and other gears with the other ends left free. This piping should be connected to the respective lubrication point after completion of hydraulic test to ensure thorough flushing of this lubrication distribution piping.

k) Control oil line leading to protection system connected from the post is to be dummied at the base. AK the pipelines connected to the post except the orifices and the filter are to be placed in position and left free at the other end.

l) The inlet and drain pipes at both ESV servomotors are to be looped together near the valves and the cutlets are to be left in the front bearing oil drain sight box. Also loop the inlet and drain pipes of both

IVs together.

m) Open the inter connection between lub. oil and governing oil line near the SOP.

n) Make a temporary connection by looping the inlet and drain of ISPUG.

o) Start SOP and complete the third stage oil flushing as described earlier.

4.1.4 Fourth Stage Oil Flushing:

a) This includes suction lines of MOP upto its base.

b) After completion of third stage oil flushing remove the dummy provided at the suction line of MOP near the front bearing pedestal.

c) Start the SOP for fourth stage oil flushing with discharge valve in throttled condition such that the bearing pedestal does not flood with oil.

d) Do it 4 or 5 times as given above if bearing pedestal is flooding, otherwise run the pump for half an hour.

4.1.5 Fifth Stage Oil Flushing:

a) This includes delivery line of MOP upto its base and the governing oil line inside the pedestal by placing back the MOP. \ As during flushing there will be a tendency for MOP impeller to rotate in reverse direction it must be ensured that either the impeller should be free to rotate or it should be removed and only MOP casing should be installed in position.

b) After completion of fourth stage flushing put back the dummy on the suction line of MOP near bearing pedestal.

c) Remove the delivery dummy &: flap of NRV of MOP delivery line.

d) Restart the starting oil pump and flush by throttling the delivery valve to the required flow in the delivery line.

e) Stop the pump after completion of flushing of MOP discharge line upto the pump base.

f) Put back the pump assembly and fix back the NRV of MOP.

g) Remove the dummy provided on the intermediate pilot valve base at the control oil line.

h) Start the starting oil pump after charging of control oil lines.

i) After satisfactory completion of flushing stop the pump.

j) Put back the dummy at the intermediate pilot valve base on the control oil line.

k) Remove the dummy provided on the centre oil post loading to the protection circuit.

l) Start the oil pump and do the flushing for the above mentioned line.

m) Stop the pump after fifth stage oil flushing.

4.1.6 Sixth Stage Oil Flushing:

a) This includes the intermediate pilot drain line connected to MOP.

b) Fix back the delivery dummy near the bearing pedestal.

c) Remove the dummy at the suction of MOP.

d) Remove the dummy provided at the intermediate pilot drain loading to the suction of MOP.

e) Start the oil pump and do the flushing.

f) After satisfactory flushing of the lines stop the oil pump.

g) Remove all temporary connections and dummies.

h) Assemble all the governing elements and normalise all the pipes lines in the bearing pedestal. Take governing system characteristics before doing Hydraulic test.

5. HYDRAULIC TESTING OF OIL SYSTEM

5.1 Place the control valve servomotor without connecting the rocker arms of HP & IP cam shafts.

5.2 Change the motor of starting oil pump with a test meter having 1500 rpm for the pump to develop 40kg/cm pressure.

5.3 Change a pressure gauge in the control oil system to (0.60kg/cm) range, a pressure gauge before oil coolers (0-10 kg/cm-) range and a pressure gauge at the lub. oil header to (0-3kg/cm) range. Isolate all other pressure gauges.

5.4 Disconnect the stem of IV from the lower rocker of IV servomotor to avoid

the damages of the bushes.

5.5 Check the control gear is in zero position.

5.6 Start the starting oil pump (after establishing the oil circuit by standby oil pump), with a delivery throttled so as to get a pressure of 20kg/cm^2 in the control oil circuit.

5.7 With the help of control gear, bring the servomotors of control valve of ESV and IV to the full open position.

5.8 Carryout the Hydraulic test of oil pipelines by further opening of the delivery valve of the starting oil pump.

5.8.1 Test the Governing system at a pressure of 40 kg/cm^2 in the pressure line for about 5 minutes. (While raising the pressure watch the lub. oil system pressure). The hydraulic test pressure will be different for KWH Turbine Governing System.

5.8.2 Test the-lubricating line before the oil coolers at a pressure of 6 kg/cm^2 for about 5 minutes by throttling the outlet valves of oil coolers.

5.8.3 Test the lubricating system after oil coolers at a pressure of 2kg/cm^2 for about 5 minutes by adjusting the spring of the drain valve of the lubrication line so as to achieve the test pressure.

5.9 After the test reduce the pressure in the oil system to 20kg/cm at control oil and check' carefully the complete oil system. Any defect leakages noticed during the test must immediately be attended and oil system should be tested again hydraulically.

5.10 After, completion of the hydraulic test switch off the oil pump and replace

the test meter with the normal operation motor.

5.11 The relief valve which was adjusted during hydraulic test should be readjusted to the old position.

5.12 Drain entire oil tank, oil coolers, and the entire oil system.

5.13 Overhaul the injectors.

5.14 Clean the oil tank thoroughly.

5.15 Clean the oil tank filters and place it in position.

5.16 Fill the oil tank with fresh oil through centrifuge.

5.17 Start the centrifuge and circulate the oil in the oil tank by maintaining a temperature of 55°C for about 24 hours.

5.18 Start the standby oil pump.

5.19 Open the interconnection between lube oil and control oil! system.

5.20 Start the starting oil pump and circulate the oil through bearings and governing elements for about 24 hours by maintaining oil temperature about 50 to 55°C.

5.21 After completion of flushing reduce the oil temperature to 40°C.

5.22 Adjust the relief valve such that the lube on pressure at the bearings inlet is about 1.0 kg/cm^2 .

5.23 Adjust the pressure switches on lube .oil circuit for auto start of AC standby

oil pump at 0.6kg/cm' and the DC emergency oil pump-at 0.5kg/cm and auto stop of gear motor at 0.3kg/cm .

5.24 Now the oil system is ready for checking and adjusting of the governing system as well as for barring gear operation.

6. ADDITIONAL CHECKS TO BE MADE ON TURBINE OIL SYSTEM

6.1 Lub. oil flow through bearing number one should be checked by running the AC lub. oil pump *&.* keeping the inter-connection valve between lub oil & governing oil line closed.

This way only lub. oil will be flowing through the bearing number one drain & not the governing oil. Check the return oil drain sight box for adequate quantity of oil. Sufficient oil! flow through the other bearings of turbine should also be checked-

6.2 For checking the sufficient quantity of lub. oil How through the bearings of Generator, stop the seal oil pump (make sure that the Generator is not charged with Hydrogen or A if at the time of this checking) and check the return oil flow.

6.3 The temperature sensing elements should always dip m the oil. For this check the length of the probe. If it dose not dip in the oil, fill the thermo-well with oil so that the probe ran sense, the temperature through conduction.

6.4 Work permit system for the T.G. oil system must be followed strictly.

6.5 After this stop all oil pumps and run the A.C. seal oil pump alone and ensure sufficient drainage through the generator bearings. By this procedure adequate lube oil to all the bearings and seal oil to the generator seals are being ensured.

C. Jacking Oil System

1. OIL FLUSHING

1.1 With a temporary flexible hose connection, the flange which is to be connected to the suction of the 30P, can be connected to one of the nipples of the circular blank welded to 30P discharge pipe lines at 30P end.

1.2 The relief valve discharge header is connected back to the bearing oil drain after removing the dummy. The internals of the NRV's are kept removed.

1.3 By fully opening the globe valve in the suction line oil can be injected into one of the discharge line to which suction pipe has been connected. The flushing for each line must be done at least for 45 minutes. Thus all the discharge lines including the suction line of 30P can be flushed.

1.4 During flushing the relief valve springs may be tightened so as to flush thoroughly the discharge pipe lines connected to bearings. Then for sometime the relief valve springs may be completely released so that flushing of the relief valve discharge header also takes place. If necessary the internals of the relief valves can also be kept removed.

1.5 The flushing of the jacking oil lines is taken up during II stage oil flushing and can be completed alongwith II stage oil Hushing.

1.6 During flushing special care must be taken to see free flow of oil in the lines.

1.7 After the oil flushing NRV's and the relief valves are normalised.

1.8 The cleanliness of the internal pipes to be installed inside the bearing pedestals (from the special pipe joint to bearings) must be ensured before fitting the same. The pipe lines must be installed in position after normalisation of the bearing and should be suitably clamped at appropriate points.

1.9 The circular blanks welded at 30P discharge pipe lines at 30P and should be removed by grinding off the welding done and thereafter the permanent connection to be the discharge pipe lines to 30P must be done.

2. RELIEF VALVE SETTING

2.1 All the lines are normalised. Suction and discharge lines are connected to JOP which is in position.

2.2 During trial run of jacking oil pump, the relief valves must be suitably adjusted for a working pressure of 140kg/cm^2 . This should ensure a lift of about 0.07 to 0.1 mm in all the bearings.

3 PREPARATIONS FOR HYDRAULIC TESTING

3.1 The erection of the jacking oil pipe lines is to be completed except for the jacking oil pump and pipe No.1 connected to the discharge valve.(Fig II-4)

3.2 The jacking oil pipe lines must be kept well cleaned by blowing compressed air and then steam. The pipe lines must then be kept preserved by applying oil so as to form a continuous thin layer all along the internal tube surface.

3.3 The connectors should be connected only to pipe No. 2 i.e. 30P end of the pipe line leading to bearings, which will be hydraulicaily tested.

3.4 The-test pressure gauge must be of suitable range to read 210kg/ cm and

should be connected to the pr. gauge tapping point in the discharge line.

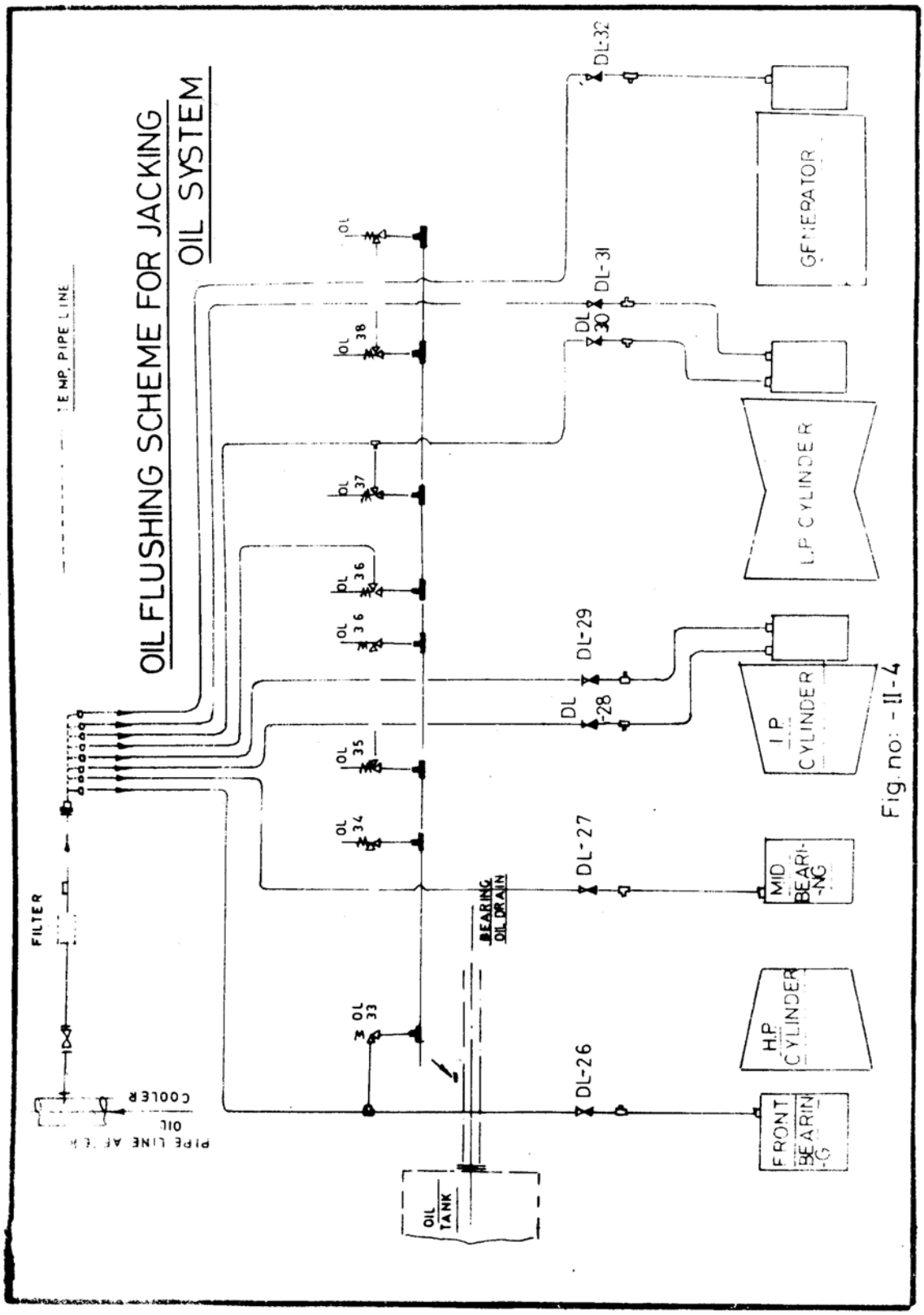

OIL FLUSHING SCHEME FOR JACKING OIL SYSTEM
TEMP. PIPE LINE
FILTER
COOLER
OIL
PIPE LINE AT T.B.
OIL TANK
BEARING OIL DRAIN
DL-26
DL-27
DL-28
DL-29
DL-30
DL-31
DL-32
OL 33
OL 34
OL 35
OL 36
OL 36
DL 37
OL 38
OL
FRONT BEARING
HP CYLINDER
MID BEARING
IP CYLINDER
LP CYLINDER
GENERATOR

Fig. no: - II-4

3.5 The relief valve in the discharge line header connected to the bearing oil drain should be disconnected. The top flange is kept open and the bottom flange is dummied. This arrangement will ensure detection of any water passing through the relief valve and will also prevent its entry into the main oil tank.

3.6 The flaps in the NRV's (discharge line) are kept removed and the relief valve spring is fully tightened so that the relief header is not pressurised.

4 HYDRAULIC TESTING

4.1 Connect the manual Hydraulic pump at the nipple of the circular blank welded at 30P end of the pipe lines. Fill each line with water after removing the blanking nut and then firmly tighten the same.

4.2 By the hand pump build up pressure upto 210kg/cm^2 in the lines one by one. If any leakages are noticed the same must be attended so that the line can withstand the test pressure for five minutes.

4.3 After the hydraulic testing, the plugs provided should be removed and the relief valves must be completely released.

4.4 The pipe lines must be completely drained, cleaned and dried by hot compressed air and then should be preserved by oil spraying.

D. Governing System

1 CHECKING OF GOVERNING SYSTEM

1.1 Preparation

1.1.1 Check whether the front bearing pedestal pipings are completed.

1.1.2 Check that all the governing elements to be mounted in the F.B. Block are thoroughly cleaned. Slightest dirt or any other foreign matter may hamper the function of the whole system.

1.1.3 Check that all the pressure gauge impulse lines in the front Bearing Block (5 Nos.) and other pressure gauges in the oil and governing system (6 Nos.) are properly fitted. Ensure proper calibrations of all pressure gauges are as follows:

a) Delivery of starting oil pump.

b) Main oil pumps delivery before NRV.

c) Suction of main oil pump.

d) Line to emergency stop valve and interceptor valve.

e) Protection line.

f) Charging line of emergency governor pilot.

g) Below differentiator.

h) Below intermediate pilot (Primary sensitive line).

i) Lub. oil line.

j) Below control valve servometer piston.

k) Secondary sensitive oil lines.

1.1.4 Check that the pipings in the front bearing pedestal are fitted and tightened properly to avoid any leakages.

1.1.5 Check during erection that the clearance between the emergency governor strikers with respect to emergency governor levers is within 1 $\pm$ 0.2 mm design limits. This is to be checked byt lifting the main pilot spool of emergency governor pilot to the max. position and record it in governing logsheets.

1.1.6 Check during erection that the clearance between the emergency governor striker with respect to emergency governor rubber rollar for indication are maintained at 1 + 0.2 mm and record it in governing logsheets.

1.1.7 Check ducing erection the clearance between the speed governor and 'nozzle of follow pilot valve is as punched on the speed governor when the speed governor block lever pulled out to the extreme and record it in governing logsheets.

1.1.8 Control valve servomotor should not be connected with camshaft of HP & IP through the tie rod. The tie rod is to be connected after testing of servomotor alone. Two eye belts are to be put on the levers and are to be tied together.

1.1.9 Check during erection the speed governor dimensions as given in the passport regarding K1, al and a2 and record them in governing log sheets.

1.1.10 Check during erection that the clearance between yoke and top cover is 9 mm for both emergency stop valve and interceptor valve as given in the drawing.

1.1.11 Rotate the load limiter in both direction for checking the freeness and check up whether the movement of the bush in load limiter unit equals that of graduation provided on load limiter drum.

1.1.12 Check during erection that the actual full movement of speeder gear pilot with a dial gauge installed after opening inspection cover provided on top cover of FBP is 36 + 2.00 - 1.00.

1.1.13 Provide a dial gauge with special attachment to be fixed in the front side of the bearing pedestal behind follow up pilot valve to measure the movement. Adjust the dial reading to zero.

1.1.14 Provide a dial gauge with special attachment to be fixed in the top of the front bearing pedestal just above intermediate pilot valve to measure the movement. Adjust the dial reading to zero.

1.1.15 Check whether the steam pressure unloading gear unit is in zero position and the pressure oil inlet valve in closed position.

1.1.16 Check whether the Hydraulic amplifier pilot spool unit of the Electric Hydraulic Transducer is kept isolated by screwing the pilot spool towards right stop.

1.2 System Preparation

1.2.1 Check the main oil tank level is about 30 cm. at the oil tank level indicator when none of the oil pumps are in service and seal oil system damper tank is full. (Zero level corresponds to 520 mm from the cover of the tank.

Highest level permissible in the tank is 140 mm from the cover of the tank).

1.2.2 Check whether the lub. oil cooler inlet and outlet valves are opened completely on the oil side.

1.2.3 Keep open the suction valves of starting, standby emergency oil pumps.

1.2.4 Keep close the valve interconnecting the lubricating and governing oil line.

1.2.5 Check whether the vapour extraction fans are in operation.

1.2.6 Check the standby oil pump and start it.

1.2.7 Open discharge valve gradually to full open position.

1.2.8 Check whether the bearing inlet oil pressure is 1 kg/cm . If not adjust the relief valve to maintain a lub. oil pressure to bearing to 1 kg/cm .

1.2.9 Check the main oil tank level is above 10 cm. reading in level indicator.

1.2.10 Open the interconnection line from lub. oil to governing systems for charging and complete to evacuation of air in the governing systems for minimum 15 minutes.

1.2.11 Check that turbine trip solenoid is in de-energised condition and turbine in reset condition.

1.2.12 Rotate the control gear in the anti-clockwise direction upto 8 mm for charging ESV control oil line.

1.2.13 Check whether any union or flange joints are leaking in the front bearing pedestal. If so attend to it. Then bring the control gear back to zero position.

1.2.14 Turn the overspeed governor testing cock handwheel towards anti-clockwise to feed oil to striker No. 1 and check whether oil is coming out from the nozzle to the chamber of the striker No. 1 by opening the top over in the front bearing pedestal.

1.2.15 Similarly carry out the checking for striker No. 2 also.

1.2.16 Start the starting oil pump and open slowly the discharge valve.

1.2.17 Check whether lub. oil pressure is increased slightly.

1.2.18 Stop the A.C. standby oil pump.

1.2.19 Check whether the governing oil pressure is about 16 to 17 kg/cm^2 with CVSM in closed position (with *MOP* running at 3000 rpm the governing oil pressure will be 20 kg/cm^2).

1.2.20 Check whether MOP suction pressure is 1 kg/cm^2 .

1.2.21 Check whether the lub. oil pressure before oil cooler is about 3 kg/cm and after oil cooler is 1 kg/cm^2 .

1.2.22 Raise the oil temperature and maintain around 50°C ± 5°C.

1.3 System Checking on Stationary Turbine (Refer fig. no.11-7)

1.3.1 After the oil temperature is raised to 50 _»_ 5°C, the checking of governing system is to be started.

1.3.2 Operate the control gear in anticlockwise direction and check whether the emergency governor pilot gets reset at 2.5 J_ *0.5* mm. This can be ensured by checking if the pressure gauge ui Emergency Governor Pilot charging line reads 16 to 17 kg/cm .

1.3.3 Check that the ESVs, IVs and CVSM are in closed condition and the scales read zero. Check that all hand wheels for ESVs and IVs are in fully open position.

1.3.4 Rotate the control gear in anticlockwise direction and check whether it is possible to open the ESVs, IVs and CVSM fully.

1.3.5 Bring the control gear back to zero position and see if all the ESVs, IVs and CVSM, have come back to full closed position.

1.3.6 Check whether at 75 mm travel of interceptor valve corresponds to position of control gear is 5.3 $\pm$ 0.8 for both right &. left valves.

1.3.7 The full opening of interceptor valves for right and left corresponding to the travel of 1.4mm of control gear.

1.3.8 Check whether at 75 mm travel of intercepter valve for both right and left the oil pressure under piston is 8.0 $\pm$ 0.2 kg/cm^2 and under pilot valve 9.0 $\pm$ 0.2 kg/cm^2 .

1.3.9 Check the full opening of intercepter valves for both right and left and the total movement is 150 $\pm$ 2 mm

1.3.10 Press the emergency push button for energising the electro magnet solenoid provided on turbine tripping circuit and check whether both right and left intercepter and emergency stop valves close fully and scale reads to zero. The emergency, governor pilot charging line Pr. gauge should read below 13 kg/cm .

1.3.11 Bring back the control gear to zero position by rotating clockwise direction.

1.3.12 Operate the control gear further in anti-clockwise position and check the start off opening of the emergency stop valves.

1.3.13 Check whether the emergency stop valve servornotor for both right and left begins to open when the control gear position is 5.5 mm and fully opens when the control gear position is 6.7 mm. The full opening of emergency stop valve servomotor corresponds to the travel of 1.2 mm of control gear.

1.3.14 Check whether at 50 mm travel of emergency stop valve servo-meters for both right and left corresponds to position of control gear 6.1 $\pm$ 0.8 mm.

1.3.15 Check whether at 48 mm travel of the emergency stop valve servomotor for both right and left, the oil pressure under servo-meter piston is 4.2 $\pm$ 1.4/0.8 kg/cm^2 and under 13 $\pm$ 0.25 kg m^2.

1.3.16 check the full opening of emergency stop valve for both right and left and the total movement is 95 + 3 mm and with movement of damper is 102 + 2 mm2.

1.3.17 Press the knob for tripping turbine manually and check whether both the emergency stop valves close fully and the scale reads to zero. The emergency governor pilot charging line Pr. gauge reads below 13 kg/cm^2.

1.3.18 Bring back the control gear to zero position by rotating in clock wise direction.

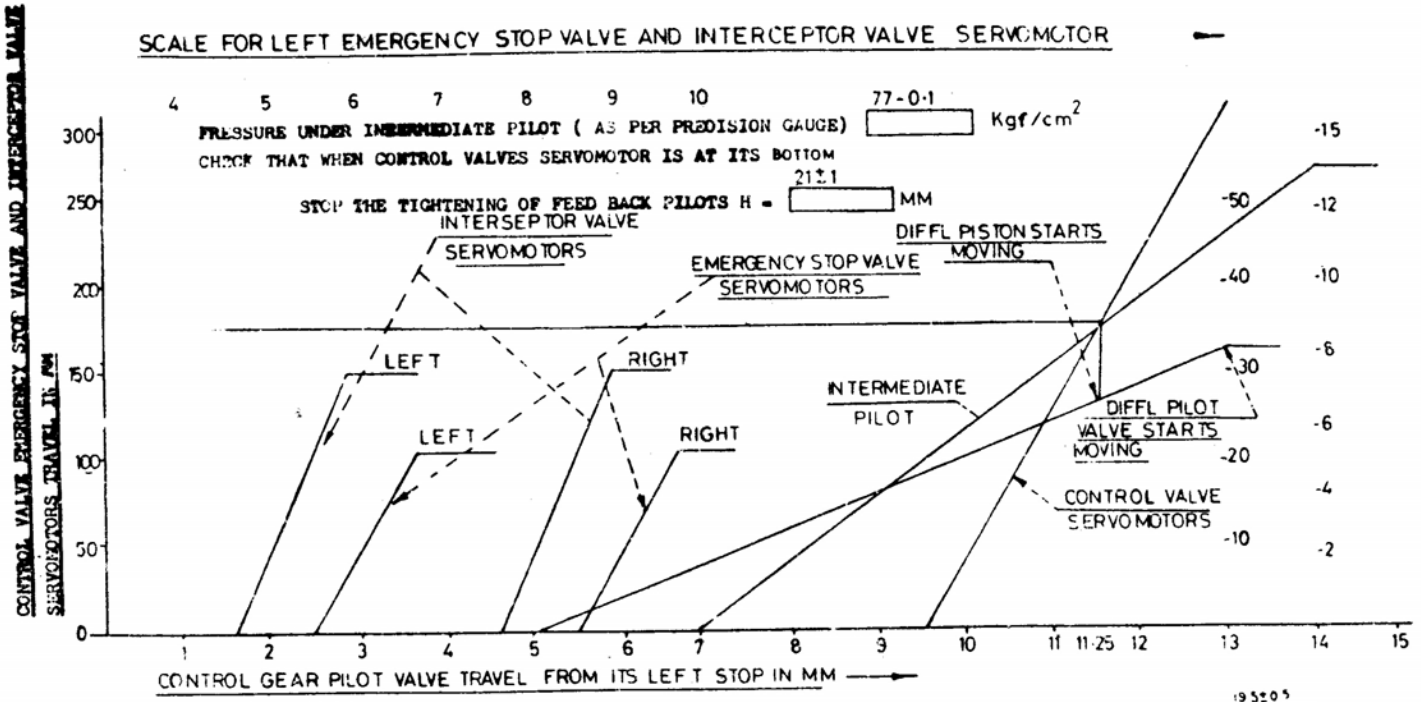
1.3.19 Rotate the control gear in anticlockwise direction and check whether the intermediate pilot begins to move from its bottom position when the control gear position is 6.9 + 0.5 mm by a dial gauge provided on the top of the pedestal.

1.3.20 Operate further the control gear and check whether the full travel of intermediate pilot corresponds to displacement of control gear is 7 + 1 mm.

1.3.21 Bring back the control gear to a position of 8 mm.

Fig.no:-II-7

TESTING OF GOVERNING SYSTEM STATIONARY TURBINE (Typical case of 200/210 MW Turbine) (BTPS/SSTPP)



CHECK FROM THE CURVES THE FOLLOWING:-

1. THAT WHEN CONTROL GEAR IS AT 2.5 MM THE OIL PRESSURE IN THE CHARGING LINE OF EMERGENCY GOVERNOR PILOT IS P E G P = 19.5±0.5 Kgf/cm²
2. THAT INTERMEDIATE PILOT BEGINS TO MOVE FROM ITS BOTTOM STOP WHEN CONTROL GEAR IS AT 7±1 = 6.5±0.5 MM
3. THAT FULL TRAVEL OF INTERMEDIATE PILOT CORRESPONDS TO DISPLACEMENT OF CONTROL GEAR = 15±0.3 MM
4. THAT 142 MM DISPLACEMENT OF CONTROL VALVES SERVOMOTOR CORRESPONDS TO DISPLACEMENT OF CONTROL GEAR = 17.7±0.5 MM
5. THAT DIFFERENTIAL PISTON STARTS MOVING FROM ITS UPPER POSITION WHEN CONTROL VALVES SERVOMOTOR TRAVELS YES MM. ADJUSTMENT MAY BE CARRIED OUT WITH THE HELP OF SPECIAL BOLT.
6. THAT 50 MM TRAVEL EMERGENCY STOP VALVE SERVOMOTOR CORRESPONDS TO POSITION OF CONTROL GEAR = 6±0.8 MM
7. THAT 79 MM TRAVEL OF INTERCEPTOR VALVES SERVOMOTOR CORRESPONDS TO POSITION OF CONTROL GEAR = 6.1±0.8 MM
8. OSCILLATION OF INTERCEPTOR VALVE SERVOMOTORS SHOULD NOT EXCEED 2 MM

RIGHT 6.3±0.8 MM
LEFT

NOTE: THE ABOVE CHARACTERISTICS SHOULD NOT BE DRAWN KEEPING THE LOAD LIMITER OUT OF ACTION

1.3.22 Operate the control gear in anticlockwise direction and check whether the control valve servomotor starts to open 9.6 mm of control gear position.

1.3.23 Open the control valve servomotor upto 60 mm and check whether the intermediate pilot valve (from dial gauge provided) travel in 6.2 +0.3 mm.

1.3.24 Raise the opening of control valve servomotor to 142 mm and check the control gear displacement corresponds to 1.54 + 0.3 mm.

1.3.25 Open the control valve servomotor to full and check whether it had travelled upto 300 mm.

1.3.26 Press the knob for tripping turbine manually and check whether both the right and left emergency stop valves and intercepter valves and the control valve and the control valve servomotor close fully.

1.3.27 The emergency ^governor pilot charging line Pr. gauge should read below 13 kg/cm'".

1.3.28 Bring back the control gear to zero position.

1.3.29 Operate the control gear and open all emergency stop valves interceptor valves and control valves servomotor to the full open position.

1.3.30 Press the emergency push button for energising the Electro magnet solenoid provided on turbine tripping circuit and check whether both right and left emergency stop valves and interceptor valves and the control valve servomotor closes fully.

1.3.31 Bring back to control gear to zero position.

1.3.32 The emergency, governor pilot line pressure gauge should read below 13 kg/cm2.

1.3.33 Operate the control gear and open fully the emergency stop valves, intercepter valves and control valve servomotor.

1.3.34 Operate the load limiter in clockwise direction from zero position gradually to maximum and check whether control valves servomotor starts closing gradually to the fully closed position.

1.3.35 Operate the load limiter in anti clockkwise direction towards zero position and check whether control valve servomotor opens to the full open position.

1.4 Adjustment of CAM & ROLLER clearances of. HP & IP Control \ Valves of 200/210 MW Steam Turbines

4.1 At some of the sites it has been found that the clearance between cam and roller of the control valve's lever are not kept properly during assembly due to which either the valves remain open under tripped condition or there is undue stress on linkages. In order to avoid such type of mistakes, the following procedure should be adopted, while adjusting the gaps between cam & rollers at sites.

a) Initially put 5 mm gap between the cam and rollers of all the 8 number (4 at HPC and 4 at IPC) Control valves in the cold state (at ambient temperature). Take the governing characteristics and then plot the curve between the angle of rotation of cam shaft and stem lift of the valves. (Refer fig no .11-5).

b) Adjust the gaps between the cam and roller of each valve, so at to get approximately the same curve as the design curve given in the above log sheet. Then measure the gaps for each of the control valve.

c) Then for the side control valves of HPC these gaps be increased by 4 mm for IPC by 5 mm, to account for thermal expansion during hot

condition of the turbine. Thus in the cold condition the gaps are set as given at S.No. 3 of Table-1.

d) The unit is started and load taken on the turbine. The final checking of these gaps under hot conditions are again done after the unit has run at full parameter (normal working temperature). Immediately after turbine trips, in hot condition measure these gaps between cam and rollers of all the 8 control valves. Let the values of gaps thus obtained be as given at S.No. 4 of Table-I.

e) If these gaps are same as adjusted under cold condition (as~ per S.No. 2 of Table-1) then no further adjustment shall be necessary. If these are not same then set the gaps in hot condition as per S.No. 2 of Table-1.

f) The difference of values of the gaps between S.Nos. 4 <Sc 2 gives the values by which the set gaps under cold condition are to be modified. Thus the 'Should be' gap under cold condition for that particular turbine can be derived from these values and are as given at S.No. 5 of Table-1.

g) The values of the gaps given at S.No. 5 are the final gaps to be set under cold condition of turbine. Such that during the working of the turbine under hot conditions, these gaps are such that the characteristics of the opening of the control valves shall nearly correspond to the design characteristics. These values for that particular turbine should be properly recorded for further use during over-hauling or whenever required. For easy understanding, one example of these values of gap between cam &: rollers of HP valves, is given below in Table.

TABLE-1

S.	Particulars		Values of Gap in mm for Values Number			
			3 side	2 top	1 top	4 side
1.	Under Cold	'Initial'	5.0	5.0	5.0	5.0
2.	Under Cold	'Adjusted'	4.5	4.5	4.6	4.7
3.	Under Cold	'Set gaps'	3.5	4.5	4.6	8.7
4.	Under Hot	'Should be'	4.7	4.6	4.7	5.2
5.	Cold condition	'Should be'	8.3	4.4	4.5	8.2

E. Regenerative System

1. INTRODUCTION

1.1 It is important that the regenerative system must be thorough!) cleaned to remove the dirt, rust oil, grease, weld slag etc. or else the presence of these undesirable matter will contaminate the condensate flowing through the system.

2. PREPARATIONS

2.1 Ensure that the hydraulic tests of the entire system as per the pressure prescribed in the drawings have been completed. After all the regenerative equipments are installed in position and tested, complete the temporary pipe line connection as shown in the enclosed Schemes.

2.2 Close tightly all the gate valves of the steam extraction lines to heaters. Ensure .t all the NRVS in these lines are also closed by keeping open the drains before these NRVs in atmosphere and observing for any passing. It should be ensured that the alkali solution does not enter the turbine, condenser, heaters, GC-1, GC-2 and main ejectors by any chance. Valves on the delivery of BFPs & Condensate pumps should be closed properly prior to the flushing to prevent the entry of the flushing fluid into the pumps.

2.3 Make sure that all the chemicals and laboratory reagents and apparatus are available.

2.4 Ensure that the required quantity of filtered water and D.M. Water is available for the process. Steam at 8-10 Kg/Cm pressure and 150 to 200°C temperature should be available for heating the alkali solution/water.

2.5 All the valves in the steam lines to and from deaerator should be closed.

2.6 The pressure gauges should be fixed on the discharge line of alkaline pumps.

2.7 All safety valves are to be removed from H.P. heaters and blanks are to be provided with a valves for air venting. Temperature stubs in extraction steam lines for L.P. heaters are to be used for venting of LP heaters. While carrying out the flushing of shell side of HP and LP heaters, care is to be taken for properly venting the heaters for proper filling.

2.8 Ensure that no cutting/welding work is carried out on any equipment after the flushing is completed.

2.9 All the orifices/flow nozzles in the system are to be removed before flushing and if necessary to be replaced with spool pieces.

2.10 The shell side and the tube side of the regenerative equipments are to be flushed separately as per the details given below. The flushing has to be done as per the two schemes attached herewith. For flushing of tube coil side refer Fig. No. II-1 and for the shell side flushing refer Fig No. 11-2.

2.11 Ensure that all the cutting and welding work, which is done on H.P. heaters for gauge glass and level switch fittings is completed before commencing the flushing. However they are to be blanked during flushing.

2.12 The internals of all regulating valves are to be removed before Alkali Flushing.

2.13 Condenser Hotwell and Deaerator should be hand cleaned to the extent possible. Painting of feed storage tank should be done after alkaline flushing and in case any primer is there, this should be removed before

alkaline flushing.

2.14 All the instruments in the system which will be subjected to flushing should be isolated before the flushing starts, except those required during flushing.

2.15 Ensure that proper supports, preferably permanent supports are provided for all the valves before starting the flushing.

2.16 Requirement of Materials

a)	Sodium hydroxide	1000 kg approx.
b)	Filtered water	
c)	Laboratory Equipment for testing PH value, alkalinity etc.	
d)	Trisodium phosphate	1500 kg approx.
e)	Lissopal-D	150 kg approx.
f)	D.M. Water	
g)	Alkali pumps	
	2 Nos.-200 T/hr.	190 MWC
	or 3 Nos.-150 T/hr.	190 MWC

h) Temporary pipes, flanged dummies ends etc.

i) Thermometer (0-200°C) 2 Nos.

j) Sampling bottles 12 Nos.

k) Mixing tank - capacity 50 tonnes.

3. PROCEDURE

3.1 The /flushing of the system is done in the following four steps

a) Mass flushing

b) Alkaline, flushing

c) Rinsing operation

d) Final flushing with DM water.

3.2 Mass Flushing

a) Firstly mass flushing is done with cold filtered or raw w 'er. The mixing tank is filled with the filtered water and then the system is also completely filled with it. After filling the system open the drain do as to drain the water. Again fill the system with water. Now run the system for 30-45 minutes with D1. closed and D1, open. After running for this time stop the pumps and drain the complete system and again refill the system, repeating this procedure till the effluent is clear.

b) For hot water flushing close the drain valve D1, and the inlet valve of water V1, to the mixing tank and me system on recirculation by opening the valve D1. Start heating the water in the mixing tank, by opening the steam valve V1, and keep the system on recirculation for about 8 hours with the temperature of water at about 80°C. Then drain the complete system by closing the valve D, and opening the valve D,,. The process of hot water mass flushing is deemed complete when the turbidity and conductivity of water at inlet and outlet are same.

3.3 Alkaline Flushing ;

Fill the mixing tank with filtered water and raise its temperature to 50°C by admitting steam through the steam valve V-,. Start the alkaline pump and fill the system completely. Keep the system on recirculation for 15 to 20 minutes till the temp. of water in the entire system comes to about 50°C. Then chemical reagents may be added in the following quantities in the mixing tank and properly mixed by starting one of the pumps and opening the valve V. of the recirculation line and keeping the valve V, in the closed position.

a) Trisodium phosphate 5 kg/ton of water i.e. 5000 PPM

b) Sodium hydroxide 3 kg/ton of water i.e 3000 PPM

c) Lissopal - D 0.2 kg/ton of water.

Lissopal - D. must be mixed little by little observing the foaming in the tank. After mixing the chemicals to the required concentration raise the temperature of the solution to 80°C, which is to be maintained throughout the process. Open valve V5 and close the valve V5. Check the concentration and if necessary add more chemicals to bring the chemicals to the desired strength. Keep the loop under circulation, at these conditions for 10 hours. The samples are taken from inlet and outlet ends of the loop at intervals of every hour and are to be analysed for mechanical impurities, iron content and PH value. The process should be deemed as complete when the above values are same at both inlet and outlet ends. Then drain the complete loop through valve D0, and stop the circulation.

3.4 Rinsing Operation : Immediately after the completion of the alkaline flushing operation, the loop should be rinsed with DM water to remove the alkalinity

left over on the surfaces, after alkali flushing. Fill the mixing tank with DM water by opening the valve V-. Start the alkaline pumps and fill the system, keep the loop on 'circulation for 15 to 20 minutes. Then open the drain D,, by a little amount. Make up the level in the mixing tank by DM water. Try to drain maximum quantity of water from the system continuously throughout the operation. The samples are taken at outlet and at the interval of 1 hour, and analysed for phosphate, alkaline contents and conductivity. The conductivity and PH value of DM water used is also found out. The rinsing process is deemed to be complete when the conductivity, and PH value are same at outlet end as at the inlet end. Then drain the complete system.

3.5 Flushing with DM Water: After rinsing operation, final mass flushing should be done with DM water. Fill the mixing tank and the system with DM water. Raise the temperature of water to SO'C. Keep the system under circulation for sometime and drain the system.

3.6 Sequence and circuitry of flushing tube/coil of pre-boiler system of 200/210 MW. MW turbine (BTPS, SSTPP).

3.6.1 Make the temporary connections as per the scheme shown in the Fig. No. 11-1 The suction and discharge side valves of condensate pumps and discharge side valves of BFP remain in closed position.

3.6.2 The complete scheme has been divided into three loops and at a particular time only one of the loop is put into circulation for flushing operation.

a) Loop No.l: Includes LP heaters on the tube sides alongwith their bypass lines, and discharge line of the condensate pumps. This loop can be put in the circuit by opening valve No. V-5 and V-8 and closing valves V-4, V-6 and V-7.

b) Loop No.2 : Includes HP heaters on the coil side alongwith their

bypass line and discharge line of feed pumps. This loop can be put into circuit by opening valves Nos. V-5 and V-6 and closing valves V-4, V-7 and V-8.

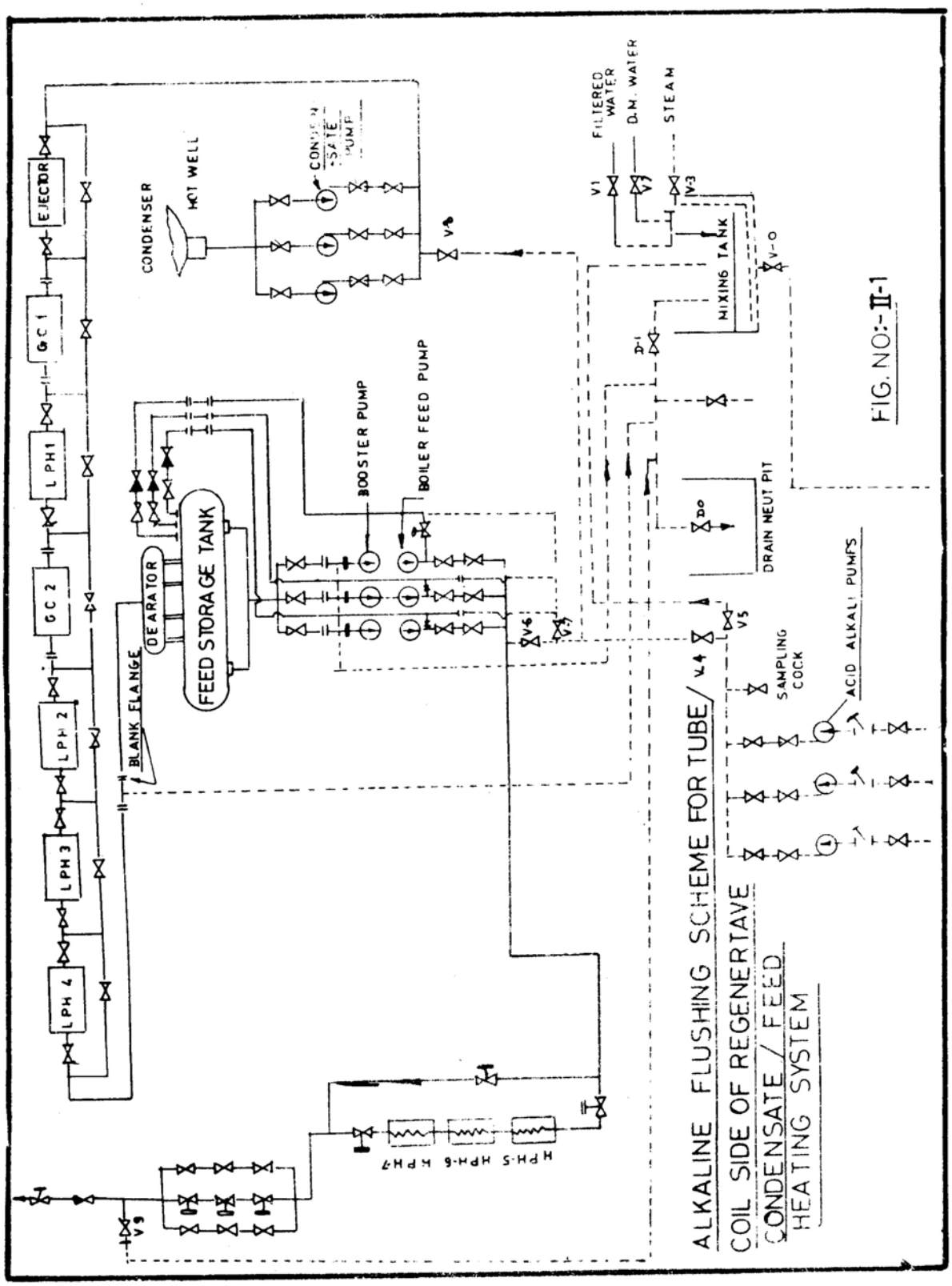
c) Loop No.3: Includes the recirculation lines of feed pumps, feed storage tank of deaerator and suction line of BPP. The loop can be put into circuitry by opening the valves V-5 and V-7 and closing valves V-4, V-6 and V-8.

3.7 Mass flushing of the system is done in two stages. First the loops have to be flushed with COLD WATER and thereafter with HOT WATER. The circuitry for mass flushing shall be as follows:

3.7.1 Loop No.I

a) Mixing tank-circulation pump - condensate pump discharge line - ejector bypass, GC-1, bypass, LPH-1 bypass, GC-2 bypass, - bypass lines of LPH 2,3,4 and then to mixing tank from a point before the deaerator. The flanges at the inlet and outlet of the GC-1 & GC-2 are to be blanked during the flushing.

b) Mixing tank - circulation pump-condensate pump discharge line - then through ejector and by passing ail other equipments, GC-1 and by passing all other equipments, then LPH-1 and by passing all other equipments, then GC-2 and by passing all other equipments then LPH-2 and bypassing all other equipments, then LPH-3 and by passing other equipments, and finally through LPH-4, by passing all other equipments - to mixing tank.


EJECTOR
GC 1
LPH 1
GC 2
LPH 2
LPH 3
LPH 4
CONDENSER
HOT WELL
FEED STORAGE TANK
DEARATOR
BLANK FLANGE
BOOSTER PUMP
BOILER FEED PUMP
FILTERED WATER
D.M. WATER
STEAM
MIXING TANK
DRAIN NEUT PIT
SAMPLING COCK
ACID ALKALI PUMPS
HPH-5 HPH-6 HPH7
ALKALINE FLUSHING SCHEME FOR TUBE/
COIL SIDE OF REGENERTAVE
CONDENSATE / FEED
HEATING SYSTEM
FIG. NO:- II-1

3.7.2 Loop No. 2

a) Mixing tank - Circulation pump - feed pump discharge line - bypass line HP heaters - feed control station to mixing tank from a point before the NRV of economiser inlet valve.

b) Mixing tank - Circulation pump - feed pump discharge line - through coils of HP heaters - feed control station to mixing tank from a point before the NRV of economiser inlet valve.

3.7.3 Loop No. 3

a) Mixing tank - Circulation pump - feed pump recirculation line - deaerator feed storage tank - suction of BFP - Mixing tank through strainers at the suction of BFP.

3.7.4 After mass flushing, the loops are to be alkali flushed as per description given in para 3.3 above. The circuitry for the alkali flushing shall be as follows:

a) Loop No. 1

a) No alkali flushing through the tubes shall be done.

b) Loop No. 2

a) Same as in 3.7.

b) No alkali flushing through the tubes shall be done.

c) Loop No. 3

a) Same as in 3.7.

3.7.5 Rinsing operation, after alkaline flushing is to be carried out as per circuitry

mentioned in 3.7.4 to be followed.

3.7.6 Final D.M. water flushing is to be done as per the description in para 3.5 and circuitry mentioned in para 3.7.

4. SHELL SIDES & DRAIN LINES OF HEATERS

4.1 Make temporary connecting as per the scheme shown in the Fig. 11-2.

4.2 The shell sides of HP heaters are to be flushed by filling individual heaters and then draining the system by opening the shell side drains of 1'ie individual heater.

4.3 The mass flushing of the system is done in two stages. First the loop is flushed with COLD WATER and then with HOT WATER. The circuitry for the mass flushing shall be as follows:

4.3.1 Fill the individual HP healers and then drain the complete system by fully opening the bottom shell drains.

4.3.2 Mixing tank - Circulation pump - extraction steam line to HPH-7 downstream of valve ES-2 shell side of HPH-7 Through heater drain of HPH-7 shell side of HPH-6. Through heater drain of HPH-6 shell side of HPH-5 Through heater drain of HPH-5-Shell side of LPH-3 Through heater drain of LPH-3 shell side of LPH-2-to mixing tank through temporary line, by opening valve no. V-10.

4.4 <u>Post Flushing Operation;</u>

4.4.1 Remove all the temporary lines 01 the loop and isolate the mixing tank and alkaline pumps suction, from the permanent operation scheme.

4.4.2 Make and check that all the pipe-lines and connections as per the final scheme of the normal operation.

4.4.3 Fill the condenser hot well with D.M. water and run the condensate pump, thereby filling the deaerator completely. Open the drainage of the deaerator and drain it completely.

4.4.4 After draining the deaerator inspect it from inside for it's substance and clean thoroughly.

5. SAFETY AND PRECAUTION

5.1 Alkaline solution may cause Skin burning and as its fuels are injurious to eyes, all the safety precautions must be taken during alkaline flushing.

5.1.1 The operators and workers must use rubber gloves, eyes protecting glasses, Approns, Gum boots, masks etc. While flushing process is going on and they are working on the job.

5.1.2 Due precautions must be taken while tightening the flanges of temporary pipe joints of the loop so that they do not leak when the pumps is started and thereby a spray of alkali leaks through these joints.

5.1.3 Before a person enters the deaerator for inspection, its manhole may be kept opened for 8 - 10 hours and air nay be forced in the deaerator during the period.

5.1.4 No drilling, welding or cutting operation are allowed during the process.

6. HP/LP HEATERS

6.1 <u>Checks</u>

6.1.1 Check whether the heater connections, both on water side as well as steam side are as per scheme.

6.1.2 Check the extraction drains of each heater and confirm whether they are as per drawing.

6.1.3 Check whether the heater deaerations are provided on water side as per scheme.

6.1.4 Check whether the safety valves are mounted after duly testing hydraulically. Set pressure of the safety valve should also be checked.

6.1.5 Check the relief valve on water side of L.P.H. are mounted after duly testing hydraulically.

6.1.6 Check all the hand operated valves for their freeness.

6.1.7 Check whether the gate valves and regulations valves are operating properly and its limit switches are functioning for full opening and full closing position.

6.1.8 Check whether the float switches are mounted as per drawing and ensure its proper functioning.

6.1.9 Check whether the shell and extraction line pressure gauges are mounted as per scheme, after duly calibration.

6.1.10 Check whether the thermometers are mounted properly in water side and steam side.

6.1.11 Check whether the level instruments are placed in the panel, after duly calibrating the same.

6.1.12 Check that the resistance thermometers are provided as per the scheme and the same is being properly transmitted to control room.

6.1.13 Check the gauge glass for proper mounting.

6.1.14 Check and ensure the availability of the drip pump after complet-ion of motor trial.

6.1.15 Check for the insulation of the heaters and its connected pipelines

6.2 Commissioning of LPH

6.2.1 Ensure water side is through and all its by passes are closed.

6.2.2 Check that the cascading drains of all extractions are in open condition.

6.2.3 Check whether the FC NRV water side is kept in charged condition and its NRV servomotors are in open position.

6.2.4 Check the supply availability for the FCNRV protection solenoids.

6.2.5 Check if the drains between FC NRVs and the heaters are in open condition.

6.2.6 Check that the cascading drains of the heaters are through.

6.2.7 Keep the level regulating valve of each heater in closed position.

6.2.8 Check if the deaeration line of each heater (steam side) is opened to condenser, or to the lower heater as the case may be.

6.2.9 Open slightly the steam extraction electrically operated valve bypass or

main valve for warming up the extraction upto the heaters.

6.2.10 After the proper warming up, open gradually the steam. valve and observing the heater level in the gauge glass.

6.2.11 If the level starts increasing more than normal level, bring the level controller into circuit. (Refer fig. II-6)

6.2.12 Open the steam valve fully and maintain the heater level at normal value, by keeping the level controller in manual channel.

6.2.13 After satisfactory performance of level controller in manual channel, change over to into channel.

6.2.14 Put the drip pump circuit on auto.

6.3 Commissioning of HPH

6.3.1 Check that the water side is through and its by pass is closed.

6.3.2 Check that the cascading drains of all extractions are in open condition.

6.3.3 Check the drain between the NRVs and the heaters are in open position.

6.3.4 Check that the shell drains are in closed condition.

6.3.5 Check that the cascading drains of heaters are through.

6.3.6 Check that the deaeration of heaters on the shell side are connected to condenser through LPH.

6.3.7 Check the supply availability for group protection solenoids.

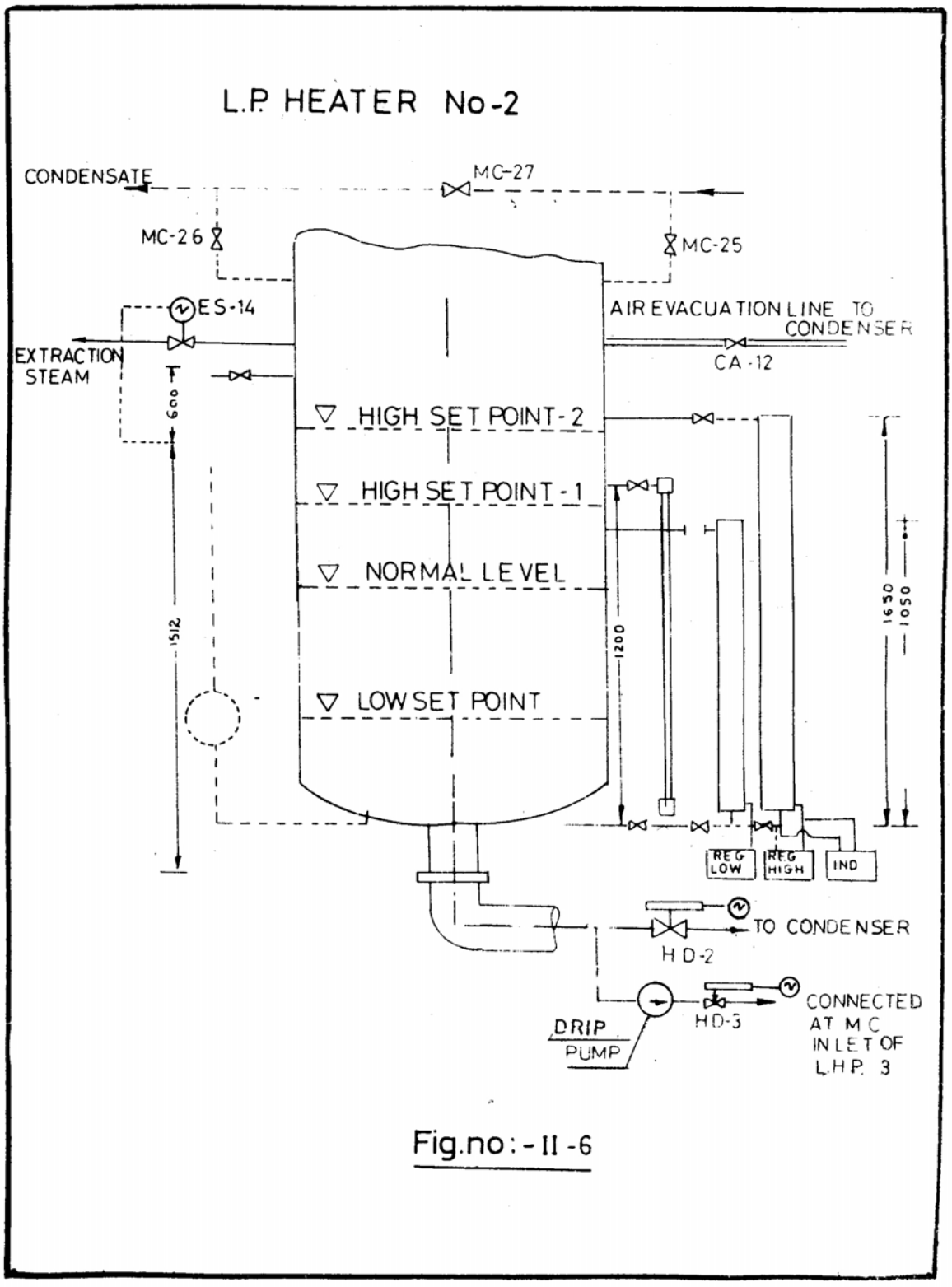

L.P HEATER No-2
CONDENSATE
MC-27
MC-26
MC-25
ES-14
AIR EVACUATION LINE TO CONDENSER
CA-12
EXTRACTION STEAM
600
HIGH SET POINT-2
HIGH SET POINT-1
NORMAL LEVEL
LOW SET POINT
1512
1200
1650
1050
REG LOW
REG HIGH
IND
TO CONDENSER
HD-2
HD-3
DRIP PUMP
CONNECTED AT M C INLET OF L.H.P. 3

Fig.no:-II-6

6.3.8 Keep the level regulating valves of each heater in closed position.

6.3.9 Operate the group protection valve and check whether the bypass of HPH, opens fully and closing command goes for isolation of heaters on water side by closing inlet and outlet valves.

6.3.10 Recharge the heaters back and check the same operation as 6.3.9 by actuating the group protection solenoid.

6.3.11 Charge the heaters in water side once again.

6.3.12 Open slightly the steam valve on the extraction line to warm up the line.

6.3.13 Open shell drain and steam air vent for proper warming up.

6.3.14 After proper warming up close the shell drains and air vent and open gradually the steam valve and observe the level in the heater gauge glass.

6.3.15 Open the steam valve fully and maintain the heater level at normal value, by keeping the level controller in manual channel.

6.3.16 After satisfactory performance of level controller in manual channel, change over the auto channel.

6.3.17 Check whether the heater drip is connected to condenser at low loads.

6.3.18 Ensure whether the heater drip is changed over to deaerator at high loads.

6.3.19 Cut in the high level protection circuit in operation for tripping the unit whenever any of the heater level raises beyond pre set value.

7. B0ILER FEED PUMP COMMISSIONING

7.1 TESTS :-

a) Constructional Tests

b) Pre-commissioning Tests

c) Commissioning Tests

7.1.1 Constructional Test : These will comprise the normal functional trials o? mechanical & electrical plant through out the system to prove erection and will be carried out, concurrently with the erection of plant.

7.1.2 Pre-Commissiomn R Tests : These tests will be carried out when construction is substantially complete and will entail the following :-

a) Inspection of plant i.e. mechanical, electrical & instrumentation.

b) Ensure tightness of pressure parts.

c) Check on all relief valve settings.

d) Flushing of lube oil system.

e) Lubrication checks on valve accuators/booster pump.

f) Commissioning of A.O.P.

g) Insulation resistance tests on motors, cables etc.

h) Rotational test on motor.

i) Operational test on valves. & Fittings.

j) Chemical cleaning of Deaerator, Boiler feed suction & discharge system.

k) Final inspection after cleaning.

l) Protection & interlock testing.

m) Flushing of cooling water system.

7.1.3 Commissioning Tests ; These tests will involve the initial operation of system to demonstrate that it is operationally sound and conforms to the tests comprise the following operations :

a) Starting and operation of Boiler Feed Pumps.
b) Automatic starting of stand by Boiler Feed Pumps.
c) Satisfactory Operation of Valves.

F. Barring Gear

1. PREPARATION

1.1 Check whether the barring gear assembly is dismantled, serviced and assembled again in position, ensuring the required clearances in the gear systems.

1.2 Check and ensure that bearings of the motor are lubricated.

1.3 Check and ensure that the motor is decoupled from the barring gear unit

1.4 Ensure all oil pipings are connected.

1.5 Start the starting oil pump and check whether lubrication oil pressure is between 1.0 to 1.2kg/cm at 40 to 50°C oil temperature,

1.6 Disconnect the lubrication-connected unions at barring gear and flush the piping. Fix back the oil piping.

1.7 Check the drain oil piping of each bearing for proper flow.

1.7. Lub. oil flow to bearing No. 1 should be checked by running the A.C. standby oil pump and closing the charging line of the governing system. This way only lub. oil will be flowing, through the drain. It should be ensured before hand that there is no leakage from the line taken as tap off from Brg. No.l supply line for oil supply to MOP seals techno motor shaft &: gear coupling lubrication, otherwise considerable quantity of oil will be bypass from Brg. No.l. Check that adequate quantity of oil is visible in the drain sight glass.

1.7.2 For checking whether adequate quantity of lub. oil is flowing to the generator bearings, stop the seal oil system and check whether adequate quantity of oil is flowing through the drain sight glass with BG disengaged condition.

1.7.3 For checking whether adequate quantity of seal oil is flowing to the generator scale, stop all lub. oil pumps and run the A.C. seal oil pump alone. Charge the seal oil system and observe if adequate quantity of oil is flowing if adequate quantity of oil is flowing through the drain sight glass.

By these procedure adequate quantity of lub. oil to all the bearings and seal oil to the generator seals is ensured.

1.8 Check in the front bearing pedestal whether all lubrication oil connections were made properly.

1.9 Check whether the protection for cutting off the barring at lubrication oil pressure of 0.3 kg/cm is connected.

1.10 Check whether the limit switch installed for cutting off the supply to solenoid (intended for auto engaging) whenever barring gear engages and trips off the motor whenever the barring gear disengages is connected properly.

2. TRIAL RUN OF MOTOR

2.1 Arrange for the electrical connection to the barring gear motor and ensure the electrical soundness of the motor for energising.

2.2 Start the motor and check the directions of rotation of the motor.

2.3 If the direction of rotation is OK trial run the motor for 8 hours.

2.4 Stop the motor after 8 hours of operation.

3. PREPARATION FOR PUTTING THE BARRING GEAR IN OPERATION

3.1 Couple the motor with barring gear unit.

3.2 Keep the barring gear in disengaged condition.

3.3 Rotate the barring gear assembly with the rotating disc. in clockwise direction and check its freeness of the gear train.

3.4 Check whether lubrication oil pressure is normal. In case A.C. standby oil pump is running the charging line to gov. sys. should be open.

3.5 Check whether the return oil flow from all the bearings are normal.

3.6 Engage the barring gear with the turbine shaft by rotating disc. in clockwise direction and simultaneously pushing the engaging lever.

3.7 Check whether lubrication for barring gear assembly is proper during oil flushing.

3.8 Discharge the barring gear by rotating the disc. in anti-clockwise direction and check whether lubrication oil to barring gear cuts off automatically.

3.9 Try the auto engaging of the barring gear (Caution : Without giving supply to barring gear motor by switching off the CB) by giving supply to engaging solenoid and simultaneously rotating the rotating disc by hand.

3.10 Check whether supply is cut-off for engaging solenoid as soon as the barring gear engages.

3.11 Disengage the barring gear by rotating the rotating disc. in anti--clockwise direction.

3.12 Check whether protection for tripping the barring gear when the lubrication oil pressure drops to 0.3kg/cm is available.

3.13 Check whether A.C. and D.C. emergency oil pump auto scheme is available.

3.14 Check whether bearing metal temperature, and seal oil system temperature recording instruments are in working condition.

3.15 Check whether local glass thermometer for measuring the drain oil temperature are placed in position.

3.16 Check that the turbovisory eccentricity measuring instruments is available and the direct reading dial gauge also fixed in bearing No.2 for eccentricity measurement. The seal interface pick up should be made ready and switched on before engaging the barring gear.

3.17 Check whether seal oil system is in service with proper oil pressure with compressed air filled. And also proper interlocks for the seal oil system is available.

3.18 Check whether oil inlet temperature to the bearings is ^0°C to 50°C.

3.19 Engage the barring gear manually.

3.20 Start the barring gear and note down the starting current and normal current.

3.21 Check for any abnormal noise at turbine glands and bearings with a hearing

rod/seal interference pick up.

3.22 Stop the barring gear. Note down the coasting down period. Start the B.G. again.

3.24 Start the barring gear motor after engaging the gear.

3.25 Watch the return oil temperature from oil bearings and from the generator seals also.

3.26 Note down the eccentricity value at the control room and at the bearing No.2 pedestal (dial gauge). It should be same at UCB and Brg. No.2.

3.27 Check once again at turbine glands and generator seals for the healthy condition. Measure the vibration at Barring Gear Pedestal and at bearing covers of worm shaft and meter.

G. Vacuum Tightness Test

1. Vacuum tightness test, is carried out to find out the leakages, if any, in the vacuum system before first rolling of turbine. This test should be carried out before the various lines are insulated. This is done in two phases.

1.1 Firstly by filling up with DM water upto turbine glands.

1.2 Secondly by raising vacuum in the system.

2. PREPARATION OF THE SYSTEM BEFORE FILLING WITH DM WATER

2.1 This test should be done only when the casing temp. below 50°C, if it is done after synchronisation.

2.1.1 Check whether r" the piping in the vacuum system are completely erected. The circuit which come under vacuum are HP Cylinder, reheater, IP cylinder, LP Cylinder, condensate flash tank, HP and LP bypass system, extraction lines of HP and LP headers, condenser, flange and stud heating system etc. R.H. should be prepared for raising vacuum.

2.1.2 Check whether all the valves provided are as per the piping -scheme.

2.1.3 Prepare a list of dummies to be provided before filling up of the system.

2.1.4 Check whether gland sealing lines are provided for all the valves which come under vacuum as detailed at item No. 9.4,1 and ensure that these lines are flushed and proper flow is established at the open and before finally connecting these lines.

2.1.5 Check whether all the drain valves in the condenser system and HP heaters

to atmosphere are kept closed.

2.1.6 Provide a transparent tube at the header or any steam side vent upto 9 meters to know the level in the system during filling up.

2.1.7 Check whether the gauge glasses are provided in Hotwell, GC-1 and all the LP & HP heaters.

2.1.8 Check whether props/jacks are provided for the condenser spring supports for jacking purpose during fill test. These props/jacks should be removed before raising vacuum.

2.1.9. Connect all LP heaters, GC-1, GC-2 and drain expander to the condenser. All vacuum gauges are to be isolated.

2.1.10 Keep open the condenser manholes on cooling water side for checking of any defective tubes in condenser.

2.1.11 Keep the suction discharge and desecration valves of all the condensate pumps in open position.

2.1.12 Keep closed the valve from condensate pump delivery to the sealing header for sub-atmospheric valves.

2.1.13 Provide dummy on the exhaust line of drain expander, after NRV. This dummy should have a valve for deaeration while fitting.

2.1.14 Close the valves in the syphone filling lines (15 M syphon for drain expander <5c 3 M syphon for ejectors) and isolate them from the main condensate line.

2.1.15 Keep suction deaeration and delivery valves of both drip pumps

open.

2.1.16 Keep open the air evacuation line valves of condenser (2 Nos.)

2.1.17 Keep open the air line valve of starting ejector and close the and exhaust line drain valves.

2.1.18 Keep open the air line valves and the drain valve to condenser of both main ejectors, (the pressure testing of the ejectors done separately).

2.1.19 Checking whether the float level switches of the following equipment are mounted:

a) Condenser
b) Gland steam cooler and gland cooler.
c) LPHs
d) HPHs

2.1.20 Keep open the deaeration line valves to condenser from LPH 2,3 & 4.

2.1.21 Keep the vacuum breaker in open position.

2.1.22 Check whether the interlocking wiring circuit of regenerative systems are completed.

2.1.23 Check whether turbine bottom casing insulation has not been taken up.

2.1.24 Keep open all heaters extraction valves. Check the level indicating instruments, pressure & vacuum gauges of LP heaters 2, 3 &: 4 are made ready.

2.1.25 Open the transfer pipe drain valves of HP <5c IP cylinder and curtis drain valves to condensate flash tank (CFT).

2.1.26 All drains of CFT to be open. Keep the extraction force closing NRV drains to condensate flash tank in open position (i.e. 7, 6, 5, 4, 3 & 2 steam extraction line NRV).

2.1.27 Provide dummy at the air & steam mixture exhaust flange *oi* gland steam cooler.

2.1.28 Keep open CRH and HRH drains to condensate flash tank. Close the gland steam inlet and its bypass valve.

2.1.29 Keep open the individual valves loading to all turbine glands and the header drain to condensate flash tank.

2.1.30 Keep open flange and stud heating return line to condenser d its drain but isolate it from the main steam line.

3. VACUUM TIGHTNESS TEST BY FILLING UP WITH DM WATER

3.1 Analyse the DM water before filling .up, check PH value corresponds to 7-8 and conductivity below 1 micromhos.

3.2 After checking all the system, start filling up with DM water.

3.3 While filling up check whether there is any leak and arrest the leak immediately if noticed.

3.4 If the leak noticed is heavy in nature stop the filling. Attend the leak, then proceed for further filling up.

3.5 Once the water reaches the bottom portion of gauge glasses of LPH's 2, 3 & 4 start watching the float switch operation while further filling up of LPH-2, 3 & 4.

3.6 Stop filling, when the LPH-4 gauge glass level is about 90%.

3.7 Observe whether the level instruments corresponds to direct level gauge readings at different levels.

3.8 Check the functioning of float switches of all the heaters whether it corresponds to actual reading while filling up and during draining operation of the heaters.

3.9 Check whether all the float switches operation and level instruments are found satisfactory. Isolate float switches of LPH's, GCII whenever system filled above normal level.

3.10 Fill the system upto turbine glands.

3.11 Check whether all lines are filled with water.

3.12 Check for any leakage in the tubes of condenser, watch the level for about 24 hours and whether the level remains constant or goes down. In general level drop of about 2 to 3 cms. in 24 hours may be allowed.

3.13 If the level goes down check the system thoroughly again for any leakage and attend to the defects.

3.14 After ensuring that there is no leak in the system, start draining the complete system.

3.15 Check the float operation and interlocks of HP healers by connecting the HP

heater drip line to condenser.

3.16 Check whether the level in the condenser is normal.

3.17 Remove the props/jacks provided for the spring supports of the condenser.

3.18 Check whether the dummies provided for carrying out leak tests are removed and the connections are made through as per the scheme.

3.19 It is recommended to conduct this test 2-3 tunes before first vacuum raising.

4. RAISING THE VACUUM IN CONDENSER

4.1 Start standby oil pump.

4.2 Charge the governing system.

4.3 Put the turbine on barring gear when the oil temp. is mm 38°C.

4.4 Check whether the vacuum breaker valve is kept fully closed.

4.5 Check whether a 'U' tube manometer is installed for measuring the vacuum directly.

4.6 Check whether the atmospheric drains of CRH and HRH lines are closed

4.7 Isolate the HP heaters drip line, which are connected to the condenser and vacuum circuit.

4.8 Charge the cooling watersides of both condensers. Ensure proper air venting while charging.

4.9 Keep the condenser hot well level normal.

4.10 Keep all drain lines to CFT open. Open all inspection lines to check all pipes are without water and close the inspection valves after checking. Prepare the main condensate circuit through ejector, gland steam cooler and all heaters. Close the outlet valve of the LPH-4 on main condensate side.

4.11 Start one main condensate pump and keep it under recirculation through ejector and gland steam cooler.

4.12 Fill the 15 M siphon line from main condensate and check individually as per list at Seriatim 9.4-1, that the valves which are coming under vacuum are sealed with water from the discharge of condensate pump.

4.13 Aux. steam for Gland sealing, GC-1 & Ejectors may be taken through Aux. PROS.

4.14 Warm up the steam lines of gland steam cooler, ejectors and gland steam header after opening their respective drains and by opening their respective steam inlet valves.

4.15 Commission the gland steam cooler and maintain suction pressure from glands at about 80 mm of mercury column vacuum.

4.16 Open the steam valve of starting ejector by one or two turns for warming up. After sometime, open the steam valve fully.

4.17 Open the air valve gradually and observe the raise in vacuum.

4.18 Check whether condensate from the delivery of condensate pump for drain expander is opened.

4.19 After changing the ejector^ starting scaling the glands for all three casings with steam parameters temp. min 150°C pr. - 0.1 .to 0.2 atg.

4.20 Take both the main ejectors in service by opening their steam valves. Ensure that the 1st stage drains at the ejector to the condenser is in open position.

4.21 Note down the vacuum obtained in both the main ejectors.

4.22 Open the air valve gradually and observe the raise of vacuum in the system.

4.23 Check that the level is maintained in the gauge glass of ejector.

4.24 Cut off the starting ejector by first closing the air valve and then the steam valve when the vacuum becomes constant and note its value. If air valve is found passing keep open steam valve.

4.25 While raising vacuum beyond 650 mm of Hg column check whether the vacuum pr. switch gets reset and annunciation disappear.

4.26 Wait till the full vacuum is reached i.e. when it becomes constant. Now cut off one of the main ejectors. Vacuum is good if it is around 96 to 97%.

4.27 Observe for any fall in the vacuum. If there is no fall in vacuum. it is concluded that the tightness of vacuum system is normal. Now test whether the vacuum can be maintained with the other ejector alone.

4.28 Check the following with the candle or shock pulse meter if available after obtaining full vacuum:

a) Parting plane of the LP casing.
b) Explosion diaphragms points.

c) LP exhaust hood dummy plugs.

d) Cross over pipe, joints of IP exhaust & LP inlet.

4.29 After finishing the vacuum test, the ejector can be cut off by closing the air valves and steam valves.

4.30 Close the drain valves of both the main ejectors. Note down the rate of drop of vacuum of mercury column.

4.31 When the vacuum drops to 50 mm of mercury column cut off the sealing steam of all three casings and cut off gland steam cooler. Also open the vacuum breaker immediately.

4.32 Stop the main condensate pump (approx. after 2 hours).

4.33 Stop the barring gear after 8 hours operation.

H. Check List For First Rolling Of Turbine 200/210mw

1. PREPARATION

1.1 Check whether the electrical supply for HT and LT auxiliaries is available.

1.2 Check the position of DM water stock and availability.

1.3 Check the quality of DM water for conductivity (PH value between 7 to 8 and conductivity less than 1 micro-mho).

1.4 Fill up the feed tank and condenser hotwell upto the normal level.

1.5 Ensure, the control and annunciation circuits for regenerative system are working satisfactorily.

1.6 Check whether all the differential expansion pick-ups are mounted properly and their annunciations at the control room are okay.

1.7 Check whether the shaft eccentricity pick-up is mounted properly and its annunciation at the control room is okay.

1.8 Check whether the Axial-shift pick-up is mounted properly, and its annunciations at the control room are okay.

1.9 Check whether the main oil tank high & low level annunciations appear at control room, while testing the level switches.

1.10 Start the cooling water pump and charge the condenser. Open the air vent

valve of the condenser for ensuring complete deaeration of cooling water side. A steady flow of water ensures complete deaeration in the cooling water side. Check that the condenser jacking arrangement is removed.

1.11 Maintain a cooling water pressure as per design value in each condenser.

1.12 Check that the cooling water is available for oil auxiliaries and the oil coolers.

1.13 Check the oil level in the bearing and rotate the A.C. standby oil pump rotor by hand as per direction shown on the pump, before starting the pump and ensure the deaeration of the pump also check whether cooling water is available to the bearing.

1.14 Start the vapour exhaust fan.

1.15 Start the A.C. standby oil pump. Open delivery valve slowly to evacuate the air and to charge the system with oil. \.

1.16 Run the pump for 10 minutes and check that the return oil flow from each bearing through the sight window is adequate.

1.17 Open the inter connection line from lub. oil to governing system for evacuating the air and charging the governing elements with oil. It normally takes 8 to 10 mins. for proper charging.

1.18 Start the starting oil pump, open the delivery valve slowly and check whether it develops a pressure of 16 to 17 kg7cm when the delivery valve is fully opened.

1.19 Stop the standby oil pump and check whether the lub. oil pressure remains same or above 1.0 kg/cm .

1.20 Ensure that the A.C. standby oil pump cuts into service when the lub. oil pressure drops to 0.6 kg/cm by operation of the oil pressure drc slay.

1.21 Ensure that the D.C. Emergency oil pump cuts into service when the lub. oil pressure drops to 0.5 kg/cm by operation ot the oil pressure drop relay;

1.22 Switch on all the instruments at control room both recording and indicating types.

1.23 Check that "Bearing Babbit Temperature High" and "Lub. oil temperature high after oil coolers", annunciations appear in control room by making the contacts of the respective relays.

1.24 Maintain the lub. oil temperature after the oil cooler around 40 to 45°C.

1.25 Check that the oil channels around the front and middle bearing pedestals are clean and not clogged. Also check the clearances of the key ways of HPT and IPT (Sliding surfaces) along the expansion path for any checking. The spherical washers of the LPT spherical washers of the LPT should be free.

1.26 Check the interlocks of the barring gear. Ensure that the lub. oil to the barring gear drive is available. Check the Barring gear operation for auto engagement.

1.27 Ensure that the seal" oil system is put into operation and the respective interlocking and protection systems are available.

1.28 Engage the barring gear after ensuring proper lubrication to bearings.

1.29 Remove the fuse from motor control circuit and check the protection of or tripping of barring gear motor by draining the oil near OPDR.

1.30 Start the barring gear motor.

1.31 When the turbine is on barring gear note down the following readings:

1.31.1 Bearing babbit metal temperatures and drain oil temperatures.

1.31.2 Axial shift.

1.31.3 Differential expansion of the Rotors.

1.31.4 Lub. oil temperature before and after oil coolers.

1.31.5 Metal temperatures,

1.31.6 Shaft eccentricity.

1.31.7 Current drawn by motor.

1.32 Check the stationary governing characteristics for proper opening and closing of E.S.Vs Interceptor Valves & Control Valve servo-meter are as per design characteristics curves.

1.32.1 Check whether the main steam, cold reheat, hot reheat, expander drains are in full open position.

1.32.2 Check whether these drain lines are getting hot during warming up.

1.32.3 Close all the valves of LP heaters and HP heaters on the steam side.

1.32.4 All the solenoids for force closing NRV's on extraction side should be in de-energised condition.

1.32.5 Gland steam leak off line is to be diverted to LPH4 and rotor heating lines are to be isolated.

2. PRELIMINARY OPERATION BEFORE ROLLING

2.1 Ensure that ESVs, IVs and CVs are fully closed. Start the main condensate pumps and keep it in recirculation. Ensure proper deaeration of the main condensate line from GCI and from the main condensate line.

2.2 Ensure that all gland seal valves in vacuum system are sealed with condensate water.

2.3 Ensure that the 15 M syphon, LPH-1 syphon etc. are filled. Check whether an orifice is there in the 15 M syphon filling line.

2.4 Check whether main steam admission electrically operated valve and its bypass valves are in closed condition.

2.5 Warm the following steam lines:

2.5.1 Ejector steam line.

2.5.2 HP, IP & LP gland steam lines upto isolating valve near turbine.

2.5.3 Gland steam cooler ejector line.

2.6 Keep closed the HP & LP bypass system and EV-1 and EV-2 valves.

2.7 Check whether the vacuum breaker is fully closed. Also check whether the reheater vents are closed.

2.8 Cut in starting ejector.

2.9 When the vacuum reaches about 100 mm seal all the HP, IP <5c LP glands.

2.10 Commission the gland steam cooler GC1 and maintain about 50 mm of Hg vacuum at gland steam cooler.

2.11 Take both the main ejectors in service and ensure that the 1st stage drain is open. Cut off the starting ejector at 500-600 mm of Hg vacuum.

2.12 Check up the vacuum protection switch for annunciation at 650 mm Hg column and for tripping at 540 mm Hg.

2.13 After attaining the full vacuum, check the following turbine protections.

2.13.1 In admissible value of axial shift.

2.13.2 In admissible vacuum in the condenser.

2.13.3 Drop in lub. oil pressure to in admissible value.

2.13.4 In admissible values of mains and reheat steam temperature.

2.13.5 Operation of generator protection.

2.13.6 Remote manual trip.

2.13.7 HP Heater level high.

2.13.8 HPT exhaust temperature high.

Protections U) and (iii) should have been checked prior to raising vacuum to avoid the opening of vacuum breaker.

2.14 Check for the above each tripping the following actions:

2.14.1 Emergency stop valve servomotor limit switch act and following actions occurs:

a) Signal at UCB "Closure of ESVs".

b) The solenoid valves for positive closing of extraction line NRVs get opening command by closure of one or both ESVs.

c) To de-energise the electromagnet of turbine shut down switch.

2.14.2 Interceptor valve, servomotor limit switches act and following actions occur:

a) Signal at UCB "Closure of IVs".

b) The solenoid valves for positive closing of extraction, line NRVs get opening command by closure of one or both IVs.

c) To de-energise the electromagnet of turbine shut down switch.

2.14.3 Control valve servomotor limit switch acts.

2.14.4 The solenoid valves for positive closing of extraction line NRVs should reclose after closing of main stop valves and their bypass valves.

2.1.5 Check whether emergency stop valves closed when the oil pressure in the governing system drops into 10 kg/cm (gauge) and interceptor valves close when it drops to 6 kg/cm .

3. OPERATION TO BE CARRIED OUT FOR THE UNITS WITH HP/IP BYPASS SYSTEM

3.1 Before HP/LP bypass stations are brought into operation, check the following:

3.1.1 Emergency stop valve & interceptor valves are in closed position.

3.1.2 Oil system of bypass system is put into operation.

3.1.3 Vacuum in condenser is more than 540 mm of Hg column.

3.1.4 Condensate flow to steam throw off devices in the condenser are established by opening the respective motor operated valves.

3.2 Ensure that all the valves in the bypass system are fully closed and the respective position indicator reads zero.

3.3 Set the temperature set point of HP bypass valves on manual' mode.

3.4 Put the pressure controllers of HP bypass valves on manual mode.

3.5 Put the LP bypass valve on auto mode and set the temperature set point of LP bypass station to 200°C,

3.6 Set the pressure set point at 6 ata at LP bypass station.

3.7 Check that the HP turbine evacuating valves EV1 and EV2 and bypass valves across NRV of cold reheat lines are tightly closed.

3.8 Check whether the superheat flow has been established through the start up vent.

3.9 After the proper superheat in the superheated steam is established, open the HP bypass valve gradually such that the steam flow assists in heating up of main steam, cold reheat and hot reheat lines and also the parameter of the steam raises smoothly and quickly.

3.10 If the heating rate of steam lines exceeds me prescribed limits adjust the position of HP bypass valve to bring down the heating rate within permissible limits.

3.11 After warming up CRH and HRH lines close the HP & LP bypass and bring the reheater under vacuum.

3.12 Conduct the test for checking the tight closure of interceptor valves.

3.13 Connect special differential manometer for measuring between the condenser pressure and pressure in the chamber after the first stage of IP Turbine.

3.14 Make sure that MSV. & its bypass, ESV's, IV's & control valve servometer are in closed condition.

3.15 Check that steam is not supplied to reheat circuit, through HP bypass valve from main steam circuit.

3.16 Turn the speeder gear in anti-clockwise direction and open the ESVs, IVs and control valves of IPT.

3.17 By turning the handwheel of interceptor valve servomotor close both the interceptor valves completely.

3.18 Bring in service the HP bypass station/and raise the pressure gradually in the reheat circuit to a value of not more than 6 kg/cm .

3.19 Watch IP transfer pipe metal temperature. The temperature should not increase beyond the room temperature.

3.20 While doing the above operation constant watch should be there on the operation of the barring, gear. If any time, turbine gets speeded up, close and HPBP, and bring the reheater circuit under vacuum by operating the LPBP.

3.21 If there is no raise in the IP transfer pipe metal temperature and the differential manometer shows zero, gradually close the transfer pipe line drains which go to condensate flash tank.

3.22 Watch the differential pressure manometer.

3.23 Gradually raise the reheater pressure to 4 ata, and check that the differential pressure in the manometer is less than ^0 mm of mercury column, it can be construed that the interceptor valves are having tight closure.

3.24 Close the HPbP system and move the control gear in clockwise direction to close ESV, IV & IPT control valve.

3.25 Open transfer pipe drains of IPT.

3.26 Open the LPBP system to bring the reheater pressure to condenser pressure than close the LPBP system.

3.27 Open the handwheel of interceptor valve servometer to full open condition.

3.28 After 50°C superheat is available at the superheater outlet, heating up of transfer pipes of HP turbine is permitted.

3.29 Check that the steam pressure in the hot reheat line which should be less than 1 kg/cm (gauge) before starting the heating of steam admission - pipes. If the pressure in the hot reheat line exceeds 1 kg/cm and if the vacuum is deep, the barring gear may disengage during warming up of steam admission pipes of 1PT control valves due to side control valves of IPT have been provided with built in relief holes through which steam may leak.

3.30 Open ESV upto 10 to 20 mm as per the scale. Care should be taken so that control valves of HP turbine should remain closed.

3.31 Keep open the transfer pipe drains, cylinder drain & extraction drain, of HP Turbine.

3.32 Open the MSV bypass valve little by little for warming up transfer pipelines of HP turbine upto control valves to a temperature of 150°C.

3.33 Open the bypass valves across NRV in cold reheat line and heat the HP turbine upto 150°C.

3.34 Open the transfer pipe drains, cylinder drains and extraction drains of IP turbine;

3.35 Open the interceptor valve servomotor upto 10 to 15 mm as per the scale by taking precautions written in the point No. 3.2.9.

3.36 Heat the steam admission line upto control valves of IP Turbine upto a temperature of 100°C.

3.37 During the process of heating the pipelines of HP & IP turbines ensure that the drain system is working normal and there is no clogging of drain lines.

3.38 Close the bypass valve of MSV, ESV's and NRV by pass in the cold reheat lines when the steam parameters before MSV are 20 kg/cm and 270 - 280°C and HPT steam admission pipes casing are heated upto 150°C.

3.39 Close the IVs when the steam admission pipes of IPT are heated upto 100°C. The IP casing temp. should be preferably between 75to 80°C minimum to avoid condensations of steam in IP casing.

3.40 Manually close the HP bypass valves and when the pressure in the reheater reaches condenser pressure, close the LP bypass manually.

I. DATA TO BE COLLECTED DURING COMMISSIONING AND ALSO AFTER FIRST LOADING TO FULL CAPACITY IN 200/210 MW TURBINE GENERATOR SET

a) The starting/normal current in HT/LT motors both motor is in decoupled as well as when coupled to th/' driven equipment operating under normal conditions.

b) Time for opening and closing of all motorised valves indicating the condition of operation.

c) Vacuum tightness test, i.e. rate of drop of vacuum with the valve, between condenser and ejector in closed position.

d) Time to build up the vacuum of 600 mm with the starting elector or plus normal -ejector indicating the ejectors which were ir-operation while pulling the vacuum and indicating the steam parameters to the ejector.

e) Vacuum sustained by the machine when only one x 100% normal ejector is in operation at full load.

f) Condenser cooling water inlet, outlet and corresponding vacuum at full load with valves in circulating lines fully open with normal level of condensate in the hot well.

g) Governing characteristics obtained during the test at site.

h) Lub. oil system

   a) The discharge pressure of AC standby pumps when discharge valve in fully closed and then in open posit ion with only AC standby oil pump running and lub. oii pressure in the bearing supply mains.

b) Same as above when only DC emergency oii pump is running.

c) Same as above when SOP is running and relay oil pressure.

d) Discharge pressure of MOP then both MOP and SOP are running.

e) The setting at which SOP, EOP and seal oil pumps cut in.

i) Current drawn by the generator when turbine emergency as well. as intercepter valves are closed. One has got to be rational while doing this test as machine will be metering and low forward power relay/reverse power relay may have to be blocked and recommissioned after ie test. The valves should not he kept closed for a period of more than, say 10 sees.

j) Vibrations in all the three directions in all the bearings of turbine generator and also in the pedestal and foundation indicating exactly the position where the pick Ups have been placed while taking these readings at 3000 rpm.

k) Cooling curve of HP & IP cylinders, i.e. metal temperature against time indicating the initial condition of the steam air the time of trip.

l) The time for machine to come to rest from 3000 rpm, both with and without breaking the vacuum.

m) Time taken for operation of ESV, IV & control valve to close on full load throw off and the maximum speed obtained alongwith a curve of time against speed till the speed is stabilised.

n) Time required for operation of forced closing non-return valve (with the help of XY recorder).

o) Axial thrust pressure on working and non-working pads with machine on turning gear, at 3000 rpm, and at various loads.

p) Axial position indicator initial setting, readings at various loads.

q) Differential expansion at 3000 rpm. 40% load, 60% load, 80% load and 100% load.,

r) Steam parameters and flow at inlet to emergency stop valve at 3000 rpm., 40% load, 60% load, 80% load and at 100% load and corresponding vacuum.

s) Extraction pressure and temperature (indicating clearly where these have been. measured near the turbine or near the heaters).

t) Conductivity of condensate and quantity of make-up water per day.

u) Quantity of make-up oil required every month in the main oil tank.

v) Rate of hydrogen consumption after ensuring that the bottles used are 100% full.

w) Results of oil sample from generator transformer for the chemical analysis and dielectric strength.

x) AVR performance on load throw off.

y) Reactive load sharing with other machines.

z) The s!ip ring brush wear out over a course of time.

za) Voltage across (he neutral earthing transformer secondary at various loads and no load.

zb) Leakage current in the relay for inter-turn fault of stator windings.

zc) Date of commencement and date of completion of each and every comissioning activity in the chronological order with short details of any problems encountered.

zd) Details of commissioning of auto control loops.

ze) Detailed piping scheme layout covering turbine and auxiliaries which, should also include the systems under consultant's/customer scope.

*) Complete interlocks and protections as available for turbine and generator. All the setting and results of testing/checking the same.

Part – III Generator & Auxiliaries
A. Generator

1. PRELIMINARY CHECKS OF RESISTANCE

1.1 Insulation Resistances The insulation resistances of various electrical equipments including the generator and excitation system should be measured periodically commencing from the time they are received at site, till they are finally energised.

1.2 Records of insulation resistance of following should be maintained:

a) Stator winding of generator

i) Each phase to ground (other phase's shorted together and floating)
ii) Each phase to other two phases shorted together and floating.
iii) All the three phases together to ground.

b) Rotor winding

Slip rings shorted together to rotor shaft (rotor shaft grounded).
15 Sec. and 60 Sec. values should be taken with 500 V megger.

c) Generator bearing pedestal on exciter end to ground taken with 1 kV megger.

d) Rotor slip rings brush gear to ground with 500 V megger.

e) Generator bearing housing to oil pipes with 1 kV megger.

f) Generator resistance temperature detectors to stator with 100 V - 250 V megger.

g) Shaft seal on exciter side to ground with 1 kV megger.

h) Stator water "headers to ground with 500 V megger.

i) Generator bearing assembly to foundation plate on exciter end with 500 V megger.

j) Seal body to stator (Exciter end) with 1 kV megger.

k) Generator end shield oil catcher at exciter end to stator with 1 kV megger.

l) Generator seal body to connected piping with 1 kV megger.

m) Generator fan shield to end shield (exciter side) with 500 V megger.

1.1.2 For H.P. excitation system the insulation resistance of following should also be measured and records maintained.

a) H.F. exciter bearing on generator side to ground with 500 V megger.

b) H.F. exciter bearing on pilot exciter side to ground with 500 V megger.

c) H.F. exciter resistance temperature detector to ground with 100-250 megger.

d) H.F. exciter AC winding, 3 phases shorted together to earth with 500 V megger.

1.1.3 For static excitation system the insulation resistance of following should also be measured and records maintained.

a) Excitation transformer rectified power stage R S T to ground with 2.5 kV megger.

b) Rectifier power stage field breaker, plus and minus poles to ground with 500 V megger.

c) Field breaker, rotor brushes, plus and minus poles with 500 V megger.

1.2 Ohmic Resistances Ohmic resistance measurement of the following should be carried out at the first opportunity and recorded.

1.2.1 Generator Stator Winding

a) Measure resistance between terminals
C1-1C1, C4-2C1 & C4-1C1, 2C1 shorted
C5-1C2, C5-2C2 & C5-1C2, 2C2 shorted
C6-1C3, C6-2C3 & C6-1C3, 2C3 shorted

b) Generator rotor winding -
   i) Measure resistance between slip rings
   ii) Measure impedance of rotor winding with 100 V, 220 V and 388 V, 50 C/S supply with Ammeter volt meter methods

c) Generator R. T. Ds.

1.2.2 Also carry out the following ohmic resistance measurements of H.F. excitation system.

a) H.F. exciter A.C. winding

b) Pilot exciter stator winding

c) H.F. exciter field windings 1 EXF, 2 EXF, 3 EXF and 4 EXF.

d) H.F. exciter RTDs.

B. Seal Oil System

1. EQUIPMENT INSPECTION

1.2 Check the specifications of the seal oil system equipment comprising of following items and ascertain proper erection.

2. CONTROL PANELS

a) Seal oil starting panel

b) Seal oil signaling panel

2.1 Ensure that the panels are grouted firmly and anti vibration/shock absorbers mountings are provided.

2.2 Check and ensure cleanliness of the panels and all panel mounted equipments. Also ensure that the panels are adequately covered to avoid ingress of dirt and dust.

2.3 Ensure that the mounted equipments e.g. relays contactor", eu-are free from mechanical damage.

2.4 Ensure that all the terminals of the various terminals blocks are in good condition i.e. free from rust, mechanical damage and the fixing is sturdy and rigid.

3 AC SEAL OIL PUMP MOTOR SET

3.1 Ensure the following

3.1.1 Tightness of foundation bolts.

3.1.2 Freeness of rotation.

3.1.3 Earthing to the motor (at least at two places).

3.1.4 Greasing of the bearing.

4. DC SEAL OIL PUMP MOTOR SET

4.1 Ensure the items from 3.1.1 to 3.1.4 in para 3.

5. OIL INJECTOR

5.1 Check that the orifice is of proper size.

5.2 Check that the pipes have been properly connected.
Series resistance box for DC seal oil pump motor. Ensure proper value of resistance.

6. INDUCTION LIQUID INDICATOR

6.1 Ensure that ILI is mounted vertically, the plunger with the ball should be free to move and the coils should be healthy.

7. SEAL OIL COOLERS

7.1 Ensure that the hydraulic test at 12 kg/cm for 15 minutes has been completed.

7.2 Ensure that the oil and water pipings are connected properly at the inlet and outlet of the coolers. Also ensure that the coolers are connected in parallel

with a common bypass on the oil side.

7.3 Ensure that vent/drain cocks/valves are provided both on oil as well as water side.

7.4 Ensure that calibrated mercury thermometers are mounted vertically for measurement of oil and water temperatures at inlet and outlet.

8. SEAL OIL FILTERS

8.1 Ensure that the filters are mounted in parallel.

8.2 Ensure that the filter elements are free from mechanical damage.

9. DAMPER TANK

9.1 Open the damper tank end covers and check the cleanliness of the tank.

9.2 Ensure that the elevation of the tank and ILIs mounted on the riser pipe above the tank are as per the scheme.

10 DIFFERENTIAL PRESSURE REGULATOR

10.1 Ensure that the inlet/outlet connections, oil and gas impulse connections are as per scheme and that DPR height -corresponds with the centre line of the TG.

10.2 Strip open the DPR and ensure the cleanliness of the piston, cylinders, sleeves and dead weight discs. The ports should be clean and unblocked.

10.3 Measure the clearance between the piston and sleeves at the sealing zones. The radial clearance should be less than 0.03 mm.

10.4 Ensure that the ends of the grooved portion of the piston should be sharp and surface of the piston and sleeves should be smooth and shining.

11. PRESSURE OIL REGULATOR

11.1 Ensure that the oil inlet/outlet connections, the feed-back impulse connection and the drain connections are as per Fig. No.III-1.

11.2 Strip open the POR and ensure the cleanliness of the piston, cylinders, sleeves and dead weight discs. The surface finish should be smooth and shining. The ends of the grooved portion of the piston should be sharp. The ports of the sleeve and cylinder should be clean and unblocked.

11.3 Measure the clearance between the piston and sleeves at sealing zones. The radial clearance should be less than 0.03 mm at the top sleeve zone and it should be within 0.05 mm at the middle and bottom zones.

12. EXHAUST FAN AND MOTOR ON THE DRAIN HEADER

12.1 Check -the mounting platform of the exhaust fan and motor for rigidity.

12.2 Overhaul the fan and motor, if they were stored for more than one year. Check for mechanical damage.

12.3 Check and record the IR value of motor.

13. EXHAUST FAN AND MOTOR ON MAIN OIL TANK

Repeat the checks from 12.1 to 12.3 in para 12.
Seal oil system piping and valves:

13.1 Check that the piping erection has been completed as per scheme, all the

pipes and equipments are properly supported, flange joints are tightened perfectly and proper gaskets of good quality and correct sizes are provided. Ensure that the gaskets are not protruding in and obstructing the oil flow. Ensure that all drain pipes have a downward slope.

13.2 Check that the impulse lines are provided with root valves as well as equipment isolation valves at the ends and ihey are supported properly.

13.3 Ensure that pipes and impulse lines have been cleaned by blowing compressed air before final assembly.

13.4 Ensure that non return valves are mounted in Horizontal mode and that the direction of NRVs and other valves marches with that of the system.

13.5 Ensure that all valves are free to operate and have proper access for operation. Also check that all valves are provided with proper tags.

13.6 Ensure that valves have been mounted after testing for leakages at rated pressure and that their glands are properly packed.

14. COMMISSIONING OF SEAL OIL STARTING PANEL

14.1 With power cables, both for AC seal oil pump motor and DC seal oil pump motor isolated from the starting panel the operation of all the logics of the starting scheme should be checked as described below:

14.2 Check all the relays & contactors for pick up &; dropout voltages & record these values. While doing this also measure the coil resistance, insulation resistance and check the proper configuration of the auxiliary contacts.

14.3 Checks with DC control supply of AC motor:

a) Ensure that control leads 927 and 940 are not shorted and neither of the two are earthed.

b) Measure resistance between 927 & 940 with 8START' push button of AC motor pressed. It should be about 6 K.Ohm. Also measure resistance between 927 & 940 with 'STOP' push button pressed. It should also be about 6 K.Ohm.

c) Check the supply voltage control fuse and switch 'ON' the isolator. Check that relay 1 AUXR. is energised.

15. COMMISSIONING OF SEAL OIL SIGNALLING PANEL

15.1 Following equipment will be required for commissioning of seal oil signalling panel:

a) Multimeter
b) 220 volts. DC supply, preferably a compact test kit.
c) Shorting leads
d) Screw driver set with line' tester
e) HRC fuses
f) 500 V. megger.

15.2 Check all the relays for pick up and dropout voltage and record these values. While doing this also measure the coil resistance, insulation resistance and check the proper configuration of the auxiliary contacts.

15.3 Pre-supply checks

a) Check for no shorting between positive and negative terminals of 220 V DC supply. Also check that none of these terminals is earthed.

b) Check the internal & external cabling of the panel thoroughly.

15.4 Checks with 220 V. DC

15.4.1 Check the supply voltage and fuse ratings and switch 'ON' the supply to the panel.

15.4.2 As soon as the supply is switched 'ON' check that the following annunciations appear:

a) Pressure of seal oil 'low'

b) Pressure of thrust oil 'low'

c) Differential pressure between oil and hydrogen 'low'

d) Oil level in damper tank 'low'

e) Oil level in damper tank 'temporary'

f) Oil level in hydraulic seal 'low'

g) Pressure of cooling water to seal oil cooler 'low'

h) Power/control supply to AC seal oil pump failed.

i) DC seal oil pump supply failed

j) AC/DC seal oil motor control circuit faulty

k) Hydrogen pressure in generator casing 'low'

l) AC & DC pump auto impulse 'ON'

15.4.3 Press the 'Accept' push button and check that the flickering stops and the hooter sound is cut 'off.

15.4.4 Now by opening the initiation contact of each of the above annunciations check that the annunciation can be reset by pressing the 'Reset' push button.

15.4.5 Press the 'test' push button and check the appearance of all other remaining annunciations.

15.4.6 By shorting each of the fault contacts check the appearance of annunciations with flickering of lamp & sound of hooter. With contacts shorted in each case press 'Accept' push button & check cancellation of hooter sound & flickering. Now check in each case that as long as the fault contacts are shorted indication cannot be reset by pressing the 'Reset' push button.

16. CHECKS WITH 200 V DC AND AC SUPPLIES

16.1 Check the AC supply voltage and fuse ratings. Remove fuses F6 & F5 for instruments as ILI respectively and energise the AC circuit while DC is 'ON'.

16.2 Switch 'off DC supply and check that DC failure relay drops and DC failure annunciation appears .with ringing of bell. Accept the annunciation & check that the ringing of bell stops while indicating lamp keeps glowing even after pressing the 'reset' push button. Again switch 'ON' the DC supply & reset the indication.

16.3 Measure the secondary voltages of transformers 3 T and 2 T for instruments and ILI respectively. These should be 127 V for 3 T and 36 V for 2 T.

16.4 Check the current relays of ILI as described below.

Keep the Rheostat in max. resistance position. Set relay setting at minimum

and slowly reduce the Rheostat resistance and note the current at which relay picks up. Slowly increase the resistance and note the value of current at which the relay drops out. Repeat the same for other relay setting also.

16.5 Check the pick up and drop out of all the current relays by actual movement of the ILI position. This can be done by filling oil in the ILI.

17. TRIAL RUN OF SEAL OIL PUMP MOTORS

17.1 AC seal oil pump motor

17.1.1 Having ensured the healthiness and logics of the control circuits, normalise the control and power cable connections. Decouple the motor from the pump and check for the free rotation of the motor rotor.

17.1.2 Ensure that the IR value of the motor and power cables are good. Compare the present IR value of the motor with that obtained during erection and in the test certificate. The value should not have deteriorated very much. If so, examine the cause for deterioration, and eliminate it. Also check the ohmic resistance of winding and compare it with test protocol. The difference between the ohmic resistance values of all phases individually should not be more than 2%.

17.1.3 Put selector switch to local position at the starting panel. Ensure balanced 415 volts supply at the motor control centre (MCC) and give a pump and stop the motor. Check for the correct direction of rotation and any abnormal noise, if the direction of rotation is not correct, interchange any two of the three phases terminations at the motor terminal box.

17.1.4 If the motor has started smoothly, again start it from local and record the starting current and no load running current in all the phases. Check for the noise level and temperature rise of the motor particularly at the bearings.

Measure and record the axial, vertical and horizontal vibrations of the motor at free as well as coupling end.

17.1.5 Ensuring that the noise level and the vibrations are within the limits, carryout the trial run of the motor. Note the phase to phase voltages, no load running current, vibrations and temperatures at cold state running of the motor, i.e. soon after starting.

18. DC SEAI. OIL PUMP MOTOR

18.1 Carry out the checks similar to checks described in (A) & (B) in 1.27 above.

18.2 Put selector switch to 'Local' position at the starting panel. Ensure healthiness of station battery and check the polarity and voltage of supply at the input terminals of starter panel. Give a starting impulse from control room and stop the motor after 30 seconds. Ensure that the direction of rotation's is correct and there is no rubbing noise. If direction of rotation is reverse, correct it by changing the polarity of either the armature or the field connections at the motor terminals.

18.3 If the motor starting is smooth, again start it and record the starting current, no load running current, field current, voltage before and after the resistor, motor, speed, vibrations and surface temperature of the motor near the bearings. Also observe the noise level. Depending upon the motor speed and voltage at the armature terminals, the series resistor taps should be selected. Stop the motor and change the tap if required and again start the motor. Care should be taken not to exceed the number of permissible start per hour as recommended by the motor manufacturer.

18.4 Proceed with the trial run of the motor if noise level and vibrations are within limits. Record the surface temperature at cold state and subsequently at one hour interval. Observe the thermal stability after 8 hour trial run or later.

Stop the motor after achieving the thermal stability. Release the motor for coupling with the pump.

19. TRIAL RUN OF EXHAUST FANS

19.1 The capacity of the exhaust fan motors is very small. Hence, the trial run of the fan-motor set can be carried out together without dismounting the fan from the shaft. Follow the same guidelines as described in case of AC seal oil pump motor, monitor and record the parameters such as voltage, current, speed, vibration, noise level and temperature rise.

20. OIL FLUSHING

20.1 The whole of the system should be flushed with oil at about 60-65°C temperature to clean the system of any dirt/dust. Flushing will be carried out in 5 stages as described below. For valve positions during flushing prefer to the drawing of seal oil system enclosed with this manual.

20.2. Oil Filing of seal oil system

20.2.1 Pre-requisites

a) Ensure that AC flushing oil pump can be used for initial filling up of the seal oil system or starting oil pump is commissioned. Alternatively AC seal oil pump is commissioned as described at para 1.33.

b) Fill up the system with oil by running the AC flushing oil pump, in the following sequence. At each step, check for any oil spillage at the concerned flange joints valve glands and outlet of drain/vent valves.

Utmost care should be taken that at no stage AC flushing oil pump be over loaded.

20.3 First Stage Flushing

20.3.1 With system filled as above (coolers, FOR, DPR and DT bypassed condition) continue to flush the system by running AC flushing oil pump. Change-over to filter No. 2 by opening the valves SO-16 & SO-18 after two hours. Isolate filter ;No. 1 by closing the valves SO-15 & SO-17. Keeping a tray or bucket underneath the filter No. 1, open the top flange, remove the internals of the filter. Depending upon the quantum and type of dirt collected the frequency of the changeover of filters has to be decided from time to time. Initially, the changeover may be required once in 4 to 8 hours. After each changeover clean the dirty filter and ensure its availability as standby filter. One or other filter has to be in service during entire operation of the system.

20.3.2 Continue the first stage flushing for about two days. Ensure that AC flushing oil pump is not overloaded because of the overburden caused by the seal oil system.

21. TRIAL RUN OF AC SEAL OIL PUMP

21.1 Keep all the valves of the system closed except the balance leak off valve. Gradually open the suction valves SO-5, of the pump and check for oil leakage at the flange joints, seals and pressure gauge isolating valve. Vent end flush the impulse line and valve in the suction gauge. Similarly vent and flush the impulse line of the discharge gauge too. Keep the discharge gauge isolated. Deaerate the pump.

21.2 Monitor and record the 3 ph. voltages at the MCC. Ensuring availability of power supply and control supply, give a starting impulse and stop it immediately. Check for correct direction of rotation and observe for rubbing noise, if any. Monitor the starting current.

21.3 If the direction of rotation and noise level is okay, restart. Monitor and record the starting current and running current. Vent & flush the discharge gauge impulse line once again, and valve in the gauge. Record the shut off pressure. Record the phase to phase voltages and line currents (shut off state). By physical inspection check the vibration and temperature rise. If normal, open the system bypass valve SO-H fully. There should not be any change in the discharge pressure and line current which ensures perfect seating of the discharge valve SO-7.

21.4 Monitoring the line current, gradually open the discharge valve by quarter turn. Record the line currents and discharge pressure. As the system resistance is very low, the pump would draw the full load cur-^nt for a fraction of turn opening of the discharge valve. So carefully open the valve by another quarter turn. Record the discharge pressure and line current. If the line current is less than the rated current (27.0 Amperes), open the valve further till that current is drawn. Otherwise close the valve till the current has come down to rated value. At rated current, record the discharge pressure, suction pressure, phase to phase voltages, discharge valve position, vibrations and surface temperature of the seals, bearings, body and frame of the pump-motor. Monitor the surface temperatures at every hour and carry out the trial run of the pump for about eight hours subject to normal vibrations, temperature rise and noise level.

22. SECOND STAGE FLUSHING

22.1 In this stage cooler No. 1, DPR, POR and DT would be included in the flushing circuit. This stage of flushing will be started during trial run of AC seal oil pump & continued.

22.2 Close the bypass valves. Open the inlet and outlet valves of FOR, DPR and DT. Vent, if required. Flush the impulse lines of pressure gauge before and after filter. Valve in PG-8 and PG-9. The filters should be changed over

when the differential pressure between them is more than 0.5 kg/cm .

22.3 Continue the flushing for a day. Then close the outlet valve, SO-64 of DT to have effective flow in the pipe lines connecting hydraulic seal tank and damper tank. Carry out the flushing in this stage for half a day.

23. THIRD STAGE FLUSHING

23.1 If high pressure starting oil pump has been commissioned further flushing of seal oil system should be carried out with oil injector in place of AC seal oil pump or AC flushing oil pump.

Flushing in this stage will be started with coolers, FOR, DPR and DT bypassed. During flushing these equipments will also be taken in and flushed.

23.2 Carryout the flushing for about two days. Changeover the filters as guided by the differential pressure across the-, filters, when the differential pressure is raised to 0.5 kg/cm , change the filter. With time, the' changeover frequency should come down indicating the progress of cleaning process of the system. Ensure that the oil purifier is in continuous service.

24. FOURTH STAGE FLUSHING

24.1 In this stage, the internals of POR and DPR should be assembled and flushed. Also all the instruments will be taken into service after flushing their impulse lines. Carry out the flushing preferably with oil injector as the temperature of oil can then be easily raised to 60 to 65°C.

25. FIFTH STAGE FLUSHING

25.1 This is the last stage flushing and hence it should be terminated only when

the content of sediments is reduced to 0.05% by weight. Carryout the flushing with AC SOP or oil injector or with both. While doing the flushing with SOP ensure that the motor is not overloaded. When AC SOP and oil injector are pressed parallely into service, ensure that the pressure at DPR inlet is not exceeding 10.00 kg/cm .Valve in all instruments in this stage of flushing.

26. COMMISSIONING OF THE SYSTEM

26.1 Seal Oil Tank;- Ensure that the seal tank is drained fully and all valves are closed but for the locked open valves (suction and balance leak off valves of AC SOP). Keep both the filters clean and valve in any one of the filters. Valve in PG-4, PG-5, PG-8, PG-^, PG-10 and PG-11. Start AC flushing oil pump and open its discharge valve monitoring the discharge pressure. Charge any one of the coolers. Keep lubricating oil system under shut down.

26.2 Charging of _Pressure--011 Regulator Open the inlet valve of POR. Keep the impulse line valve, SO-41 open. Gradually and continuously open the outlet valve, SO-40 of POR observing the POR outlet pressure.- at PG-11. The pressure would tend to raise above 1.8 kg/cm - Open the valve SO-40 fully. Watch the oil drainage at the generator outboard bearing lub. oil drain window and at the generator in board end. Ensure that there is no oil drain through the oil check pipes (H., side drain pipes to seal tank) and no oil collection indicator. Flush the impulse lines of ECPG-3 and ECPG-4 and valve in them. The pressure of pressure oil should be equal at both ends and should be around 1.8 kg/cm . The number of dead weight discs inside the POR may be altered, if required by valving out POR.

26.3 Charging of Differential Pressure Regulator Open the oil impulse line valve. Open the air side impulse valve. Open the hydraulic seal tank drain valve and damper tank bypass valve. Open the inlet valve of DPR. Gradually and

cautiously open the outlet valve, observing the DPR outlet pressure at PG-10. The outlet pressure would go above 0.9 kg/cm" initially while opening the valve. Open the valve such that the pressure never goes above 2.0 kg/cm and keep on slowly opening the, valve. The DPR outlet pressure would settle around 0.9 kg/cm . Keep the outlet valve fully open. Observe the hydrogen side drain through oil check pipes at either side. It would be bare minimum. Check the ILI-5 and ensure that no oil is collected at the liquid collection indicator. As oil drains to- the seal tank, its level would raise. Maintain normal level in the seal tank by draining through centrifuge. Flush the impulse lines of ECPG-5 and ECPG-6 and valve in them. The seal oil pressure at both the seals should be equal and around 0.9 kg/cm .

26.4 Charging of Damper Tank Keep the vent valve crack open with a man posted near the valve. Instruct him to close the valve after proper venting or if oil escapes through it. Keep the valve fully open. Open the inlet valve of DT gradually. Check the oil raise visual window, ILI-1 and 1LI-2. The very low level and low level in DT annunciations should disappear. Keep a man posted near seal tank, observing the visual window just above. There should be no oil through it. Gradually and simultaneously open the outlet valve and close the bypass valve. Check for no oil collection at the visual window and open valve. Observe for equal seal oil pressure at PG-10, ECPG-5 and ECPG-6.

26.4.1 Run the system for couple of hours and ensure normal operation. Thus the system is commissioned. Open the discharge valve of AC SOP fully and measure the running current. Record all the pressure gauge readings.

26.5 Trial Run of DC Seal Oil Pump Keep the system under shut down. Open the balance leak off valve and suction valve of DCSOP, valve in PG-6 and PG-7. Check for no oil leak through the glands of the pump. Take all precautions, as described in para 21. Start the pump and stop it immediately, Check for any abnormal noise. Start again and monitor the

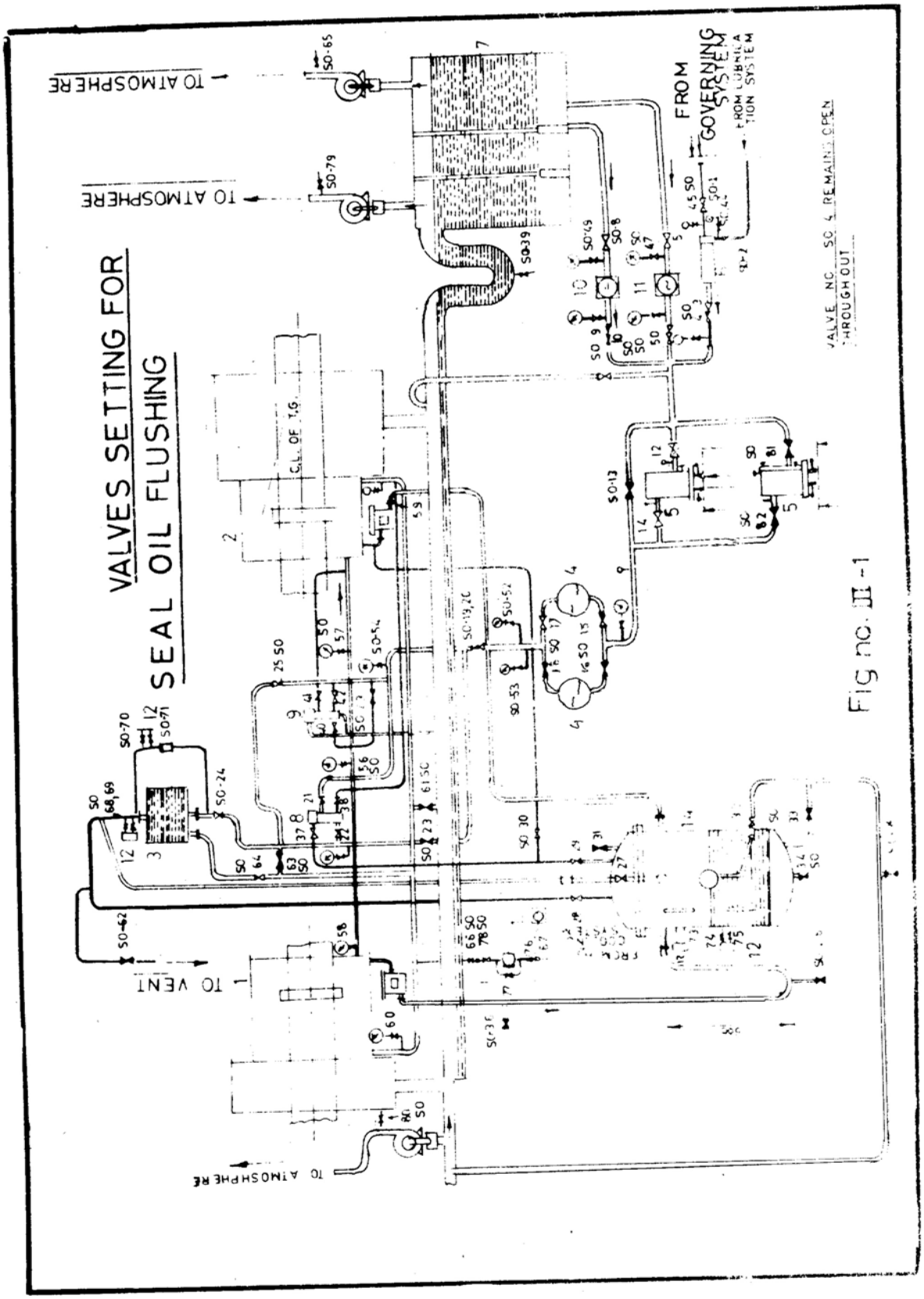
voltages before and after the resistor, starting and running current, field current and discharge pressure at shut off condition. Keep the system bypass valve SO-11 fully open. Ensure that the inlet valves and bypass valve of the cooler and SO-4 are fully closed. Open the discharge valve gradually monitoring the discharge pressure and running current. Do not overload the motor. Measure and record the speed of the pump.

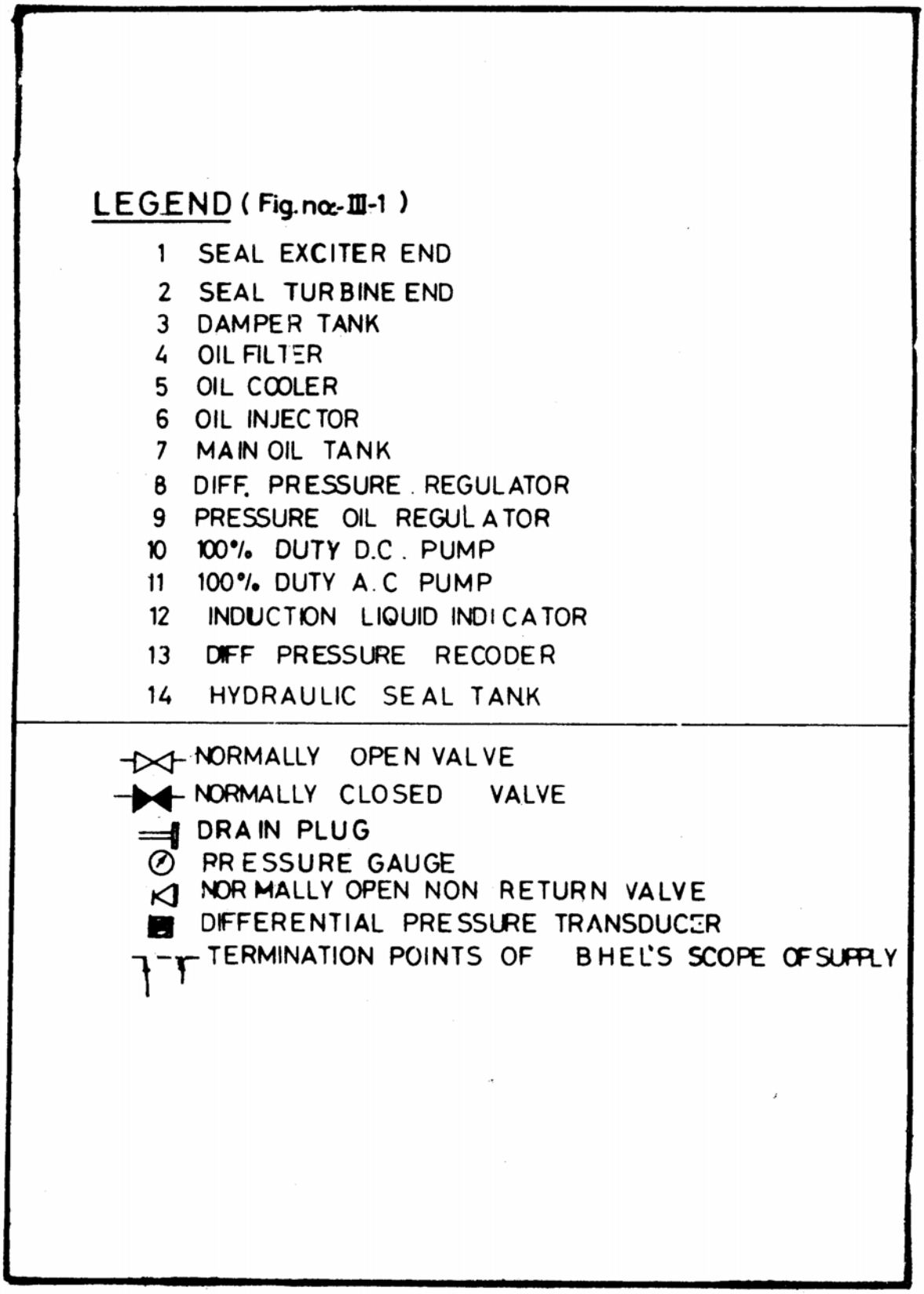
26.5.1 If need be adjust the series resistance of shunt field of the motor to achieve the rated speed. Measure the resistance and the current through the additional resistance provided.

26.5.2 Close the /pass valve provided and charge the system i.e. cooler, filler, POR, DPR and DT in sequence. Measure the running current, discharge pressure and speed. Also record the readings of all pressure gauges.

26.6 Commissioning of Differential Pressure transducer and recorder Ensure proper installation DPT & DPR after calibration. Check for proper primary and secondary connections and power supply to differential pressure recorder. Open the root valve of gas line and DPT isolating valve on gas side. Ensure that the DPT equalizing valve is closed. Switch on the Differential pressure recorder. The readings should be zero. Disconnect the coupling just prior to DPT isolating valve on oil side.

26.6.1 Open the root valve gradually and flush the oil impulse line. After thorough flushing, close the valve and connect back the coupling. After connecting, open root valve. Gradually open SO-78. The-differential pressure recorder should read around 0.9 kg/cm and differential pressure low annunciation should clear. Keep the system and differential pressure recorder in service for couple of hours and observe the performance.


VALVES SETTING FOR
SEAL OIL FLUSHING
TO ATMOSPHERE
TO ATMOSPHERE
TO ATMOSPHERE
TO VENT
FROM GOVERNING SYSTEM
VALVE NO. SO 4 REMAINS OPEN THROUGHOUT
Fig no. II-1


LEGEND (Fig.no.-III-1)
1 SEAL EXCITER END
2 SEAL TURBINE END
3 DAMPER TANK
4 OIL FILTER
5 OIL COOLER
6 OIL INJECTOR
7 MAIN OIL TANK
8 DIFF. PRESSURE REGULATOR
9 PRESSURE OIL REGULATOR
10 100% DUTY D.C. PUMP
11 100% DUTY A.C PUMP
12 INDUCTION LIQUID INDICATOR
13 DIFF PRESSURE RECODER
14 HYDRAULIC SEAL TANK
NORMALLY OPEN VALVE
NORMALLY CLOSED VALVE
DRAIN PLUG
PRESSURE GAUGE
NORMALLY OPEN NON RETURN VALVE
DIFFERENTIAL PRESSURE TRANSDUCER
TERMINATION POINTS OF BHEL'S SCOPE OF SUPPLY

C. Hydrogen Gas System

1 EQUIPMENT INSPECTION

1.1 Check the specifications of the hydrogen gas equipment comprising of the following items and ascertain the proper erection.

2. HYDROGEN MANIFOLD

2.1 Check that proper stands have been provided for holding the cylinders. Ensure that suitable pressure regulators are provided for hydrogen cylinders. Also ensure that the hydrogen manifold has been provided with a relief valve set to blow off at pressures exceeding 5.5 kg/cm .

3. CARBON DIOXIDE MANIFOLD

3.1 Check that proper stands have been provided for holding the cylinders. Ensure that the CO- manifold has been provided with a pressure relief valve set to blow off at pressures exceeding 5.5 kg/cm^2.

4. HYDROGEN GAS DRIER

4.1 Check that proper size of silica gel has been used in the drier and that the gas can easily pass through it. Ensure that the silica gel in drier is not in the form of powder. Check that the perforations and the wire mesh are of proper grade. Also ensure that the silica gel used is in perfect dried up condition.

5. HYDROGEN CONTROL PANEL

5.1 Ensure that the panel is grouted firmly and anti-vibration pads/shock

absorbers are provided.

Check and ensure cleanliness of the panel and all panel mounted equipments. Also ensure that the panel has been adequately covered to avoid ingress of dirt and dust. Also ensure that all the panel mounted equipments are free from mechanical damage.

Ensure that all the terminal strips are in good condition i.e. free from rust, mechanical damage and that the fixing is sturdy and rigid.

6. HYDROGEN COOLING WATER PUMPS AND MOTORS

6.1 Ensure the following;

6.1.1 Tightness of foundation bolts

6.1.2 Smoothness of rotation

6.1.3 Earthing of the motor (at least at two places)

6.1.4 Greasing of the bearings

7. HYDROGEN GAS COOLERS

7.1 Ensure that the hydrogen gas coolers have been hydraulically tested for leakages before insertion and that there was no leakage found.

7.2 Ensure that adequate arrangements have been done for venting the coolers.

8. GAS SYSTEM PIPINGS AND VALVES

8.1 Check that the piping erection has been completed as per scheme, all the pipes and equipments are properly supported, flange joints are tightened

perfectly and proper gaskets of good quality and correct sizes are provided.

8.2 Ensure that pipes and impulse lines have been cleaned by blowing compressed air before final assembly.

8.3 Ensure that all the valves are free to operate and have proper access for operation. Also ensure that ail the valves are provided with proper tags.

8.4 Ensure that valves have been mounted after testing for leakages at rated pressure and that their glands are properly packed.

8.5 Similarly check the piping & valves of hydrogen cooling water system also.

9. INSTRUMENT

9.1 All the pressure gauges should be checked for proper range, tap size, calibration, accuracy and repeatability.

9.2 Ensure that pressure indicators on gas control panel have been calibrated with their respective pressure transducers for accuracy and repeatability.

9.3 Ensure that the gas purity indicator has been calibrated with the gas analyser and has been checked for accuracy and repeat ability.

10. GAS TIGHTNESS TEST OF GENERATOR WITH GAS AND SEAL OIL SYSTEM

10.1 This test is carried out to ensure that there was no damage to weld seams during transportation and erection, and that the generator assembly along with the system including flanges & valves are gas tight.

10.2 The test envisages filling the stator of the whole machine along with the

pipings of systems with air at a pressure *of* 3.5 atg/4.0 atg. (for 200/210 MW machines) and checking the leakage at the possible places by soap solution.

Generator along with the system piping is said to be gas tight if the leakage of air in 24 hours referred to atmospheric pressure is not more than 5% of total internal volume. The quantity of air leakage is determined by finding out the drop in pressure taking into account the temperature corrections.

10.3 The testing of system for gas tightness will be done in ix stages namely:

10.3.1 Hydrogen manifold and associated elements and pipings.

10.3.2 Carbon dioxide manifold and associated elements and pipings.

10.3.3 Gas analyser and associated elements and pipings.

10.3.4 Damper tank, hydraulic seal associated elements and pipings.

10.3.5 Generator and gas system complete piping including para

11. REQUIREMENTS

11.1 Dry compressed air which should be free from dust moisture, oil and other foreign material.

11.2 The seal oil system should be commissioned and established for continuous operation.

12. TESTING OF CO_2 MANIFOLD ASSOCIATED ELEMENTS AND PIPING

12. 1 Blank valve C-ll, at the flange connection.

12.2 Close valve nos. C-il, C-2, C-3, C-4, C-5, C-6, C-7., C-8 and C-10.

12.3 Open valve Cl.

12.4 Fill dry compressed air in the circuit by opening C-10 at a pressure of 5 kg/cm and then close it.

12.5 Check the various joints for leakages by soap solution. Check for leakage at blank of valve C-11. Check for the passing of relief valve C-9.

12.6 Check for the passing of valves C-10, C-8, C-7, C-6, C-5, C-4, C-3 and C-2. Also check valve glands for leakages.

12.7 Check for leakage at weld seams of CO- manifold and piping by applying soap solution.

13 TESTING OF GAS ANALYSER, ASSOCIATED ELEMENTS AND PIPING

13.1 Blank valve nos. H-20 and H-19 at its connections.

13.2 Install a temporary pipe connection between valve nos. H-22 and H-24.

13.3 Close valve nos. H-20, H-19, H-28 and H-ll. Open valves H-12, H-27, H-24 and H-22.

13.4 Fill dry compressed air by opening valve H-ll at a pressure of 5 kg/cm and then close it.

13.5 Check for leakage at joints by applying soap solution.

13.6 Check for passing of the valves H-ll and H-23.

13.7 Check for leakage of blanks at valves nos. H-19 and H-20.

13.8 Check for passing of valve H-23 at the time of gas tightness test of stator together with system.

14. FINAL GAS TIGHTNESS TEST

14.1 Requirements

14.1.1 Seal oil system in operation with all interlocks and annunciations in service.

14.1.2 Dry compressed air. No water should *be* present in *Hy* coolers and stator winding.

14.1.3 U Tube mercury mano meter to read up to 4 atg/3.5 atg (210/200 MW).

14.1.4 Portable barometric pressure indicator (barometer).

14.1.5 Mercury thermometers in position in Generator and shields and in the middle of the casing for casing air temperature measurement.

14.1.6 All the pressure gauges/pressure indicating instruments of gas system are calibrated and mounted in position.

14.1.7 Soap solution and personnel for checking/noting down the leakages and for attending, if any.

14.1.8 Induction liquid indicator checking completion for proper annunciation on signalling panel.

14.1.9 Generator should be put on barring gear.

14.2 Filling the Generator with air;

14.2.1 Set the position of the system valves corresponding to 'Filling up of the system with air' (Except H-15 to be closed to see that air is filled" up through Gas drier).

14.2.2 Admit dry compressed air through valve A-l upto a pressure of 3..5 atg/4.0 atg. (for 200/210 MW and close the valve A-l and open H-15 valve.

14.2.3 Check by soap solution all the possible places of leakages and if any to be attended in position or by disassembling the same for which if required the system may have to be depressurized.

14.3. Method of calculation of gas, leakages from the generator.

14.3.1 Leakage of Gas may be calculated from the formula;

$$SO = \frac{925}{T}\left(\frac{P1}{273+{}_{t}t_1} - \frac{P2}{273+t_2}\right)\%$$

Where SO = Leakage of gas in 24 hrs. referred to atmospheric pressure (760 mm Hg) and temperature of 20°C as a percentage of gas volume of the Generator.

P_1 & P_2., = Absolute pressure of air in mm of Hg at beginning and end of the test respectively.

t_1. & t_2 = Temperature of air inside the generator at the beginning and end of test respectively in °C.

T = Duration of test in hours.

Absolute leakage of gas from the generator in M can be calculated from the formula.

$$Vo = \frac{SO \times V}{100}$$

Where V = Gas volume of. Generator which is 56 M with rotor and 60 M without rotor.

Although the generator is tested for gas tightness with air medium it is desirable to determine the expected leakage of hydrogen in actual working conditions. Leakage of hydrogen can be calculated by using the formula:

$$\frac{V \text{ (Hydrogen)}}{V \text{ (air)}} = \frac{\text{Density of air at 20°C temp.}}{\text{Density of } H_2 \text{ at 20°C'Temp."}}$$

$$= 3.2$$

$$V \text{ hydrogen)} = 3.2 \text{ (V.air)}$$

14.4 Generator and the system is said to be gas tight and ready for hydrogen filling when the leakage per day is not more than 5% by volume. (Take 60 M as the volume of the generator • system piping).

15. TRIAL RUN OF HYDROGEN COOLING WATER PUMP MOTORS

15.1 Trial Run of Motors

15.1.1 Ensure the healthiness and logics of the control circuits. Check the power supply available at the MCC outgoing terminals after removing the cables. Normalise the control and power cable connections. Decouple the motor from the pump and check for the three rotation of the motor rotor.

15.1.2 Check the IR valves and ohmic resistance of the motor. Also' check IR of power cables. The difference between the ohmic resistance values of all phases individually should not be more than 2% and compare these values with test protocol. Also compare the present IR values of the motor with that obtained during erection and that of test certificate. The value should not have deteriorated very much. If so, examine the cause of deterioration, eliminate it, and also dryout the windings if required.

15.1.3 Ensure that the motor is adequately protected as recommended / by the manufacture.

15.1.4 Bump and stop the motor. Check for the correct direction of rotation and any abnormal noise. If the direction of rotation is not correct, interchange any two of the three phase terminations at the motor terminal box.

15.1.5 If the motor has started smoothly again start it and record the starting current and no load running current in all the phases. Check for the noise level and temperature rise of the motor particularly at the bearings. Measure and record the axial, vertical and horizontal vibrations of the motor at free as well as coupling end.

15.1.6 Ensure that there is no abnormal noise and the vibrations are within the limits. Carryout the trial run of the motor. Note the phase to phase voltages, no load running current, vibrations and temperatures at cold state running of the motor, i.e. soon after starting.

At the end of eight hours run, measure and record the hot state running current, terminal voltages, vibrations and surface temperature. The surface temperature should have stabilized by this time. The rate of temperature rise (degree centigrade per hour) should tend to approach zero. Release the motor for coupling it with the pump.

16. TRIAL RUN OF THE PUMPS

16.1 Ensure that adequate quantity of water is available for running the pump, suction and discharge pressure gauges are calibrated and' installed properly and that the whole piping erection work is completed as per the s'/stem layout.

16.2 Ensure that the bearings are okay and filled with lubricant upto normal level and that trial run of the motor has been taken.

16.3 Arrange to measure the starting current and running current of the motor, voltage at motor terminals, vibrations and temperature rise.

16.4 Keep all the valves of the system closed except balance leak off valve. Gradually open the suction valve of the pump and check for water leakage at flange joints, seals and pressure gauge isolating valve. Vent and flush the impute line and value in the suction gauge. Similarly vent and flush the impulse line of the discharge gauge too. Keep the discharge gauge isolated. Deaerate the pump.

16.5 Monitor and record the 3 phase voltages at the MCC. Ensuring availability of power supply and control supply, give a starting impulse and stop it immediately. Check for correct and stop it immediately. Check for correct direction of rotation and observe for rubbing noise if any. Monitor the starting current.

17.0 CHARGING *AE* HYDROGEN COOLERS

17.1 With one of the two hydrogen cooling water pumps in service open the inlet valve of one cooler.

17.2 Open the vent of the cooler and close it when water starts coming through

it. Keep a watch on the induction liquid indicator for detection of presence of liquid in generator casing and ensure that no water comes in it.

17.3 Now open the discharge valve slowly and close the system bypass valve, while opening the discharge valve keep a watch on the current drawn by the motor. It should not be allowed to increase beyond its rated value.

17.4 In a similar way one by one charge the other three coolers also. Each time keep a watch on the induction liquid indicator and ensure that no water comes in it. Also while charging the coolers ensure that the motor is not overloaded.

18. CONCLUSIONS

18.1 Thus for the gas system including the cooling system has been prepared for the normal operation except for the actual filling up of the hydrogen gas in the system. The filling up of the casing with hydrogen will be required after the dry out of generator in "air has been done. So the operation of filling hydrogen will be detailed with drying out operation.

D. Stator Water System

1. EQUIPMENT INSPECTION

1.1 Check the specifications of the stator water system equipment comprising of the following items and ascertain the proper erection.

2. STATOR WATER COOLING PUMPS AND MOTORS

2.1 Ensure the following:

2.1.1 Tightness of foundation bolts

2.1.2 Smoothness of rotation

2.1.3 Earthing of the motor (at least at two places)

2.1.4 Greasing of the bearings

3. WATER COOLERS

3.1 Ensure that the hydraulic test has been completed.

3.2 Ensure that the primary and secondary DM water pipings are connected properly at the inlet and outlet of the coolers.

3.3 Ensure that vent/drain cocks/valves are provided on primary as well as secondary DM water side.

3.4 Ensure that calibrated mercury thermometers are mounted vertically for measurement of primary and secondary DM water temperatures at inlet and

outlet.

4. WATER FILTER

4.1 Ensure that the filters are mounted in parallel.

4.2 Open the filters and check that size of meshes used is as per specification.

4.3 Ensure that filter internals are not rusted and filter elements are free from mechanical damages.

5. MAGNETIC FILTER

5.1 Check that the magnetic filter is mounted vertically and properly fastened to corresponding piping flanges by means of bolts.

5.2 Open the magnetic filter and clean the magnetic plates thoroughly.

5.3 Check for proper gap between the plates. Check the magnetic characteristics of the magnetic plates.

6. EXPANSION TANK

6.1 Check that the stainless steel body expansion tank is provided with the. following fittings:

6.1.1 A gauge glass to indicate the level of water in the tank.

6.1.2 2 Nos. transducers for level signalling devices to give high and low level alarm signals.

6.1.3 A vacuum gauge to indicate vacuum inside the tank.

6.1.4 A float operated level regulator to regulate the make up water.

6.1.5 A drain vaive to facilitate draining of the complete tank in case of necessity.

6.2 Ensure that the tank and the fittings are free from mechanical damage.

6.3 Check that return line from the windings to inlet of the tank is provided with a perforated plate of specified perforations.

6.4 Ensure that the hydraulic test of expansion tank has been carried out at 1.5 kg/cm pressure for 15 minutes without any leakage.

7. WATER 3ET EJECTOR

7.1 Check the internals of the water jet ejector for any physical damage.

7.2 Ensure that the operating water is provided with filter.

8. STATOR WATER SYSTEM PIPING AND VALVES

8.1 Check that the piping erection has been completed as per scheme, all the pipes and equipments are properly supported, flange joints are tightened perfectly and proper gaskets, of good quality and correct sizes are provided. Ensure that the gaskets are not protruding in and obstructing the water flow.

8.2 Check that the impulse lines are provided with root valves as well as equipment isolation valves at the ends and that they are properly supported.

9. GAS TRAP

9.1 Ensure that the gas trap is firmly fixed on the foundations in the vertical direction.

9.2 Check the gas tightness of the gas trap.

10. INSTRUMENTS

10.1 All the pressure, gauges as well as electrical contact pressure gauges should be checked for proper range, tape size, calibration, accuracy and repeatability. Gauges should be mounted vertically. Also ensure that ECPG settings are as per specifications.

11. COMMISSIONING OF STATOR WATER STARTING PANEL

11.1 Check all the relays and contractors for pick up and drop out voltages and record these values. Also measure the coil resistance and check the proper configuration of the auxiliary contacts.

11.2 With power cables for both the motors isolated from the stator water starting panel the operation of ail the logics of the starting scheme should be checked.

Since the starting scheme varies from project to project a detailed check list for logics can not be generalised. It is however necessary that before switching 'ON' the motor from the starting panel the interlocks and protections as applicable in case of the project should be checked and ensured.

12. CHECKS WITH 220V DC AND AC SUPPLIES

12.1 Check the AC supply voltage and fuse ratings. Remove fuses for instruments and energise the AC circuit while DC is ‘ON'.

12.2 Switch 'OFF' DC supply and check that DC failure relay drops and> DC

failure annunciation appears with ringing of bell. Accept the annunciation and check that the ringing of bell stops while indicating lamp keeps glowing even after pressing the 'reset' push button. Again switch 'ON' the DC supply and reset the indication.

Measure the secondary voltage of transformer 2T. It should be 220V.

13. TRIAL RUN OF STATOR COOLING WATER PUMP MOTOR

13.1 Trial run of both the stator cooling water pump motors should be taken as described in the previous chapter para 15 for the hydrogen cooling water pump motor. After trial run release the motor for coupling with the pump.

14. FLUSHING OF STATOR COOLING WATER SYSTEM

14.1 Purpose The flushing of stator water cooling system is a must to check the following:

14.1.1 The completion of erection of all mechanical & electrical equipments in the generator stator water cooling system

14.1.2 To flush the whole system in stages for clearing.

14.1.3 To run the stator water pumps and check their performance.

14.1.4 To find out the defects in the system components if any and to rectify accordingly.

14.1.5 The different parameters such as pressure and flow are to be monitored.

15. FIRST STAGE FLUSHING (By pass all equipments except filters)

15.1 Keep all the valves in the system in the positions as instructed.

15.2 Open DM water supply valve gradually. The water flows through the bypass lines of the pumps and coolers and flushing outside through the temporary pipings.

15.3 When the flushed out water is clear, <-lose the DM water supply valves.

16. SECOND STAGE FLUSHING (Cooler B included)

16.1 Keep the system valves in positions.

16.2 Open DM water supply valve and flush the line and equipment until the flushed water becomes clear. Open drain of cooler and flush it till clear water comes out and close drain. Close DM water supply valve.

17. THIRD STAGE FLUSHING (Cooling A included)

17.1 Set the valves and proceed as per para 17.2. and proceed as per 16.2.

18. FOURTH STAGE FLUSHING (Magnetic filters included)

18.1 Set the valves and flush the system till clear water comes out of the flush line.

18.2 Flush the sensing lines of differential pressure transmitters as per standard practice taking care no water enters the instruments till the sensing lines are thoroughly flushed.

19. TRIAL RUN OF STATOR WATER PUMPS (5th stage flushing)

19.1 Set the valves. Remove the blanks at the expansion tank and blank of flushing line.

19.2 Fill up the expansion tank to full level and check the operation of float valve by draining the filling.

19.3 Check the free rotation of pump & motor. Apply proper lubricant.

19.4 Arrange communication between stator water expansion tank floor elevation and staler water panel with instructions to maintain water level in tank by filling the tank.

19.5 Start pump and check up the vibration, discharge pressure, bearing temperature, leakage, and any abnormal sound. Measure the current and record. If the level in the expansion tank falls, stop the pump. After satisfactory run of pump stop the pump.

20. COMMISSIONING OF THE SYSTEM (Final run)

20.1 Temporary flushing line is removed after the above flushing and return line is connected back to the stator water expansion tank. The bypass around the stator water conductor is removed and normalised. The flow orifice is introduced.

20.2 While starting the final stage of flushing the air locks if any in the conductors and headers must be released by opening valves Y-32 & Y-33 and only then the valve Y-13 opened.

20.3 Start stator water pump A and monitor and record all the parameters such as pressure, flow etc.

20.4 Check the system parameters with the stator water pumps B running.

20.5 Periodically clean the filters.

20.6 Take water samples and check its properties. If necessary, drain some water from the system by opening drain valve at the outlet of stator conductors and fill up fresh DM water in the expansion tank.

20.7 Check the logics and protections of the system by actually creating the abnormal running condition in the system.

E. Rolling And Dryout Of Generator

1. REQUIREMENTS FOR ROLLING

1.1 It is essential that the following works should be completed before clearing the TG set for mechanical rolling.

1.1.1 All the construction works as for seen in the project.

1.1.2 Erection of all the main auxiliary equipment.

1.1.3 Cleaning, flushing, setting, trials on the water cooling, oil supply and hydrogen gas system.

1.1.4 Pre commissioning, electrical measurements and tests such as insulation resistance, ohmic resistance and impedance measurement.

1.1.5 Checking and setting of temperature control, protection and other signalling schemes.

1.1.6 Safety precautions including tne fire fighting equipments.

1.1.7 Reliable station battery supply including proper battery charging system.

1.1.8 Setting of slip ring brushes and adjustment of proper brush tension; Check that the brushes are freely sliding in Their holders. Adjust pressure on the brushes so that it is uniform on all the brushes and is about 0.8 to 1.0 kg. on each brush. A suitable spring balance may be used for checking the brush tension. Also ensure the cleanliness of the slip ring and that the brushes are of recommended grade.

1.1.9 Seal oil system is reliably established for mechanical run.

1.1.10 Cooling water system for hydrogen gas coolers is established.

1.1.11 The generator temperature recorders for bearing oil and seal oil drain temperature recording.

1.1.12 In addition to the boiler, turbine protection the following should also be ensured; Unit trip with emergency oil level in damper tank with a times delay of 20 Sec.

2. REQUIREMENTS FOR DRYOUT

2.1 It is essential that the following additional' work; should also be completed before rolling the TG set for dry out operation.

2.1.1 Machine filled with dry air and further supply of dry air for make up available.

2.1.2 Readiness of drier in gas system along with silica gel and reactivating arrangements.

2.1.3 Satisfactory completion of gas tightness test at 3.5/4.0 kg/cm for a period of 24 hours.

2.1.4 Generator stator output terminals to be connected to bus bars after IR value measurement. 3 phase shorting to be prepared on phase side bus duct beyond the CTs after isolating the rest of bus bar.

2.1.5 Arrangements to be made near neutral grounding transformer for measurement of insulation resistance during dry out operation. Earthing of the neutral grounding transformer to be isolated for IR measurements. Also

isolate generator PT and SP from bus duct.

2.1.6 Stator water cooling system inlet and outlet pipe connections to be isolated below the generator from inlet and outlet water headers after completely removing the water from the stator winding by blowing with compressed air.

2.1.7 All the generator temperature recorders to be commissioned and kept in continuous service.

2.1.8 For monitoring temperature of generator rotor winding by voltage drop method, arrange for the storage battery, a thermostat voltmeter and ammeter of suitable ranges.

2.1.9 Make arrangements for impedance measurement of rotor winding at standstill, 500 rpm and 300 rpm.

2.1.10 Generator seal oil system to be kept in continuous operation with all the annunciations, interlocks and protections ensured. Forced draining of oil from hydraulic seal tank to be arranged for maintaining the level in it.

2.1.11 Generator casing to be pressurised to 0.2 kg/cm with dry compressed air. Mercury monometer to be arranged for this pressure measurement.

2.1.12 Hydrogen gas cooling water booster pump and system to be kept ready for operation during rolling from 1000 rpm and through out dry out for temperature control.

High frequency exciter air cooling water system to be ready.

2.1.13 Operating personnel are required for:

a) Seal oil system local operation.

b) Gas system local operator for maintaining pressure during periodical purging.

c) Gas coolers cooling water system operation.

d) TG hall operator for seal oil system generator, gas system and for recording the gas temperature etc.

e) Control room operator for recording the temperature of generator stator winding, core, gas temp. and cooling water temperatures etc.

f) Insulation resistance measurement of stator rotor temperature measurement by resistance method.

2.1.14 Hydrogen system should also be ready together with purity indicator at UCB.

3. ROLLING (200/210 MW MW TURBINES) BTPS/SSTPP

3.1 Preparation for Rolling Just prior to rolling the protections of the generator should be ensured by simulating the actual fault conditions. This is described below;

3.1.1 Oil level in damper tank emergency class B tripping after 20 sec. delay* By actually reducing the level in damper tank by partially closing the inlet valve, check this tripping takes place after the specified time delay at the specified level.

3.1.2 Distillate flow to stator winding emergency class B tripping after 2 minutes time delay.

By closing the inlet valve reduce the flow of distillate through the stator winding to below 13 M /hr. Check that the tripping occurs after the specified time delay.

3.1.3 Distillate specific resistance emergency class B tripping.

By switching 'OFF' the resistivity indicator check that the tripping occurs when the needle passes below 50 K ohm Cm value.

3.1.4 Ensure the tripping of the unit through manual tripping switch.

3.1.5 Ensure that all the bearings and seals have adequate supply of oil for lubrication.

3.1.6 Check and record all the parameters of all the auxiliary systems prior to roiling.

3.1.7 Measure and record the IR value of stator and rotor and impedance of rotor at barring speed.

4. CHECKS DURING ROLLING

4.1 Immediately after rolling As soon as the machine is rolled and barring gear disengages check the bearing vibrations, rubbing if any inside the generator or any other abnormal sound. Keep a close watch on the bearing oil & sea! babbit temperature.

4.2 Checks at 500 RPM As the machine speed is stabilised at 500 rpm check the following:

4.2.1 Measure the bearing vibrations and record. Also record the bearing oil & seal oil drain temperature, seal babbit temperatures and generator RTD recordings. Also record the important working parameters of all the auxiliary systems in service.

4.2.2 Measure IR value of the rotor. Also measure the impedance 4.2 of rotor winding.

4.2.3 Check the bedding of the slip ring brushes at 500 rpm.

4.2.4 Measure the IR values of seal oil inlet and outlet pipes and bearing oil inlet & outlet pipes of bearing number 7.

4.2.5 In addition the following checks should be carried out on high frequency excitation system with machine at 500 RPM.

a) Check phase sequence of pilot exciter output voltage.

b) Measure the pilot exciter voltage and record. As the speed is raised keep on measuring the pilot exciter voltage at a gap of every 200-rpm to draw speed Vs. Voltage Characteristics of pilot exciter.

4.3 Checks at 1200 rpm

4.3.1 Measure the bearing vibrations and record. Also record the bearing oil and seal oil drain temperatures, seal babbit temperatures and generator temperatures as given by RTDS.

Also record the important working parameters of all the auxiliary systems in service.

4.3.2 Measure the IR value and the impedance of rotor winding.

4.3.3 Measure the pilot exciter voltage.

4.4 Checks at 3000 RPM

4.4.1 Repeat checks & measurements given at 1.11

4.4.2 Measure the shaft voltage at bearings 7 to 11 and ensure the healthiness of bearing insulation at each of these bearings.

5. DRY OUT OPERATION

5.1 The dry out of the generator is carried out as follows:

5.1.1 Pressurise the generator casing to 0.2 kg/cm with air. When machine speed is raised to 3000 rpm charge the hydrogen gas coolers to regulate the temperature rise to within 5°C per hour. Gradually let the stator temperature get stabilised at 75°C.

5.1.2 On completion of mechanical run of turbine i.e. completion of over speed tests and other governing system checks, continue the dry out at 3000 rpm with 0.2 kg/cm^ air pressure.

5.1.3 Replace periodically the hot (moist) air by admitting fresh (dry) air. For doing this first reduce the pressure by purging from 0.2 kg/cm to 0.1 kg/cm and then admit fresh dry air to increase the pressure back to 0.2 kg/cm . During the initial stages of dry out period of replacement can be about half an hour while later on it can be gradually increased to about 2 hours.

5.1.4 Measure IR valves of stator winding periodically and declare completion of dry out with air operation on reaching acceptable values as given at 1.17.

5.1.5 On declaring the dry out with air operation complete, stop the machine and fill up the casing with hydrogen pressure of 3/3.5 kg/cm & required purity.

5.1.6 Run the machine at 3000 rpm with hydrogen filled in and verify again the IR value of stator winding. On reaching acceptable IR values as given at 1.17 declare completion of dry out and prepare for circulating distillate through stator winding for excitation.

5.2 During dry out operation continuous monitoring of the following is to be carried out:

5.2.1 Hourly measurement of insulation resistance of stator winding.

5.2.2 Hourly recording of all the generator temperatures in UC8 and the mercury thermometers fixed on the generator along with the insulation resistance measurement stated above.

5.2.3 Hourly recording of all the temperatures and pressures in seal oil system.

5.2.4 Hourly measurement of Rotor temperature by measurement of rotor resistance. This should not exceed 100°C. The resistance Vs. Temperature graph may be followed to find out temperature for corresponding resistance of rotor measured.

5.2.5 Control the cooling water to Hydrogen coolers such that the rate of rise of temperature of stator winding, core does not exceed 3 to 5°C/hr. till it attains 75°C.

5.3 Do not exceed the following parameters:

a)	Air pressure	0.20 kg/cm at XSOO rpm
b)	Stator winding temp	75°C

c)	Bearing babbit metal temp. of generator, main exciter &: pilot exciter.	75°C
d)	Seal linear babbit	75°C temp.
e)	Seal oil temp. after cooler	40°C
f)	Cold gas	50°C
g)	Hot gas	75°C
h)	H2/Seal oil differential pr.	0.5 to 0.9 kg/cm^2
i)	Pressure oil	1.5 to.2.2 kg/cm
j)	Seal oil pr. after filter.	9 to 10 kg/cm
k)	H2 gas cooling water pressure	2-3 kg/cm .
l)	High frequency exciter cold air.	43°C
m)	High frequency exciter hot air	75'C
n)	High frequency exciter core	100°C
o)	Bearing drain oil	65°C

p) Purge out the moist air from the Generator continuously and admit fresh dry air.

q) Drain the collected water from the drier and reactivate the silica gel when required.

5.3.1 Continue the process of dry out until the following results are obtained at

75°C of stator winding temperature from 3 to 4 consecutive measurements and remain constant.

a) Ratio of

IR value at 10 minutes greater than
IR value at 1 minute or equal to. 2.0

(Polarisation index)

b) As indicated in O & M instructions, the absolute value of IR should be (Rated KV + 1) Megaohms at 40°C (winding temp.)

6. HYDROGEN FILLING IN THE GENERATOR

6.1 On completion of generated dry out the machine is stopped and put on barring gear for filling the generator with hydrogen to a pressure of 3.0/3.5/kg/cm^2 (200/210 MW sets). During this process continuous monitoring of IR value of rotor and stator windings is recommended.

6.2 Replacing air in the generator casing by CO_2

6.2.1 Connect cylinders to all .the 7 regulators at the CO_2 stand.

6.2.2 Check that the casing pressure is 0.15 to 0.2 kg/crn ".

6.2.3 Check that the valves are set as per the table corresponding to "PURGING OF AIR BY CO-". (Refer gas system drawing enclosed).

6.2.4 Admit CO_2 and feed into the casing (through valve No. C-ll) which will admitted in the bottom of the casing.

6.2.5 Allow the air inside casing to go out to atmosphere through the pipe at the top of the casing through the valves H-18, A-2 and H-10.

6.2.6 The pressure of the gas in the manifold as indicated by CPG-1 should not more than 3 to 3.5 kg/cm .

6.2.7 Purge the following lines till CO- comes out.

a) ILI line from Generator casing by opening valve L-l.

b) Impulse lines going to the instruments by opening valve Nos. H-23, H-21, H-ll, H-26 and H-28.

c) Hydrogen driers and compressed air filling line by opening valves H-34 and A-l.

d) Hydraulic seal tank by opening vent valve SO-31.

e) Hydrogen feed back line from Hydraulic seal to damper tank by opening venting valve SO-62.

6.2.8 Now, ensure that the casing pressure is 0.15 to 0.2 kg/cm and 98% of *CO2* in the gas mixture in casing.

6.2.9 CO_2 filling can be stopped.

6.3 Hydrogen Filling

6.3.1 Check that the valve are set as shown in the table correspond ing to "FILLING THE SYSTEM WITH HYDROGEN".

6.3.2 Check that H-» cylinders are connected to all the five regulators at the H_2

manifold and are provided with a pressure regulator each.

6.3.3 Admit Hydrogen from the H_2 cylinders through manifold and H_2 feed line.

6.3.4 Ensure that the H- manifold pressure never exceeds 5 atg. (Safety valve has been checked during air leakage test)

6.3.5 During this process discharge/purge the CO_2 air mixture through $C0_2$ feed pipe.

6.3.6 Continuous analysis of the concentration of H_2 in gas mixture inside the machine to be carried out by portable gas analyser and chemical method. Sample for analysis to be taken from any valve on *CO2* manifold.

6.3.7 Achieve a purity of 97% of Hydrogen in CO- and air by portable gas analyser and H_2 purity indicator GAI in control room or if mounted on local control panel. Cross check the purity by chemical analysis also.

6.3.8 Purge the following lines till complete CO- and air mixture goes out.

a) Induction liquid indicator line from generator casing by opening valve No. L-l.
b) Hydrogen gas driers and air filling line by opening valve No. A-l and H-34.
c) Impulse lines to instruments by opening valve Nos. H-23, H-26, H-28 and H-11. Open H-21 to purge CO., of air mixture in the line.
d) Hydraulic seal tank and H_2 feed back lines to damper tank by opening vent valve No. SO-62 over the damper tank of seal oil system. Vent hydraulic seal by opening SO-31.

6.4 Operational Checks

6.4.1 Check the H- pressure and make up if necessary.

6.4.2 Check the H- purity and raise if necessary.

6.4.3 Check the silica gel condition.

6.4.4 Drain the water collected if any from the drier.

6.4.5 Check for liquid in ILI and drain off if any.

6.4.6 CO_2 cylinders to be kept connected to CO_2 manifold for any emergency.

Part – IV Electrical Equipments

A. Switchyard Equipments

1. 400KV AIR BLAST CIRCUIT BREAKER

1.1 broadly the breaker' consists of the following parts/accessories:

a Supporting insulator & supporting insulator column.

b) Four chamber assembly - Bifurcation Housing.

c) Double interrupting chamber.

d) Interrupting chamber driving mechanism.

e) Control block

f) Control valve/blast valve

g) Control insulator

h) Capacitor

i) Control cubicle

j) Magnetic valve block

k) Closing resisting chamber

l) Compressed air tank - A safety valve with required setting is provided in it.

1.2 The local-remote control switch enables one to operate the breaker either over remote control or locally from the control cubicle itself over local control. One for each pole air receiver is provided vertically & supports the breaker. Interrupting chamber houses the main contracts. Here separation of contacts &: arc extinction is achieved. The two chambers have a common fixed contacts on the middle & two moving contacts are at the two ends. The centre has an aluminum body &: is resting on support insulators. Interrupting chamber driving mechanism are fixed to the moving contacts &:

cause the motion necessary for contacts making & breaking. Control block houses magnetic valve block, close & trip coils & auxiliary switches etc. It is mounted on the air receiver. The motion between control valve & magnetic valve block is transmitted by the control rod. In the line feeders, resistance is switched across each contact just prior to the closing of main contacts & cut out once the main contacts close. Condensers are also connected across each contact.

1.3 Commissioning Checks First the following preliminary checks are made:

1.3.1 Erection work is complete & erection completing certificate is obtained.

1.3.2 Compressed air system is commissioned.

1.3.3 Check leakages on the breaker at all joints, air tank safety valve, at support insulator mounting & at bifurcation chamber mounting control insulator. Alignment is also checked.

1.3.4 Check that all auxiliary contacts N/0, N/C prove as per the specifications.

1.3.5 Trip & make coils healthiness & continuity is checked.

1.3.6 Pressure switch contacts &: setting are checked.

1.3.7 All insulator are cleaned and inspect wherever possible functionally check -

- Hand valves
- NRV
- Drain plugs
- Receiver pressure relief valve
- Local pressure gauge & other indicator.

1.3.9 Check D.C. & A.C. supplies are available.

1.3.10 Check control relays in the cubicles.

1.3.11 Check heater connections.

1.3.12 Check earth strap connection.

1.3.13 Fitting of end covers on arc chambers is checked.

1.4 Now the following tests may be carried out:

1.4.1 Filling the Breaker to Normal Pressure: Open the ball stop cock in control cubicle to fill breaker air tank to about 5kg/cm . Check for leakage if any. Open the drain plug to reduce pressure to 1.5 kg/cm^2 . This operation is repeated four times. In this process make sure that the high pressure side pressure never falls below two third of its normal value. Fill the breaker to normal pressure in steps. Check the safety valve operating pressure.
Opening pressure = (po+4) $\pm$ 0.5 atg. Resetting pressure = (po+2.5) $\pm$ 1 atg.
PO = Service pressure of the Breaker

The higher pressure can be obtained by manually actuating the auxiliary relay in the automatic pressure supervision circuit.

1.4.2 Contact resistance measurement: Contact resistance is measured separately for all the four contacts in each phase. Finally the total resistance is measured.

1.4.3 Circuit breaker is closed from the local manual control <5c the operation of the breaker & indicator functioning are checked.

1.4.4 Pressure Tests: Following pressure are observed -

a) Reclosing blocking pressure

b) Closing blocking pressure

c) Opening blocking pressure, in the descending order. Check with rising pressure the resetting value should be 0.3 atm. (approx) above the operating value. Slight differences in the gauge reading to the labeling is due to the error in the gauge.

1.4.5 Measure the timings of operation using suitable time recorder.

a) Closing time) 60 & 40 ms as specified

b) Opening time) by manufacturer

c) Maximum discrepancy between poles - 5 ms.

Close & open operation time tests are conducted on each interrupter and pole. For the breaker close-open *&.* open-close tests are carried out. The pressure drops & refilling time taken to reach service pressure are recorded.

Where resistance switching is applicable resistor insertion time and part resist insertion times are to be recorded during breaker closing.

Resistance Insertion Time = Time measured from the instant of touching of the last contact of the closing resistor to the instant when the first interrupting chamber closes.

Part Resistor Insertion time = Time measured from the instant of touching of contact of the closing resistor to the instant when the last interrupting chamber closes.

Resistance Insertion time should be more than 5 m sees. where as resistor insertion time = 8 ± 2 ms.

1.4.6 Anti pumping operating test : This is done by simulating a continuous trip command by Short Circuiting the local control (LCS) thus energising the trip coils.

Command continuous 'close' by holding the LCS in close position. Check that only close open operation is possible.

1.4.7 Operation of pole out of step protection; First disconnect one of the closing coil terminal & give a 'close' command.
Check that the poles with unbroken closing coils, close and trip after a time delay set by the timer. Disconnect one of the trip coils from the control terminal block &: a trip command. Check poles with unbroken trip coils trip immediately, followed after a time lag, set in the timer, by pole with broken trip circuit. Timings are recorded in both the above cases & the process is repeated for other two poles.

1.4.8 Pick up voltage Trip : The D.C. control supply voltage is reduced exactly to 50% of its rated value. Give a 3 pole trip command <5c check the operation of the breaker.

1.4.9 Emergency Trip : Manual emergency tripping from the solenoid valves provided on Y pole of the breaker is checked.

2. PANTOGRAPH ISOLATOR

2.1 Description: It consists of a supporting insulator, drive mechanism, rotating insulator, operating mechanism and the contact drums. This is a motor operated unit.

2.2 Commissioning Checks: Following general checks are first made -

2.2.1 Check the insulators are not damaged and they are properly cleaned.

2.2.2 All moving parts are well lubricated.

2.2.3 Double & separate earthing has been done at -

- Channel base
- Operating box mechanism
- Earthing blade
- Isolator structure base.

2.2.4 Mechanical interlock is provided between isolator Ac earth switch. The control cable entry into the operating mechanism box is not putting hindrance to the operation of isolator or earth switch. Control cable wiring of the isolator and earthing switch is provided according to relevant drawing.

2.2.5 The continuity of all circuits are proper.

2.2.6 Heaters are provided.

2.3 Commissioning Checks :

2.3.1 Using emergency lever check the manual operation of the isolator.

2.3.2 Ensure that the pantograph blades properly grasp the suspended contacts.

2.3.3 See that the blades operate smoothly around the scissors joint.

2.3.4 There is no abnormal sound due to the malfunctioning of the gears in the gear box.

2.3.5 For earthing switch, the earthing blades engages properly into the earthing contact.

2.3.6 The vertical operating rods do not buckle during operation.

2.3.7 The indicator shows the correct indication - open/close of isolator.

2.3.8 The limit switches contact make at both end positions.

2.3.9 The electrical interlock between isolator & circuit breaker is proper.

2.3.10 The heaters are working satisfactorily.

2.3.11 Perform five consecutive on-off operations with operating mechanism. The thermal relay must not switch off.

2.4 CAUTION : Before doing any check, ensure that the marshalling box, main drive box & earth switch Drive box are dead.

2.5 Resistance Measurement of various circuits:

2.5.1. Meggering is done between line parts &: earth by a 5 KV megger.

2.5.2 For control circuit 500V Megger is used.

2.5.3. Contact resistance are to be found out by Kelvin Double Bridge method.

2.5.4 Coil resistances are measured by -

a) Main Drive Box
b) Interlocking Coil
c) Tripping Coil
d) Closing Coil.

2.5.5 For earthing switch drive box, resistance measurement for the following is measure bv Wheatstone Bridge.

a) Interlocking Coil

b) Tripping Coil

c) Closing Coil.

2.5.6 Heater resistances are measured for -

a) Main Drive Box

b) Marshalling Box

c) Earth Switch Drive Box.

2.5.7 Test may be made to find out the closing time. 3.

3. HORIZONTAL CENTRE-BREAK ISOLATOR :

3.1 Description : It consists of a supporting structure on which the base frame is fitted. Other parts are ; rotating insulator switch head isolator arms, isolating contacts, corona rings, operating mechanism, coupling rod & the attached earthing mechanism. The isolator for all these phases are operated by a common drive by means of a drive rod.

3.2 Commissioning Checks :

3.2.1 Check that the erection work is complete & ECC is obtained. Foundation bolts for tightness are checked. Inspect insulators for any damage or dirt.

3.2.2 Check that the arms are perfectly horizontal & corona rings are securely fixed.

3.2.3 Check contacts are properly greased & clearance in contacts are as per manufacturer's specifications for all three poles.

3.2.4 Check all three poles operate simultaneously and stop for 'ON' & 'OFF' operate simultaneously.

3.2.5 Ensure double separate earthing is provided at -

a) Channel

b) Operating box mechanism

c) Earthing Blade

d) Isolator structure Base.

3.2.6 Check coupling with motor operating mechanism.

3.2.7 Check mechanical interlock provided with earthing switch.

3.2.8 See that remote end indicator shows correct status of isolator.

3.3. Resistance Measurements:

3.3.1 Measure & record insulation resistance between line part & earth. This is done by a 5 KV Megger for all the three phases.

3.3.2 Measure and record the contact resistances using Kelvin Bridge or suitable test equipment. Sketch circuit schemes for measurements made showing points across which measurements are taken.

3.4 Operational Checks :

3.4.1 Operate isolators locally and record times taken for 'ON' &. 'OFF' operations.

3.4.2 Carry out five successive close/open operations on the isolators from local and check thermal overload relay of the motor drive mechanism does not operate.

3.4.3 Operate isolator from remote and check operation is satisfactory.

3.5. In case any adjustments are necessary manufacturer's instruction are to be strictly followed.

4. CURRENT TRANSFORMERS

4.1 Description : Current transformers used at KSTPP switchyard are of BHEL make. It is of oil filled construction where in oil serves the purpose of cooling and insulation.

4.2 Commissioning Checks :

4.2.1 Check if any damage is apparent on any part of Current Transformer.

4.2.2 Check for tightness of bolts clamps & see that the terminals etc are O.K.

4.2.3. Earth connections are proper.

4.2.4 Check oil level is up to the mark & no oil leakage is visible. Test oil for dielectric strength.

4.2.5 Check for any strains, if there on the grading ring.

4.2.6 Polarity is checked for

a) Primary
b) Secondary
c) by flick test.

4.2.7 Check the ratio of the C.Ts by primary injection for all tapings. The injected primary current has to be sufficiently high for a reasonable secondary current.

4.3 Megger test is carried out by a 5KV Megger between.

4.3.1 Primary and Earth

4.3.2 Primary A: all secondary cores (1 to 3).

4.3.3 a) Secondary Core-1 :- here megger test is carried out with the help of a 500V megger between –
- Cure 1 to
- Earth Core 1 to Core 2,3,4 & 5.

b) Secondary Core-2 –
- Core 2 to Earth
- Core 2 to Core 3,4, & 5.

c) Secondary Core -3 -
- Core 3 to Earth
- Core 3 to Core 4 & 5.

d) Secondary Core - 4 -
- Core 4 to Earth
- Core 4 to Core 5.

e) Secondary Core - 5 -
- Core 5 to Earth.

4.3.4 Following tests are common for all the windings :

a) Polarity test
b) Ratio test - This is carried out by primary injection
c) Winding resistance
d) Magnetisation characteristic

5. CAPACITOR VOLTAGE TRANSFORMER

5.1 Equipment Details : Capacitor Voltage Transformer consists of mainly the following parts :

a) Capacitor voltage Divider (CVD)
b) Intermediate voltage Transformer (IVT)
c) Carrier current connection device.

In case no carrier current connection device is used, the low voltage terminal should be solidly earthed. The CVT with the capacitor elements is hermetically enclosed in brown glazed porcelain sheets mounted on top of each other.

The CVD Is placed on top of IVT &: with an intermediate voltage connection. The bottom section of CVD is assembled on top of the IVT & together they form an integral unit.

The CPSE type CVD can be equipped with accessories enabling them to be used as coupling capacitors transmission of carrier signals to the line.

5.1.1 Capacitor Voltage Divider ; The CVD consists of porcelain sections mounted on top of each other. Each section contains a large no. of series connected capacitor elements. The elements are impregnated and the porcelains are completely filled with impregnated liquor. Each porcelain is provided with flange of aluminium. At the top of each section is provided an expansion device and a corona shield made of aluminium.

The top section is provided with corona rings. The bottom section is provided with bushings at the bottom flange for low and intermediate voltage terminals. The Sow voltage terminal is connected to trimming winding box.

5.1.2 Intermediate Voltage Transformer : This Is of minimum oil type and intended for out door installation. These are built up on a three legged core with the windings arranged concentrically on the middle leg. The primary winding consists of a main winding & trimming windings. The latter are located at neutral end. Both end of the main windings are connected to copper screens in order to have an even distribution of voltage stresses. The insulation is made of oil impregnated paper.

The IVT is furnished with a compensation reactor connected on the high voltage side in series with the primary winding.

The primary & secondary winding are divided by an earthed screen. A damping ckt consisting of a reactor and a series resistance is connected in parallel across one of the secondary windings. There are three secondary windings each with three terminals.

The IVT is provided with an ample expansion room in the upper par of the tank which is provided with an oil level indicator of the reflection type. This is furnished with oil filling plug & oil draining valve.

The amount of free oil is reduced by filling of quartz and in all free spaces. The windings are dried under vacuum and treatment. The assembled transformers are evacuated before the filling of well degassed oil. It is pressurized at this impregnated process.

The transformers are hermetically sealed. All essential metal parts are hot-dip galvanised or made of aluminium.

The damping ckt terminals are brought out into the secondary terminal box. This is to enable control measurement of the damping ckt components. Terminals & *ckt* shall be short circuited in service. The different components are housed in a steel tank provided with two terminal boxes,

one for the trimming winding terminals and the other for the secondary terminals. An earth terminal is located adjacent to the trimming winding terminals.

The high voltage terminal of the capacitor is connected to the line. The low voltage terminal is connected to the earth terminal at delivery. Both the low voltage & earth terminals are placed in the trimming winding box.

The carrier equipment shall be connected to the low voltage terminal and the ling between this terminal and the earth terminal shall be removed. The secondary terminal box is provided with a separate earth terminal to which the appropriate winding terminal are to be connected.

The terminal $d_1 – d_2$ must be short circuited for correct functioning of the transformer.

5.2 CVT - Commissioning Checks : Before checking the CVT it should be ensured that it is dead. Following guidelines for the purpose of safety should be practiced.

5.2.1 Any connection work in the secondary terminal box should be done only where the high voltage terminal is earthed.

5.2.3 The tank of CVT should be earthed properly at two independent places.

5.2.4 The upper terminal of the individual capacitor unit should be short circuited to the box by a bare wire till all connections are completed & unit is ready for commissioning. This bare wire should be removed without fail prior 10 commissioning.

5.3 Following checks are to be made before carrying out any test :-

5.3.1 No physical damage is apparent.

5.3.2 Proper earth connections are there on IVT, secondary terminal box.

5.3.3 Nuts, bolts, clamps etc. are tight.

5.3.4 Bushings are clean.

5.3.5 The oil level is up to the permissible level.

5.3.6 No oil leakage is visible.

5.3.7 Corona shields & corona rings are provided.

5.3.8 There is no stain on the corona rings.

5.3.9 Connections in the terminal box are O.K.

5.4 Tests to be carried out prior to commissioning :-

5.4.1 Megger test is carried out between primary &: earth by a 5KV megger.

5.4.2 Megger test is carried out between primary and secondary core 1,2 & 3,by a 5 KV megger.

5.4.3 Secondary side –

a) Secondary coil 1 : Here megger test is carried out by a 500V megger between –
-Core 1 to earth
-Core 1 to Core 2 & 3.

b) Secondary core 2 :

- Core 2 to earth
- Core 2 to Core 3.

c) Secondary core 3 :

- Core 3 to earth.

5.4.4 Following tests will be common -

- Polarity test
- Ratio test - this is carried out by primary injection.
- Winding resistance - wheatstone bridge is used for this purpose.
- Other tests.

6 LIGHTNING RRESTOR

6.1 Description : The Thyrite Alugaurd type Lighting Arrestor consister of a stack of one or more units connected in series. The number of units used depends on the voltage and operating conditions of lightiping arrester. This type of lightning arrester makes use of alunite gaps. The other parts are grading ring, discharge counter, insulating bases line & ground terminals.

Basically an arrester unit is nothing but a permanently sealed porcelain humming equipped with pressure relief and containing a number of thyrite element discs and exclusively alurite gaps, shunted by thyrite resistor. Arrestor units are bolted into a stack with the help of metal fittings cemented on the porcelain housing. The arrestor being a single pole design three number arresters are required for 3 phase installation. Lighting arresters are to be installed electrically as close as possible to the apparatus to be protected. The arrestor ground is connected to the apparatus ground and main station ground through earthing mat of low resistance. Earthing resistance of mat should in no case be 7 1 ohm. The elevation of lightning arrestor limits the surge voltage to a safe value by discharging the surge

currents to ground. It also interrupt the small power frequency current before the first current zero.

It is most essential that system power frequency voltage from line to ground never exceeds the specified arrestor voltage under any condition of switching, fault or over voltage, other wire arrestor will not be able to interrupt power frequency follow current.

6.2 Commissioning Checks : the arrestor remains alive unless disconnected from the line. Hence before testing or handling the arrestor, disconnect it from the line and ground this line end.
Before carrying out any tests following checks are made:-

6.2.1 No physical damage is apparent.

6.2.2 The insulator is clean.

6.2.3 The pressure relief device is O.K.

6.2.4 The bolts-nuts, terminal etc are tight.

6.2.5 There is no stain on the corona rings.

6.2.6 The discharge counter is O.K

6.2.7 Other checks if any.

6.3 Meggering tests are made for –

6.3.1 Megger valve between top & earth.

6.3.2 2nd stock & E.

6.3.3 1st Stock & E.

6.4 This is carried out by a 5KV megger. Do not forget to disconnect the ground from the line end before connecting the arrestor back to line.

7. EARTHING SWITCH

7.1 Description : This essentially consists of an earthing contact mounted on the isolator's insulator post, connected to the current carrying pivot, earthing arm, compensating spring and the drive mechanism.

7.2 Commissioning

7.2.1 Checks :-Check that –

a) Erection work is complete &: Erection completion certificate is obtained.

b) Alignment of Earthing arm <5c contact is checked. Blade distance to contact axis shall not be more than 10 mm.

c) Operating mechanism is checked for alignment,

d) Operating linkage is checked for group alignment.

e) All switches should operate in unison.

f) Motor operating mechanism is checked as per the standard checklist. Any adjustments required shall be done as per the Manufacturer's instructions.

B. Switchgear

1 DESCRIPTION

All high capacity unit auxiliaries and the low voltage distribution transformers are supplied from the 6.6 KV unit station bus Bar. This is affected through the 6.6KV circuit breakers, failure of which obviously leads to the outage of the auxiliaries themselves. Again inter linking of the unit and station buses are through 6.6 KV switchgear and hence the reliability of these equipments become still more critical. The contact alignment, contact smoothness insulation etc. are vital factors contributing to the reliability of the breaker. Protections and interlocks are to be perfect *for* the safety of the breaker and the corresponding auxiliary. In case of OCB's oil quality also is of prime importance.

2 TESTS

i) Erection Tests.
ii) Pre-commissioning tests.
iii) Commissioning tests.

2.1 Erection Tests:

These comprises of thorough checking of the breaker for any damage after erection, proper fixing and the related erection formalities.

2.2 Pre-commissioning tests:

These tests will be carried out when the erection is substantially complete and will comprise of

i) Breaker inspection.

ii) Proper fixing, body earthing, etc to be ensured.

iii) Insulation resistance of the breaker cables.

iv) Protective relays their settings and operation.

2.3 Commissioning Tests

These tests will involve the operation of the switchgear, charging and loading. In" case of breakers connecting two systems (e.g. unit and station bus coupler) ensure that phasing out test is carried out before charging.

COMMISSIONING CHACK LIST	PART	SHEET	REF. No.

6.6 SWITCH GEAR FOR

STATION PLANT	STATION PLANT CODE :

NAME PLANTS DETAILS:

MANUFACTURE	SL. NO.	TYPE	MODLE
VOLTS	AMPS	FREQUENCY	
RUPTURING CAPACITY		BREAKING CAPACITY	
MAKING CURRING		SHORT TIME CURRENT	
AUXILIARY SUPPLY			
CLOSING VOLTS	AMPS		
TRIPPING VOLTS	AMPS		
CLOSING DEVICE	SPRING		
OPERATION DUTY			

C. Transformer

1.0 DESCRIPTION

Transformer is the most vital equipment in AC systems. Transformation is one of the factors, which render AC systems superiority over DC systems. This equipment has a large range of application in power transmission/distribution.

Since this is a vulnerable part of the system extreme care is to be taken during commissioning, over and above the tests carried out at the manufacturers works, the commissioning checks and tests play vital role. The voltage ranges being up to the EHV ranges, insulation is of prime importance quality of oil is equally important as it serves the dual purpose of cooling and insulation. Terminal connections body earthing and protections are to be checked and cross checked cooling scheme has to be foolproof.

2.0 TESTS

1. Erection tests
2. Pre-commissioning tests.
3. Commissioning tests.

2.1 Erection Tests

This comprises of thorough checking of the transformer for any damage of its parts, proper foundation etc.

2.2 Pre-commissioning Tests

These tests will be carried out when the erection is substantially complete and will comprise.

1. Inspection of the transformer.
2. Ensure proper leveling and foundation.
3. Insulation resistance of transformer and cables.
4. Protective relays and their operation.
5. Operation of associated switchgear.
6. Ensure proper earihing.
7. Ensure quality of the oil.

2.3 Commissioning Tests

These tests include the charging of the transformer no load operation and full load operation and confirms the operability of all protections.

Commissioning Check List	PART	SHEET	REF. NO

TRANSFORMER

SATION STATION PLANT CODE

PLANT
IDENTIFICATION

NAME PLATE DETALES

MANUFACTURER SERIAL NO SPECIFICATION

WINDING	KVA	AMPS	VOLTS	INSULATION
HV				
LV				

PHASE FREQUENCY % IMPEDANCE

VECTOR GROUP CONNECTION

TYPE OF COOLING

TEMPERATURE RISE ^{0}C OIL ^{0}C WINDING

AIR CIRCULATION M3/MIN OIL CIRCULATION LITER / MIN

WEIGHT OF COOLERS KG WEIGHT OFCORE & Kg WINDING

TOTAL WEIGHT OF TRANSFORMER Kg. VOL. OF OIL TANK LTRS.

VOL. OF OIL IN COOLERS Kg. YEAR OF MANUFACTURER.

D. Ht Motor

1 DESCRIPTION

6.6KV squirrel cage motor is the main driving equipment for the high capacity rotary machines e.g. I.D. fan, F.D. fan, Bowl Mill, BFL, PA fan, condensate and C.W. pumps.

Since these motors operate on 6.6KV supply, the insulation provided by the manufacturer is to be checked thoroughly. Failure of insulation means damage of the motor and consequently this will increase the down time of the equipment as well as loss of generation. Before the actual start of commissioning special care is to be taken for keeping the motor insulation dry by putting the space heater in service.

The lubricant in the motor bearings plays a vital role. Proper graded grease/lub oil should be used in order to achieve long life and efficient performance of the bearings. Proper motor terminal connection is also to be looked into prior to the first starting of the motor. Loose connections or damage in the cable core insulation may cause pitting or flash over at the time of switching on the supply and there by damage to motor. Special care is also to be taken to check the operation of motor protections and its interlocks. This will prevent the motor from undesired failure whenever a fault occurs in its associated system and circuit.

2.0 TESTS

a) Constructional/Erection Tests.
b) Pre-commissioning Tests.
c) Commissioning Tests.

2.1 Constructional/Erection /Tests

These will comprise the thorough checking o{ the motor for any damage of it's parts after erection and the proper placement on the foundation with all associated erection formalities.

2.2 Pre-Commissioning Tests

These tests will be carried out when the erection is substantially complete and will comprise of the following ;-

i. Inspection of the motor.
ii. Ensure the proper levelling.
iii. Ensure the tightness of foundation bolts, end shield bolts etc.
iv. Ensure the use of proper grease/lub oil.
v. Insulation resistance of motor, cable and control cable.
vi. Settings of protective relays and their operation.
vii. Operation of associated switchgear.

2.3 Commissioning Tests;

These tests will involve the initial starting of the motor to demonstrate that it is operationally sound and confirms to the rated specifications.

The tests will comprise the following operations: -

i) Starting and operation on no load.
ii) Starting and operation on full load.
iii) Satisfactory operation of the motor.

COMMISSIONING CHECK LIST PART	SHEET	REF. NO

6.6 Kv SQUIREL CAGE INDUCTION MOTOR FOR

STATION	STATION PLANT CODE
PLANT IDENTIFICATION	STATION PLANT CODE

NAME PLANT DETAILS

MANUFACTURE		SERIAL NO	
FRAME SIZE		TYPE	
KW/HP	VOLTAGE	CURRENT	POWER FACTOR
SPEED	FREQUENCY	PHASE	RATING
INSULATION CLASS	BEARING	DE	CONNECTION
TEMP RISE	NONO	NDE	LUBRICATION

SPACE HEATER

KW/HP	VOLTAGE	PHASE

ANNEXURE-I

NATIONAL THERMAL POWER CORPORATION

---------- STPP Unit----------

Ref:----------

Dated:----------

Rectification/ requirements suggested by commissioning group

Area/ Package of Inspection:	List of Participants
	Erection
	1.
Date Of Inspection	2.
	Commissioning
	1.
	2.

1. Observations /additional Works to be done with justification enclosed:

    1.
    2.
    3.
    4.

II Whenever the present work can proceed or to stopped till be additional works identified is completed:

    1. Can Proceed/to be supported.

2. Can proceed /to be stopped

3. Can proceed/to be stopped

4. Can proceed/to be stopped

III. Whenever the above works are in the present contractors' scope or not:

1. Yes/NO.

2. Yes/No.

3. Yes/No.

4. Yes/No.

IV. If yes the program for completion of these works:

1.

2.

3.

4.

V. If these works are not in the scope of the contractor indicate the estimates for the carrying out those works (please enclosed the working sheets/ Drawing etc.)

1.

2.

3.

4.

VI. period for completion of above works

1.

2.

3.

4.

Erection Engineer — Engineer- in Charge (Commissioning)

VII. Finance for concurrence

VIII. Complete Authority for approval
(As per delegation of power)

Commissioning Copy
Erection Copy
P&S Copy
Finance Copy.

ANNUXURE-II

FORMAT AND FUIDDANCE FOR COMMISSIONING REPORTS

1.	Tile	: State Plant Tested /Commissioned
2.	Documents	: Give list of documents used.
3.	Programme	: Give details of how documents were used. Major constraints On site advice required.
4.	Testing/ Commissioning	Date commenced Initial problems- causes- solutions Staffing. Omissions
5.	Operational Results specifications.	Output/ Rating achieved Compare with Log sheets- performance figures. Failures
6.	Defects and Omissions:	Official lists Operational defects Present status.
7. Conclusions		Comments on the documents by Contractor, and NTPC staff.

8. Recommendations:

9. Appendices : Copies of Minutes, log sheets, defects/ omissions results, etc.

ANNEXURE- III

NATIONALTHERMAL POWER CORPORATION LTD.

……SUPER THERMAL POWER STATION

TO…….. Certificate No……

(Contractor)

SAFTY RULES CLEARANCE CERTIFICATE

I herby give notice that the equipment scheduled below is being MADE ALIVE/put INTO SERVICE or by reason of its approximately or relation to other must be regarded as being ALIVE/IN SERVICE, and as from ---------- hrs, on ----------will come under the control of NTPC so far as safety rules are concerned NO further work may be done or near the equipment after this time ands date unless the person in charge of such work is in possession of a permit to work card on sanction for the testing issued by a Senior Authorised person in the employ of NTPC will you please sign the master certificate and retain addressed to you.

1. Description and location of plant.

For NTPC

Erection Department

Signature----------Designation----------

Date ----------

2. Acceptance:

I agree the issue of the safety Rules Clearance Certificate for this plant that it will become subject to the NTPC- Safety Rules from the date and time specified above.

For NTPC Signature ---------- Designation----------

O & M Department Date----------

3 Acknowledgements:

I/ we acknowledge recipt of the above notice and confirm that all persons in my/ our charge have been duly warned of the above. My /our men and material have also been removed from the area / equipment of testing.

Singed for Firm of Deptt. Time Date

Distribution

Note:

a) Once this certificate is issued no work can be done on the basis equipment under consideration a proper PTW NTPC.

b) Fire Fighting System envisaged for the equipment under consideration should available before raising this certificate.

ANNEXURE-III (Contd,)

NATIONAL THERMAL POWER CORPORATION LTD.

……. SUPER THERMAL POWER PROJECT

To

Erection Department Certificate

No……

RECORD OF INITIAL OPERATION CERTIFICATE

Contract …….

Contract Ref----------

Contractor……..

1. Description and Location pf plant

2. Initial Operation

The above plant satisfactory completed its initial operation tests on ---------- 19----------in the pressure of the following witness: The defects and omissions notice during this trial that are to be liquidated by the contractor is also attached.

For Erection Deptt (Singed----------

For O&M Dept. (Singed)----------

For Contractor (Singed)----------

ANNEXURE-III(Contd.)

NATIONAL THERMAL POWER CORPOIRATION LTD.

----------SUPER THERMAL POWER PROJECT

To

O&M Department Certificate NO…….

INTERNAL TAKING OVER CERTIFICATE

Contract…….

Contract Ref……..

Contractor…….

In accordance with the conditions of the contract, the contractor is initiated to Taking Over Certificate for the following plants. However., issue of ITOC does not absolve the contractor his contractual responsibilities to rectify the plant deficiencies, The defect list/ deviations are enclosed. The defect with a time bound programmed for the contractor then out will give the discussed. Further deviations if any also discussed with the contractor Further deviation if any will also be discussed with the contractor.

1. Description and Location of Plant

2. Exception:

Subject to any you may wish make overleaf, it is proposed to issue the Taking Over Certificate.

For NTPC Erection Deptt.

Signature----------

Designation----------

Date----------

3. Acceptance

i) * I agree to the issue of a Taking Over Certificate

ii) * I have the following observation on the proposal to issue to Taking Over Certificate.

For NTPC Signature----------

Designation----------

Date----------

* Delete as appropriate

a) This certificate is to be issued after the satisfactory performance of equipment under consideration.

b) After the issue of this certificate is to the done by NTPC. Breakdown due to design deficiencies will attended to by Contractor.

ANNEXURE –III (Contd.)

NATIONAL THERMAL POWER CORPORATION LTD.

……SUPER THERMAL POWER PROJECT

FINIAL INTERNAL CONTRACT CLEARANCE CDRTIFICATE

Contract……..

Contract Ref----------

Contractor……

This is certify that the ----------months maintenance period on the following plant will be completed in (date)----------and omissions have been cleared with the exception of the minor items listed below:

1. Description and Location of plant:

2. Minor Work Outstanding:

(Signature……..General Manager)

(Date)……..

3 Acceptance:

a) * I agree the plant meets all existing operational requirements.

b) * I have the following observation in respect of operational requirements

For NTPC O&M Department

Signature----------

Designation----------

Date ----------

* Delete as applicable

ANNEXURE-IV

PROCEDURE FOR THE CONTROL& HANDLING OF DEFECTS

Stage I: Requirements for the Issue of safety Clearance Certificate

	Action	Responsibility
1.1	To multiply Performa for the recording The defects	Documentation control center.
1.2	To prepare a circulation list of reports	Commissioning Panel
1.3	To segregate all defects i.e. item Wise, contractor wise and nature – wise	D.C.C.
1.4	Record of all defects in the Performa	D.C.C
1.5	To send defect list to all as per circulation list	
	- Daily for major defects	D.C.C
	- Weekly for the other defects & omission	D.C.C
1.6	To send back the defect completion and distribution To all concerned.	Nominate Erection Engineer
1.7	To up to date the defect LISTS weekly and distribution to all concerned	D.C.C.
1.8	To prepare a consolidated list of the Defects to enclosed with safety Clearance Certificate.	D.C.C/Working Party

Stage II - Initial Operation

	Action	Responsibility
1.1	Observation/ Identification of Defects during Initial run –up and sending it to documentation center	Working Party.
1.2	Preparation of defects, list of initial operation	D.C.C.
1.3	To circulate the defect list to all Concerned. Defect completion report and up – dating.	D.C.C./Erection
1.2	To prepare a comprehensive list of Defects to be enclosed with the initial Operational certificate.	D.C.C.

Stage III: Requirement for the Internal Takeover Certificate

1.1	To review the defects status	D.C.C
1.2	To prepare the list of all defects known to be Due to defective design, faulty material or workmanship.	D.C.C
1.3	Survey of complete plant for the Identification of any further defects.	Station O&M/ Working Party.
1.4	To prepare the complete list of the	D.C.C.

	Defects and sends it to the Chief Erection Manager	
1.5	Notification of defects to be attended by Contractors.	CEM/DCC.
1.6	Notification to CEM of completion of Defects.	CONTRACTOR
1.7	Notification to D.C.C. Of the completion of defects	CEM
1.8	To prepare finial list defects if any to Enclosed with Internal Take Over Certificate. After Which Take over Certificate can be issued.	CEM.

Stage IV: Internal Finial Contract Certificate Upto Guarantee period

1.1	Internal defects report to CEM during Guarantee period	DGM O&M
1.2	Notification to contractor	G.M.
1.3	Notification to CEM of completion of defects during guarantee period	Contractor
1.3	Notification to DGM (O&M) of completion of all defects	CEM
	After Which GM will sign the FICCC.	

ANNEXIRE-V

NATIONAL THERMAL POWER CORPORATION LIMITED
(OS COMMISSIONING GROUP)

List of commissioning procedures for thermal units Requiring approval of Corporate -OS

1. BOILER

a) Boiler hydraulic fest & preservation procedure

b) Boiler alkali boil out

c) Boiler acid cleaning

d) Air & gas tightness test—furnace & ducts

e) Steam blowing of boiler including interconnecting pipeline of boiler, turbine. boiler feed pump, turbine drives, auxiliary steam header and steam supply lines

f) Steam blowing of FO system

g) Oil flushing of FO system

h) Gas distribution test of ESP

i) Air in leakage test of ESP (part of PG test but carried out during Pre-commissioning.)

j) Clean air flow test of coal pipes.

k) Oil flushing of lub oil system of rotating equipments.

2. TURBINE GENERATOR

a) Hydraulic 'test procedure for

i. Lub oil system

ii. Seal oil system

iii. Stator water system

iv. Heaters

b) Oil flushing of lub oil system

c) Oil flushing of seal oil system

d) Flushing of control fluid/oil system

e) Stator water flushing

f) Alkali flushing for pre boiler & condensate system

g) HP/LP bypass system

h) Air tightness test of generator-

i) Condenser flood test

j) Vacuum tightness test

k) Steam blowing of gland seal pipeline, aux. steam pipeline including electors

l) Generator testing, procedure for first synchronisation.

ANNEXTRE - VI

NATIONAL THERMAL POWER CORPORATION LIMITED

(OS COMMG GROUP)

List of commissioning procedures for combined cycle gas projects ! Requiring approval of corporate -OS

1. GAS TURBINE GENERATOR-OPEN CYCLE

a) Hydraulic test for
   - i) Gas pipelines
   - ii) Fuel oil lines

b) Flushing procedure for:
   - i) Gas pipelines
   - ii) fuel oil lines.

c) Gas flaring proceduce.

d) Hydraulic test procedure for lub oil/lift oil/control oil system.

e) Oil flushing of lub.oil/lift oil/control oil system.

f) Chemical cleaning of lub. oil/lift oil/control oil lines.

g) Generator testing procedure for first synchronisation.

h) Seal oil system & stator water system if applicable as given below for combined cycle.

2. COMBINED CYCLE

2.1 BOILER

a) Boiler hydraulic test & pwaervation procedure.

b) Boiler alkali boil out

c) Boiler acid cleaning

d) Air & gas tightness test-furnace & ducts

e) Steam blowing of boiler including interconnecting pipelines of boiler & turbine 0 Oil flushing of lub. oil system of rotating equipments.

3. STEAM TURBINE GENERATOR

a) Hydraulic test procedure for

- i) Lub oil system
- ii) Seal oil system
- iii) stator water system
- iv) Heaters

b) Oil flushing of lub oil system

c) Oil flushing of/ seal oil system

d) Flushing of control fluid/oil system

e) Stator water flushing

f) Alkali flushing for pre boiler & condensate system

g) HP/LP bypass system

h) Air tightness test of generator

i) Condenser flood test"

j) Vacuum tightness test

k) Steam blowing of gland seal pipeline, aux. steam pipeline including ejectors.

l) Generator testing, procedure for first synchronisation.

ABHREMATIONS USED

1.	BEI	-	British Electricity International
2.	FQA/QA	-	Field Quality Assurance /Quality Assurance
3. FICCC		-	Finial Internal Contract Clearance Certificate
4.	ITOC	-	Internal Taking Over Certificate
5.	RIOC	-	Record of Initial Operational Certificate
6.	SRCC	-	Safety Rules Clearance Certificate
7.	DCC.	-	Documentation0 Control Center
8	GM	-	General Manager
9	DGM	-	Deputy General Manager
10	CEM	-	Chief Erection Manager
11	COS	-	Corporate Operation Service
12	O&M	-	Operation and Maintenance
13	PE/ENGG	-	Project Electricity Board
14	REB	-	Regional Electricity Board
15	CEA	-	Central Electricity Authority