TURBINES

1. How is it possible for hydrogen to flow from the casing with enough pressure to go through the analyzer and flow meter and then return into casing?

2. During normal operation hydrogen is continually scavenged from turbine end and collector end of the generator. These scavenge lines are connected to a particular part of the hydrogen and seal oil system to insure a true sample What is its name?

3. Why is it desirable to maintain the lube oil temperature in the Bowser above 130° F?

4. Why do we have 2 extraction lines on No. 2 Turbine, both of which tie into the steam line to Deaerators?

5. Do the extraction valves inside the turbine tend to restrict or aid the flow of steam through the machine in order to raise the extraction pressure?

6. What is the purpose of the auxiliary oil pump?

7. What are the possible consequences if we lost all our seal oil pressure? Why, normally, wouldn't we lose all seal oil?

8. What is the purpose of the exciters?

9. Why do we use the turbine extraction for process steam instead of the de-superheating stations?

10. Explain the oil system including bearing oil and hydraulic oil. Which pumps deliver bearing oil and hydraulic oil?

11. We start slowly losing vacuum in the condenser and you get an alarm. What could be the trouble and what action do you take to correct the trouble?

12. You get a low oil level alarm in the turbine oil reservoir and on investigation you find the oil abnormally low. What action should you take to correct the trouble? What could be the cause of low oil?

13. What is meant by the saturation temperature and pressure of steam?

I. Fundamental Safety

No.	Ex. (7-6)	Good (5-4)	Fair (3-2)	Poor (1-0)
[illegible]				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
[illegible]				
15.				
16.				
17.				
18.				
19.				
20				

Total Points: ____________

Percentage: ____________

II. Job Related Safety

Question Numbers *	Ex. (7-6)	Good (5-4)	Fair (3-2)	Poor (1-0)

Total Points: ____________

Percentage: ____________

III. Technical Knowledge

Question Numbers *	Ex. (7-6)	Good (5-4)	Fair (3-2)	Poor (1-0)

Total Points: ________

Percentage: ________

TYPE OF TEST: ____

DATE TESTED: ____

TESTED BY: ____

* The numbers of the questions to be asked will be shown here.

c: 10/31/63

SAFETY REVIEW REPORT

Mr. ______________________________, having been questioned by the Review Committee on ____________________, has been found to rank approximately as follows:

- [ ] Indicates a thorough understanding of theory and application of safety related to his job.
- [ ] Is well acquainted with safety aspects of his job.
- [ ] Knowledge of job safety is average.
- [ ] Acceptable knowledge of job safety but needs to improve.
- [ ] Unsatisfactory, much room for improvement.

Mr. ________________ has (satisfactorily/unsatisfactorily) completed the General Safety Rules Test with a score of ________.

_________________________ (Chairman) _________________________ (S.S.) _________________________

The following is the safety performance rating of the above named operator given by his Shift Supervisor, ______________________________, based on observation of the past ____ months:

- [ ] Excellent performance in all respects.
- [ ] Outstanding performance.
- [ ] Satisfactory performance.
- [ ] Acceptable performance, room for improvement.
- [ ] Unsatisfactory, little or no improvement since the last review

Mr. ________________ has had _______ reports to first aid since his last review.

______________________________ (S.S.) ____________________ (Date)

______________________________ (Operator) ____________________ (Date)

TJD:jac:10/28/63

Merit Review Report

Mr. ______________________________, having been questioned by the Review Committee on _____________________, has been found to rank approximately as follows:

- [ ] Indicates a thorough understanding of theory and operation of equipment related to his job.
- [ ] Is well acquainted with technical aspects of his job.
- [ ] Knowledge of job is average.
- [ ] Acceptable knowledge of job but needs to improve.
- [ ] Unsatisfactory, much room for improvement.

_________________________ _________________________ _________________________

(Chairman) (S.S.)

The following is the performance rating of the above named operator given by his Shift Supervisor, _______________________________, based on observation of the past four months:

- [ ] Excellent performance in all respects.
- [ ] Outstanding performance.
- [ ] Satisfactory performance.
- [ ] Acceptable performance, room for improvement.
- [ ] Unsatisfactory, little or no improvement since the last review.

_________________________ _________________________

(S.S.) (Date)

_________________________ _________________________

(Operator) (Date)

DO 124193
CONFIDENTIAL

DW:jac;4/6/61

C O P Y

August 29, 1963

ALL SUPERVISORS

Recently questions have been asked as to the basis for rating an individual on his safety performance. Of course these questions have been prompted by the stated Louisiana Division policy of giving safety performance proper emphasis in performance appraisals and salary considerations.

Listed below are the main points that should be given consideration in safety performance evaluation. Your attention is called to the first point listed. One failure to report an injury overshadows completely the number of first aid reports by an individual. The number of first aid or injury reports in which an individual is involved should not be considered in performance evaluation per se. The reason for the injury or report is the prime consideration so that corrective action may be taken.

It is suggested that the following points be used as a guide or check list to safety performance evaluation:

1. Have injuries been reported promptly or were they suppressed or ignored? Prompt reporting is a credit to the man and his supervisor. The primary purpose of accident investigation is securing the facts, not to place blame. It should be remembered, 80% of injuries are caused by unsafe acts and most unsafe acts are not committed intentionally, but are due to one or more of the following factors.

    (a) Improper or lack of training.

    (b) Inattention to the job due to personal or other problems.

    (c) Man not mentally or physically capable of performing the job.

    (d) "Hurrying" to a point beyond which the job cannot be performed safely.

    NOTE: This may be the fault of supervisor, and if so, supervisor must assume responsibility. The most important point to make about injuries is not how many times

DO 124194
CONFIDENTIAL

an employee reports to First Aid for treatment, but what caused the accident in the first place.

2. Have "repeat" accidents occurred involving the same man? (Example: Repeat eye injury from not wearing eye protection.)

3. Has the employee offered suggestions for improving job safety by use of "Unsafe Condition Reports"?

4. Does the employee have to be constantly reminded about the use of protective equipment?

5. Does the employee leave his job in as safe a condition as possible for his shift relief?

6. Does the employee communicate well to his shift relief and supervisor regarding safety hazards or problems?

7. When uncertain about job duties, does the employee talk with his supervisor before attempting the job?

8. Does the employee accept safety rules and procedures as necessary?

9. Does the employee take the initiative in safety and loss prevention efforts?

10. Does the supervisor insure that all men reporting to him are properly trained in all phases of their jobs?

11. Does the supervisor always determine that safe procedures are being followed, or does he allow short cuts when on a rush job?

12. Does the supervisor encourage the reporting of unsafe conditions, and has he created an atmosphere with his men where they will do so?

13. Does the supervisor always set an example in relation to safety?

It is each supervisor's responsibility to make those people in his group fully aware of the basis for his safety performance evaluation.

Louisiana Division Safety Board

s/John C. Harvey
John C. Harvey, Chairman

mst

ma/Copied December 10, 1963

RED TAG PROCEDURE

The purpose of this procedure is to present in detail the correct method for using red tags and granting work clearances for the Power Department facilities.

Responsibility

The duty shift supervisor has the primary responsibility for issuing red tags and ascertaining that the equipment is safe to enter or perform work upon. However, the supervisor may designate the isolation and red tagging of equipment to others who are thoroughly familiar with the equipment and existing hazards that are peculiar to the equipment.

Definitions

Red Tags	Tags used to indicate and warn that the equipment or device to which it is attached must not be operated or used. Red tags must be completed in full before attaching.
Red Tag Masters	A printed form to which a number is assigned which will be the same number used on the corresponding red tags. Space is provided also for the name of equipment, description of work to be done, the number of red tags used. It is dated and signed by persons issuing, receiving and releasing the clearance. The red tag master must be completed in full and posted on the red tag master bulletin board located in the control room.
Clearance Granted Clearance Released	The portion of the red tag master that is initialed by the craftsmen before commencing work and is initialed again to indicate that work is complete. A clearance granted - clearance released will also be stamped in the Power Plant log book whenever a red tag is required. This provides a permanent record of the red tag master. It is initialed and dated by the duty supervisor upon granting and releasing clearances.

Procedure for Issuing Red Tag

Before clearance is granted to perform work on any equipment, it must be entirely safe. Electrically driven equipment must have the main disconnect switch or breaker opened or disabled. Valves must be closed on lines or equipment under pressure and bled down. If vessels, lines or equipment contain explosive material or gases, they must be purged properly. If vessels, lines or equipment contain toxic or corrosive material, they must be bled down and flushed properly.

Procedure for Issuing Red Tag (cont'd)

After ascertaining that the equipment is safe, a red tag master will be filled out completely and posted on the red tag master board. A craft representative will initial the clearance accepted portion of the master. If work to be performed involves more than one craft, a representative from each craft will initial the master. A clearance granted - clearance released will be stamped on the left side of the page in the Power Plant log book. The master number, name of equipment, number of tags used and a general description of the work to be done will be entered in the log book to the right of the stamped entry.

Example:

Clearance Release	Clearance Grant
12-31-73 M.F.	12-31-73 M.F.

No. 2 Inst. Air Comp. for P/M
960 P 7 tags

Red tags, filled out completely with the proper master number will then be attached to the isolating device (valves, switches, breakers, controller, etc.).

Locks may be used in addition to but not in place of red tags.

All red tags on a job or unit of work will be assigned the same number that is entered on the r ed tag master.

As each craftsman completes his portion of the job, a representative of his craft will initial the clearance released portion of the red tag master.

When all crafts have completed their work and initialed the red tag master, the red tags may be removed. Upon removal of all red tags, they will be returned to the control room. The red tag master will then be completed and may be disposed of. The stamped clearance release portion in the log book will now be dated and initialed by the duty shift supervisor. The red tags may be re-used if they are the plast ic type and the number can be removed.

If a red tag is found unattached or astray laying on the floor or grating, it should be returned to the control room. The number on the tag will be researched and should be replaced with a new tag.

BOILERS

A. NO. 1 & 2 BOILERS

No. 1 & 2 Steam Generators

Each of the steam generators is a Riley Stoker Corporation Unit with a continuous capacity of 500,000 pounds of steam per hour at 1,300 psig superheater outlet pressure, 1,425 psig maximum drum working pressure and 950° F. total steam temperature. The normal fuel is gas. Each unit is also capable of being fired with liquid propane at 60% capacity.

The steam generating unit includes a 60 inch I. D. steam drum; a 42 inch I. D. lower drum; a water cooled furnace; a continuous vertical loop; high velocity superheater; a continuous loop economizer; a tubular single pass cross flow air heater and a steam temperature control valve for bypassing products of combustion around the superheater.

The units are designed to permit free movement of parts, both vertically and horizontally, due to expansion, without placing strains on any part of the unit. The boiler drum and headers are suspended from overhead steel supports and the boiler and setting expands downward from the top. Refer to Procedures Manual for acidizing and/or startup instructions.

Water and Steam Paths

Circulation is based on the ring flow principle, that is, flow in each tube remains in one direction regardless of steam output fluctuations. All tubes exposed to high temperatures carry upward flows of water and steam mixtures and the down flow tubes receive water from the main drum after all steam has been removed. Steam is liberated above the working water level in the drum, the internals of which provide definite and rapid separation of steam and water.

Feedwater from the boiler feed system enters the economizer through the stop and check valves, passes through the economizer, and enters the steam drum through the condenser elements of the steam purifier unit. The feedwater passes through the condenser purifier so that the temperature of the purifier elements is lower than the steam temperature. A certain percentage of the steam is consequently condensed in the purifier fins as it passes over the purifier elements and dirt particles are washed away by the steam condensate. The steam then passes through the dryer section of the steam purifier which minimizes carryover of any entrained moisture and results in a high steam purity.

Water from the upper 60 inch drum flows by gravity through $2\frac{1}{2}$ inch downcomer tubes, which are located behind the rear baffle, and

DO 124199
CONFIDENTIAL

A. NO. 1 & 2 BOILERS (Contd.)

No. 1 & 2 Steam Generators (Contd.)

also through 3½ inch downcomer tubes, which are located in front of the rear baffle, to the lower 48 inch drum. The 3½ inch generating screen tubes carry the water-steam mixture back to the upper drum. In addition, the lower drum supplies the 14 inch front and the 12-3/4 inch side wall bottom headers through 3½ inch feeder tubes. The water absorbs heat in the 3½ inch side and front wall tubes and rises to the drum in the form of a water-steam mixture which in the case of the side wall tubes rises to the top 12-3/4 inch side wall headers and then to the steam drum through the upper side wall header release tubes. The front wall header also has a row of 3½ inch screen generating tubes leading directly to the steam space of the upper drum.

Safety Valves

Each boiler is provided with two safety valves on the steam drum and one safety valve on the superheater outlet header. In addition, a power control valve is located in the main steam header which may be operated either by excessive pressure on the header or by operation of the selector switch on the Mechanical Console Board.

One steam drum relief valve is a welded Consolidated 1500 psi 3 inch valve set to pop at 1498 psig and close at 1438 psig. The other steam drum valve is a welded Consolidated 2½ inch 1500 psi valve set to pop at 1455 psig and to close at 1397 psig. The superheater relief valve is a welded Consolidated 1500 psi 2½ inch valve set to relieve at 1370 psig and close at 1330 psig. The power Control electromatic relief valve is a welded Consolidated 2½ inch valve set to pop at 1320 psig and close at 1307 psig.

Burners

Each boiler unit is provided with ten burners arranged on two horizontal rows of five burners each. Fuel is supplied to the boiler with ten Peabody type H-26 4 inch insulated burners with center fired gas units.

The burner consists of the air register with its simultaneously adjustable doors, the gas units inserted through the hub of the air register. The air for combustion passes along the gas burner placing it in the zone of active air flow, and thus keeping it relatively cool.

Fuel gas supplied to the burners will vary in pressure depending on the steam load and number of burners in service.

Refer to safety operating procedure section for lighting burners.

Steam Sampling

Four 1 inch tandem valved sampling lines lead from the boiler steam drum and connect to a common header in order to permit spot sampling of the steam just before it enters the superheaters. The steam sample is cooled and degassified in a Powell-McChesney type steam conductivity cell. In this type of apparatus, a stainless steel capillary sampling line throttles the steam flow and condenses part of the sample by radiation. The condensed part of the sample entering the condensate cell is kept at the boiling point and continuously swept by uncondensed vapor so that the gases in the steam cannot go into solution. The electrical conductiviey is measured in the condensate cell and is recorded on Recorder Number 27 on the Process Auxiliary Board.

Air Preheaters

The air preheaters are of tubular, single pass counterflow design. Hot gas from the furnace flows through the inside of the tubes and air flows over the outside in the opposite direction. Air distribution chambers are provided on the sides of the air heater, both at the cold air entrance and hot air exit. Air heater tubes are arranged in bundles with distributing air lanes between the bundles.

Miscellaneous Connections

On each boiler, the lower drum and the front lower header are each provided with two 1½ inch tandem valved blow-down connections, while the right wall header and the left wall header are each provided with a single 1½ inch tandem valved blow-down connection, for the purpose of intermittent blow-down of boiler solids and also for draining of the boiler. For draining purposes, the 1½ inch lines connect with a 3 inch line to waste which is blocked with a 3 inch gate valve. For intermittent blow-down purposes the 1½ inch lines connect to 4 inch line which drains into the intermittent blow-off tank. A 4 inch gate valve blocks this line. An elbow and block valve arrangement permits filling the boiler with condensate makeup through a 4 inch line and a 4 inch gate valve by means of the condensate make-up pumps. An acid cleaning connection is provided in the 4 inch blow-off line.

On each boiler the following tandem valved lines discharge into a common 3 inch header which also leads into the blow-off tank where a 3 inch gate block valve is located: the 1½ inch economizer inlet header drain; the two 3/4 inch gauge glass blow-offs; the two water column drains; the two superheater header drains. An elbow and block valve arrangement in this 3 inch line permits filling with condensate through a 3 inch line from the condensate make-up pumps. The two superheater header drain lines are provided with acid cleaning connections.

Draft System

Air for combustion is supplied by two Westinghouse-Sturdevant turbo-vane forced draft fans driven by Westinghouse 200 HP, 1200 RPM motors. The fans discharge through the air heater, the wind box and into the furnace. The fan capacity is regulated by inlet louvers positioned by piston operators that are actuated by the combustion control system. The gases of combustion are drawn through the superheaters, the boiler gas passages, the economizer and air preheater by two Westinghouse-Sturdevant turbo-vane Induced Draft fans driven by Westinghouse 350 HP, 990 ~~RR~~, RPM motors. The fans may be started and stopped either locally or from the Mechanical Console.

Thermocouples are located on both fan and motor bearings, and the temperatures are recorded on bearing temperature recorder located on the Mechanical Vertical Auxiliary Board. Annunciation of high temperature is provided on the Mechanical Vertical Board.

Continuous Blowdown System

The continuous blowdown system is provided to maintain the proper concentration of dissolved solids in the boiler water. Perforated lines, running lengthwise within the steam drums below the water level discharge through one end of the drums and into the boiler continuous blowdown tanks, one tank for Boilers 1 and 2 and a separate tank for Boiler 3. The blowdown rate is controlled by manual adjustment of the flow control valves located adjacent to the flash tanks. The drains from all flash tanks discharge through a six inch line to a heat exchanger which is used to heat demin water to the storage tanks. The flashed vapor discharges through steam separators to the deaerators.

By-pass lines are provided around the "flash-tanks" which allows either or both to be isolated for inspection, maintenance, etc.

Sample lines from each Boiler blowdown line to conductivity cells with sample coolers provide conductivity readings on the Boiler Conductivity Recorder on Process Auxiliary Board. Annunciation of high conductivity is also provided on the Process Auxiliary Board.

pH Cells, also located on these blowdown sample lines, provide pH readings on Boiler pH Recorder and annunciation of high or low pH on Process Auxiliary Board. Both continuous blowdown tanks are provided with high level alarms.

Boiler water from the continuous blowdown systems from Boilers 1 and 2 may be recirculated, if desired through a 1" line into deaerators 1 and 2 to control pH in these deaerators. This system however, has never been used since Boiler pH has been controlled by feeding Caustic directly to the steam drums.

Chemical Feed System

The chemicals used for boiler water conditioning are trisodium, disodium, and monosodium phosphate, sodium sulfite and caustic soda.

The phosphate reduces hardness and minimizes scaling by combining with any calcium in the boiler water to precipitate calcium phosphate. Calcium phosphate has very desirable properties for boiler sludge. It forms a finely divided fluid sludge which can be carried by the boiler recirculation and can, in general, be removed by blowdown. As calcium phosphate is the least soluble of the calcium salts that form in the boiler water, phosphate control prevents formation of all calcium scales such as calcium carbonate, calcium sulfate or calcium silicate.

The phosphate for Boilers 1, 2, 3, 4 and 5 is mixed in neoprene-lined tanks with covers, one for each boiler. Condensate from the condensate makeup line is admitted to the bottom of the tanks through a 3/4-inch swirl jet connection for dissolving the phosphate. Chemicals for each individual boiler are mixed in their respective tanks. Each tank is connected to a diaphragm pump for injecting solution into boilers. Boilers 1, 2 and 3 have interconnecting piping allowing chemicals to be pumped to each boiler with any one of the three pumps. Boilers 4 and 5 feed stations are at different locations, so piping is not interconnected. Dosage can be adjusted by chemical weight and stroke on pump.

For standby purposes, we have surge bottles at each of the three chemical feed stations. The solution is drained by gravity through a one-inch line to the surge bottle where feedwater taken off the feedwater header through a 3/4-inch line injects the solution into the boilers.

No matter how efficiently a deaerator is designed or operated, some oxygen, however little, passes through with the water coming out of a heater. Therefore, sodium sulfite is added to the water in order to scavenge this oxygen and minimize corrosion by combining with the oxygen to form sodium sulfate. It is fed into feedwater line downstream of feedwater regulators to each boiler.

The sulfite for Boilers 1, 2 and 3 is mixed in one neoprene-lined tank with cover. Condensate from the condensate makeup line is admitted to the bottom of the tank through a 3/4-inch swirl jet connection for dissolving the sulfite. Suction from the tank goes to three diaphragm pumps used for injecting the solution into each individual boiler. Boilers 1, 2 and 3 have cross-connecting piping off the discharge of these pumps allowing the feeding of any of the three boilers with any pump. Boilers 4 and 5 have their own neoprene tanks and each has a diaphragm pump.

In addition, an EDTA chelant is fed to all boilers to aid in the control of iron. Necessary storage, mix, and pumping facilities are provided for each boiler.

Low level in the mixing tanks is annunciated on the Mechanical Vertical Board and also on the Process Auxiliary Board. The pumps are started and stopped at local pushbutton stations.

Chemical Feed System (cont'd)

Caustic soda is added to regulate the pH of the feedwater and of the boiler water. It is mixed when necessary directly with the phosphate in the phosphate mixing tanks.

Refer to safety operating procedure section for feeding chemicals to boilers.

B. NO. 3 BOILER

No. 3 Steam Generator

Boiler No. 3 is a Babcock and Wilcox Unit with a continuous capacity of 750,000 pounds of steam per hour at 1,300 psi superheater outlet pressure, 1,450 psi maximum drum working pressure and 950° total steam temperature with natural gas as fuel.

The steam generating unit includes a 66 inch nominal diameter steam drum, a 48 inch nominal diameter lower drum, a water cooled furnace, a continuous vertical loop high velocity superheater, a double flow economizer, a Ljungstrom rotary type air preheater and a spray attemporator steam temperature control valve.

The unit is designed to permit free movement of parts, both vertically and horizontally, due to expansion without placing strains on any part of the unit. The boiler drum and headers are suspended from overheat support steel and the boiler and setting expand downward from the top supports.

Refer to Procedures Manual for startup curve.

Water and Steam Paths

Water and steam path in #3 Boiler is basically the same as on Boiler 1 and 2. Only the tube, drum and header sizes are different.

Safety Valves

The boiler is provided with three safety valves on the steam drum and one safety valve on the superheater outlet header. In addition, a power control valve is located on the main steam header which may be operated either by excessive pressure on the header or by operation of the selector switch on the Mechanical Console Board.

All three steam drum relief valves are welded Consolidated 3 inch valves. One is set to pop at 1450 psi and close at 1392 psi, another set to pop at 1470 psi and close at 1411 psi, and the third to pop at 1490 psi and close at 1430 psi. The superheater relief valve is a welded Consolidated 1500 psi 3 inch valve set to pop at 1370 psi and close at 1305 psi. The power control electromatic relief valve is a welded Consolidated 2½ inch valve set to pop at 1340 psi and close at 1327 psi.

Burners

The unit is provided with twelve B & W Multispud type gas burners arranged in three horizontal rows of four burners each. This type gas burner can be effectively used to burn natural gas, refinery gas, butane gas and propane gas. The design of this type burner is such that it can be used either as a gas burner only, or included in multifuel burner arrangements for (a) gas or oil firing (b) gas, oil or pulverized coal firing.

The burner consists of the air register with its simultaneously adjustable doors, the eight gas burner spuds inserted through the hub of the air register, an impeller plate to diffuse combustion air at the burner tips and electric igniter and gas pilot for lighting the burner. The combustion air passes along the burner spuds and through the impeller plate placing them in the zone of active air flow, thus keeping them relatively cool. Each burner spud is provided with two quick connective couplings to be connected by hose to high pressure air for removal of individual spuds while the boiler is on the line.

Air Preheater

The boiler is provided with a Ljungstrom Rotary, vertical, type VIX, air preheater. This air preheater is of the regenerative type in contrast to the tubular recuperative types on Boilers 1 & 2.

The unit consists of the rotor and associated heat transfer elements; a rotor drive unit consisting of two General Electric 10 h.p. drive motors (one for service and the other for stand-by) and a Falk speed reducer; rotor housing; an oil immersed rotor guide bearing mounted on the lower end of the rotor post; an oil immersed rotor support bearing (of the Kingsbury type) mounted on the upper end of the rotor post to support the weight of the rotor; a thermostatically controlled integral rotor support bearing oil circulating system consisting of a pump and cooler mounted on the rotor support bearing housing; a heating element cleaning device consisting of a drive motor, speed reducer and oscillating nozzle connected to the 235# process steam system.

The air preheater absorbs waste heat from the flue gas, then transfers this heat to incoming cold air by means of continuously rotating heat transfer elements of specially formed metal plates. Thousands of these high efficiency elements are spaced and compactly arranged within twelve sector shaped compartments of a radially divided cylindrical shell, called the rotor. The housing surrounding the rotor is provided with duct connections at both ends and is adequately sealed by radial and circumferential sealing members -- forming an air passage through one half of the preheater and a gas passage through the other.

As the rotor slowly revolves the mass of elements alternately through the gas and air passage, heat is absorbed by the element surfaces passing through the hot flue gas stream; then, as these same surfaces are carried through the incoming air stream, they release the stored up heat -- thus greatly increasing the temperature of the incoming combustion air.

Miscellaneous Connections

On this boiler the drains and valve arrangements differ from Boilers No. 1 and 2. Each of the two side wall headers is provided with three single valved $1\frac{1}{2}$" drain connections on a $1\frac{1}{2}$" header with a downstream block valve of the same type. The floor header and rear wall header are each provided with four single-valved $1\frac{1}{2}$" drain connections on a $1\frac{1}{2}$" header with a downstream block valve of the same type. The lower drum and the intermediate header are each provided with two $1\frac{1}{2}$" tandem-valved drain connections. Since no intermittent blowdown of this boiler is required, all these connections are referred to as drains rather than blowdowns. If it is necessary to blowdown because of high drum level, it is recommended that only the lower drum be blown.

For draining purposes, the $1\frac{1}{2}$" lines connect with a 3" line to waste which is blocked with a 3" gate valve. For blowdown purposes the $1\frac{1}{2}$" lines connect with a 4" line which drains into the blow-off tank. A 4" gate valve blocks this line. A removable elbow permits filling the boiler with condensate make-up through a 4" line and 4" gate valve by means of the make-up pumps. An acid cleaning connection is provided in the blow-off line.

On this boiler the following tandem-valved lines discharge into a common 3" header which also leads into the blow-off tank: the $1\frac{1}{2}$" economizer inlet header drain; the two 1" gauge glass drains; the two $1\frac{1}{2}$" water column drains; the two $1\frac{1}{2}$" primary superheater drains; the two $1\frac{1}{2}$" secondary superheater drains. A removable elbow in this 3" line permits filling with condensate make-up through a 3" line by means of the make-up pumps. The four superheater drains are provided with acid cleaning connections.

Draft System

Air for combustion is supplied by two turbo-vane forced draft fans driven by Allis-Chalmers 400 HP, 1700 RPM motors. The fans discharge through the air heater, the wind-box, and into the furnace. The fan capacity is regulated by inlet louvers positioned by piston operators that are activated by the combustion control system.

The furnace, being pressurized (No ID fans), the gases of combustion are forced through the superheaters, the gas passages, the economizer, the air pre-heater and out the stack.

The fans may be started and stopped either locally or from the Mechanical Console. Thermo-couples are located on both fan and motor bearings and temperatures are recorded on the Bearing Temperature Recorder in the Control Room. Annunciation of high temperatures is provided on the Mechanical Vertical Board.

To allow for inspection of the furnace or maintenance on burner lighters while boiler is on the line, 100# air off the plant service air system is supplied at each furnace opening or inspection port for sealing purposes. Low pressure air off the FD fan discharge duct is piped to each opening for cooling purposes.

DO 124207
CONFIDENTIAL

C. NO. 4 BOILER

No. 4 Steam Generator

Boiler 4 is a Riley Stoker Corporation front-fired, single-drum, radiant boiler constructed for pressurized furnace operation. This boiler is designed for maximum working pressure of 1475 PSIG and will produce 1,100,000 lbs. of steam per hour continuously at 1300 PSIG and 950°F at the superheater outlet, when supplied with feedwater at 274°F at the economizer inlet, when fired with natural gas.

The boiler is supported or hung from a structural steel framework that rises from ground level of 0' and extends upward to elevation 90'. The girders and structural beams at this upper elevation carry all the pressure parts and the boiler setting. The steam drum is supported by two large "U" straps from the top girder. All headers and/or tubes are suspended from hanger bolts or multiple support rods. This entire arrangement of headers and tubes that make up the pressure parts are formed into an air- and gas-tight box or setting by continuously welding construction, covered with heat insulation and stucco embossed aluminum lagging.

Boiler Water Circulating System

The water circulation in this boiler is by natural means only or by the change in the density of the fluid (water and steam) in the boiler. The water being supplied to replace the steam generated and delivered to the Plant steam lines first passes through the economizer before entering the steam drum. On entering the steam drum, the incoming or make-up water is carried by the distributor pipe to the double bank of condenser elements before being released along the entire length of the drum to mix with the boiler water. The mixture of boiler water and feedwater flows directly toward the nearest downcomer, each originating at approximately the 1/4 point of the drum shell bottom and then downward to the main bottom waterwall header. From this main bottom waterwall header, the water is distributed to the side waterwall headers and bottom furnace platen headers. The water will now enter the various wall and furnace platen tubes and flow upward, absorbing heat and decreasing in density and is finally discharged into the steam drum.

Steam generated during this upward flow, as a result of heat absorbed, is released from the accompanying water within the steam drum. Upon entering the steam drum, the mixture is directed through the double bank of primary separators installed along the front and rear wall where the water is removed and the steam continues through the double bank condenser surface. The steam then turns upward passing through rows of drier cartons where all remaining moisture is removed into the dry steam compartment where it is distributed to and enters the superheater supply tubes that originate along the top surface of the steam drum shell. The water deflected by the primary separators again mixes with the incoming feedwater and continues the described circuit.

DO 124208
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Boiler Steam Drum

The steam drum has an internal diameter of 66", a minimum wall thickness of 3.550" in the cylinder section and an overall length of 50'7". There are two downcomers originating from the drum cylinder 9'3" from the unit centerline which supply water to all heat absorbing surface.

The drum contains the steam purifying equipment that consists of the following items located at the front and rear of the internal cylinder. First are the primary separators immediately in front of the rows of releaser tubes that return the emulsion of steam being generated and accompanying boiler water to the steam drum. The mixture enters these separators where the steam continues toward the center of the drum and the water is returned to the lower part of drum floor. The primary separators are followed immediately by the condensers. After passing through the condensers the steam turns upward and passes through the drier cartons that enclose the dry steam compartment. All moisture has now been removed from the steam. The Riley steam separator-condenser-drier section is 37'6" long and is designed to deliver steam with a maximum of ½ part per million dissolved solids content to the superheater system when the boiler water total dissolved solids does not exceed 500 ppm and the chemical ratios maintained correct. After passing through the steam purifying, steam enters the four rows of superheater supply tubes that originate along the top surface of the drum shell.

Burners

The boiler is equipped with twelve (12) Riley stoker Corp. horizontal flare type forced draft burners equipped for natural gas operation only. The burners are installed at three elevations on the front furnace waterwall, four at each level.

All burners are mounted in an integral windbox carried on the front furnace wall. Each burner includes a centrally located gas gus with stainless steel tip which is connected to the burner gas header by a flexible hose. The gas gus is also equipped with an adjustable diffuser or deflection plate. In addition, each burner has a set of adjustable secondary air vanes used to control control air flow and shape of the flame. These vanes can also be closed to restrict air flow whenever the burner is not in operation.

Each burner is also equipped with a gas-electric Riley model B-1 ignitor, complete with spark plug electrode, high tension lead cable, transformer and electric push-button station.

Air Preheater

The principle of operation of the air preheater on this boiler is similar to that described in the Air Preheater Section of this book on Boiler 3. The main difference is this preheater is mounted on a horizontal shaft, whereas, the air preheater on Boiler 3 is vertical. Rotor driving machanizm consists of a somewhat larger electric motor and auxiliary motor. All other components are similar.

Forced Draft Fans

The boiler is supplied combustion air by two Westinghouse Electric Corp. forced draft fans, size 2375D Air foil type, double width inlet with top horizontal discharge. The fans are equipped with sleeve type bearings, pedestal mounted with thermocouples in each. Air flow control is by inlet vanes. Shut-off dampers are installed at fan discharge.

Each fan is capable of delivering 180,000 cfm of air with entering temperature of 100F against a statis discharge pressure of 27" of water. The fans are driven by 1000 horsepower 1200 rpm constant speed motors.

Combustion Air and Gas Travel

The combustion air delivered by the forced draft fans is discharged to the duct and is conducted to the air preheater. The air flows forward through the Ljungstron Air Preheater, on to the air measurement device (venturi) located directly beneath the furnace and then turns upward before entering the burner windbox. In the windbox the heater air is distributed to the burners that are in service, and passes through these burners where it mixes with the incoming fuel as it enters the furnace.

In the furnace, the complete combustion of the fuel with the air takes place and the resultant products pass upward giving up heat to the radiant furnace walls and furnace platens. The gases continue upward past the deflection arch and turns rearward above the arch and passes through the rear wall screen tubes that immediately precede the high temperature superheater surface. Upon entering the high temperature superheater, the gases turn downward flowing through the remainder of the high temperature superheater surface, the primary superheater surface and the economizer in the order named.

After leaving the economizer, the cumbustion gases turn rearward and pass through the air preheater where further heat is removed. From here the gases pass directly to the stack and are thendischarged to atmosphere.

Continuous Blowdown System

The continuous blowdown system on this boiler is similar to that on Boilers 1, 2 and 3 previously described in this manual, under Boiler 1 and 2.

Chemical Feed System

The chemical feed system is also similar to that on Boilers 1, 2 and 3 previously described in the manual under Boiler 1 and 2, except PO4 is fed normally in the same manner as sulfite by use of the Proportioneer chemical feed pumps.

DO 124210
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D. NO. 5 BOILER

No. 5 Steam Generator

Boiler 5 is a Riley Stoker Corporation front fired single drum radiant boiler constructed for pressurized furnace operation. This boiler is designed for a maximum working pressure of 1500 psig and will produce 1,600,000 lbs. of steam per hour continously at 1300 psig and 950 F at the superheater outlet, when supplied with feedwater at 274 F at the economizer inlet, and fired with natural gas.

The boiler is supported and hung from a structural steel framework in the same manner as Boiler 4.

Boiler Water Circulating System

The water circulation in this boiler is the same as in Boiler 4 previously described in this manual.

Boiler Steam Drum

The steam drum has an internal diameter of 66", a minimum wall thickness of 3.528" in the cylinder section and an overall length of 51', 10½". There are tow downcomers originating from the drum cylinder 9' 6" from the unit centerline which supply water to all heat absorbing surfaces.

Purification equipment in the drum is the same as described in Boiler Steam Drum section of Boiler 4 in this manual.

Burners

With the exception of this boiler having 16 Riley Stoker Corporation horizontal flare type burners installed on four elevations on the front furnace waterwall, all other data concerning these burners is the same as described in Burner section of Boiler 4 in this manual.

Air Preheater

With the exception of drive motor sizes, air preheater operation on this Boiler is the same as Boiler 4.

Forced Draft Fans

Except for increased capacity, forced draft fans on this boiler are the same type as described on Boiler 4 of this manual. Fans on this boiler are capable of delivering 270,000 cfm and are driven by 1200 horsepower 1200 rpm constant speed motors.

Combustion Air and Gas Travel

The same as described in Boiler 4 section of this manual.

Continuous Blowdown System

The same as described in Boiler 4 section of this manual.

Chemical Feed System

The same as described in Boiler 4 section of this manual.