

LESSONS LEARNT FROM TROUBLESHOOTING

INTRODUCTION

A boiler with trouble can make the industry sick. It is necessary to stop living with problems. Interactions with manufacturer could help to find solutions. Boiler users may have to spend for regular audit of the boilers. A budget for training and annual inspection would prove worth for achieving better availability & better efficiency of the boiler.

CASE 1: STRESS INDUCED CORROSION IN EVAPORATOR COILS

- Problem: A metallurgical boiler tubes failed soon after the first light up.
- Diagnosis: The hydrotest of the boiler was done with DM water but without ensuring the pH was 9.5. The forced evaporator circuits were non drainable. The attachment welds at Evaporator spacer shoes were heavy. Being carbon steel, the stress relieving was not done at factory. But due to uncontrolled weldment size the amount of locked up stresses was high. Once the low pH water was available, the H⁺ ions diffused through grain boundaries. When the boiler was fired, the hydrogen ions led to long chain of cracks.
- Lesson: Water used for hydro must be of 9.5 pH. The water should be blown out from non drainable sections. Weldment sizes are not to be heavy. The PWHT should be practiced in case of heavy weldment.

CASE 2: TUBE FAILURE IN WATERWALL

- Problem: Tube failed only in one particular water wall tube (both left & right side of water wall at identical location).
- Diagnosis: The boiler was basically designed for under bed firing of rice husk. The boiler had provision for firing husk in over bed. Customer had operated the boiler mostly on over bed. In general about 35% of the heat is absorbed by the under bed firing due to better temperature in the bed. The heat pick up was now fully by water wall rather than the bed. The boiler was provided with a baffle to prevent gas bypassing in the gap between the ends SH coils and water wall. These baffles prevented heat transfer and these tubes started starving. The baffle was removed.
- Lesson: Uneven heat transfer can result in result in poor circulation in natural circulation design.

CASE 3: DUST POLLUTION FROM BOILER

- Problem: Increased dust pollution from chimney. The dust pollution had gone up due to poor maintenance in Mechanical dust collector.
- Diagnosis: The mechanical dust collector casing had failed due to condensation of gases. The air ingress had let to the reversal of dust in cyclones. Moreover while replacing the mechanical dust collector cones the required dimension controls were not observed. A dust trap was introduced below the ID fan suction box casing. Further a water trap was added in the ID fan delivery ducting. This was also done in another installation as the customer had complaints from residents surrounding the factory.
- Lesson: MDC maintenance should be done with care, preferably under the supervision of quality control supervisor from manufacturer. The MDC checklist can be referred at the end of this paper.

CASE 4: DEAERATER STEAM HAMMERING EXPERIENCED AT TIMES

- Problem: An 80 TPH boiler with a deaerator developed hammering at times.
- Diagnosis: The level control valve was found to be crack open (less than 5%) during normal operation. The pressure drop inlet pressure was supposed to be 3 kg/cm² g, where as the actual pressure were more than 8 kg/cm² g. Due to high inlet pressure, there will be wide variation in water flow even for a small variation in valve opening. The transfer pump was meant for transferring water to distant boiler as well. Hence the pump discharge pressure could not be changed. Hence a pressure killing orifice was added to overcome the problem.
- Lesson: Control valve operation must be logged in commissioning report.

CASE 5: DUCTING SYSTEM DESIGN DEFECT

- Problem: A 60 TPH boiler could not generate beyond 55 TPH. The ID fan impeller change / Fan change did not help.
- Diagnosis: The ducting system sizing was reviewed. The high pressure drop causing locations were identified and rectified. Even the chimney inlet opening in the concrete chimney was broken and increased to remove the excess pressure drop in the ducting system. The O₂ level which was earlier not detectable was now 6% in the flue gas.
- Lesson: High velocity gas ducting is not good. The order of pressure drops could be high depending on velocity particularly at restrictions.

CASE 6: HIGH UNBURNT CARBON IN ASH

- Problem: An 80 TPH FBC boiler was recording high unburnt level (as high as 18%) in ash. Other boiler with the same fuel was having less unburnt in ash (as low as 5%).
- Diagnosis: The air ingress was severe in roof top. The O₂ analyzer was located in after the economizer was showing 4-5% O₂ level. Looking at O₂% in boilers with air ingress can be wrong. We need to optimize the O₂ based on carbon loss in ash. Pictures above show the leakages in roof.
- Lesson: air and gas leakage test is a must. A meticulous check is a must as otherwise the resulting losses will be huge.

CASE 7: BANK TUBE LOOSENING & WATERWALL DISTORTION

- Problem: A 35 TPH boiler just after commissioning met with loosening of all bank tubes in drums.
- Diagnosis: The man posted at drum level confirmed the water level was maintained all the time. From the circular chart recorder the feed water flow was found to be erratic. The line valves from BFP to drum were all in throttled condition. The control valve was operating under throttled condition. Practically the FCV was crack open. There were no positive down comers envisaged by the boiler supplier. The gas temperature at boiler bank was sufficiently high and it could reverse the water flow in heated down comers (last three rows of bank tubes). Drum internal modification was suggested. VFD was suggested as an immediate measure, so that water flow was not disturbed. Customer did not take action. In the next month the total water wall tubes were found to be twisted. Then the customer went for VFD for pump. All the water wall tubes were replaced.
- Lesson: oversized feed pump / wrong selection of BFP can create intermittent flow to boiler.

CASE 8: REPEATED SHELL TUBE WELDMENT IN 2 PASS INLET

- Problem: A customer was very upset over repeated failure almost everyday at the same weldment. Recently the boiler was retubed and the problem started. He thought it was a workmanship problem. But even after the repeated replacement, the problem continued.
- Diagnosis: As such the shell tube weldment was experiencing high gas inlet temperature. The type of weldment was wrong. Wherever there was excess weldment, the weldment was failing again and again as it was not getting the proper cooling. The J groove weldment design was recommended and the problem did not repeat.
- Lesson: The boiler must be repaired under the guidance of QC inspector from manufacturer. This helps in ensuring the right workmanship.

CASE 9: LOW STEAM TEMPERATURE FROM BOILER

- Problem: A Customer having a 130 TPH boiler started experiencing very low steam temperature.
- Diagnosis: On inquiry the water quality slippage was noted. Foaming was suspected as there was water level was not steady in the steam drum. The source of water was changed ten days back. The water came with high TSS. This has led to slippage of suspended impurities in to the boiler. The Boiler was stopped for 8 hours. During this time heavy blow down was given from all the bottom drains. Next day the steam temperature returned back to normal.
- Lesson: Regular check on total suspended solids check in condensate and make up will help to identify the foaming problem.

CASE 10: WATER LEVEL WAS NOT STEADY IN A 10 TPH BI DRUM BOILER

- Problem: The water level jumped by near about 50 mm within 10 seconds.
- Diagnosis: Foaming was suspected. The sources of water were reviewed. The process condensate was clean as it was a closed system. The lines were of stainless steel. The make up water pH was being boosted at condensate storage tank. However the DM water storage tank was made of carbon steel. The manhole cover itself revealed the amount of corrosion products that was generated.
- Lesson: Boosting of DM water pH is a must at the outlet of DM plant itself.

CASE 11: FREQUENT GAUGE GLASS FAILURE

- Problem: The gauge glass gasket failed very often. The problem was seen in all three boilers. The pressure of the boiler was 88 kg/cm²g.
- Diagnosis: Condensate was found to be forming in the long extension pipe. This was dripping from the steam tapping line through the gauge glass. There could be considerable heat coming to gauge glass. It was recommended to add interconnection pipe before gauge glass. Further the insulation of extension pipe was to be redone. There could be foaming in all boilers due to suspended impurities in feed water.
- Lesson: Monitoring total suspended solids is not to be ignored.

CASE 12: REPEATED BANK TUBE FAILURE

- Problem: The bi drum boiler is a saturated steam boiler without economizer. The pressure of the boiler is 21 kg/cm²g. The client reported that the bank tubes were failing repeatedly in one particular row only.

- **Diagnosis:** The boiler was shut and offered for inspection. Found loose corroded iron particles in the headers, drum, and feed water tank. The cause for corrosion products was the low pH water from RO plant. The piping from treated water storage tank was of carbon steel. However the tank was made of SS. The chemical dosing was done in the feed water tank. The centre bank tube being insulated from heat transfer by the gas baffles, the circulation is expected to be poor. Hence the loose deposits inside the tubes were operating as sites for local corrosion. Pitting corrosion was seen below the rust bubbles inside the tubes.
- **Lesson:** The piping from water treatment plant should be of SS.

CASE 13: CHIMNEY VIBRATION

- **Problem:** The 2 TPH boiler chimney was vibrating at high frequency. In the nearby houses, the vibration was felt by residents at night.
- **Diagnosis:** The vibration was due aerodynamics from ID fan. The cut off between impeller and the casing was increased and this solved the problem.
- **Lesson:** When it comes to high frequency noise or vibration the source can be the fans in most of the cases.

CASE 14: FD FAN NOISE

- **Problem:** The 30 TPH FBC boiler FD fan was making such a noise that it could be heard from the factory main gate.
- **Diagnosis:** The inlet guide vane direction of opening was found to be wrong. This was inferred from the fact that the noise was gone when the IGV was fully open.
- **Lesson:** The inlet guide vane opening has to match the casing orientation.

CASE 15: NON-PERFORMANCE OF PA FANS

- **Problem:** There were 2 x 100% PA fans used for under bed fuel feeding in FBC boiler. Though each fan was designed for 100% duty, both the fans had to be run.
- **Diagnosis:** There was considerable recirculation of air through the standby fan. The multi-louver damper was not fully sealing. This was replaced with a guillotine type gate.
- **Lesson:** Isolation gates are very important for high pressure fans.

CASE 16: NON-PERFORMANCE OF ID FANS

- **Problem:** The 2 x 60% ID fans were found to be insufficient for the service.
- **Diagnosis:** The inverted 'T' duct was found to be the cause for the problem. The duct was modified to inverted 'Y' duct in the best possible manner.
- **Lesson:** Fan performance always related to ducting in most of the cases.

CASE 17: NON-LOADING OF FD FANS

- **Problem:** The 2 x 60% FD fans were meant for FBC under bed operation. One of the FD fan was taking much lower current than the other for the same % opening.
- **Diagnosis:** The FD fan discharge connections were not correct. Such a high pressure fans having discharge at right angle was the problem. 'T' duct connection was modified to a 'Y' duct connection.
- **Lesson:** Poor Fan performance is mostly related to poor ducting layout. Have it checked before going for replacement of fans.

CASE 18: CAUSTIC GOUGING IN BED TUBES IN AFBC BOILER

- Problem: The FBC boiler bed coil tubes were failing often and caustic gouging indication was available inside the tubes.
- Diagnosis: This was a single drum high pressure (105 kg/cm²g) FBC boiler. The water side parameters were checked and found to be very good. Customer was very much aware on the coordinated phosphate control and was found to be practiced. Vendor diagnosed there was circulation was poor. The risers were modified by vendor but yet the problem continued in new bed coil tubes. A mistake in drum internals arrangement was diagnosed to be the cause. The feed water distributor pipe was running just above the down comer.
- Lesson: Poor circulation can cause water chemistry related problems.

CASE 19: MUD INSIDE BOILER AND INEFFECTIVE SOFTENING

- Problem: The shell cum water wall type boiler had failed due to heavy scaling. After retubing the problem persisted. There was heavy carryover of water in steam all the time.
- Diagnosis: The entire bottom headers had accumulated mud. The inside of the shell revealed the presence of high level of suspended impurities. The softener was preceded by a multigrade sand filter. The source of water contained high level of mud as the open storage indicated. The outlet water of MGF was checked. It was having mud. Customer was regenerating the MGF only when the softener was to be regenerated. It was clear that the MGF sizing was not adequate to handle the inlet suspended matter. I advised to add a water flow meter immediately so that the regeneration of the MGF could be done based on M3 of water passed. The MGF had to be replaced. There was no softened water storage tank. The water was being pumped directly to the feed water tank. Client was advised to provide a separate treated water storage tank.
- Lesson: Slippages in water quality occur for several reasons. A separate treated water storage tank is a must. Regular analysis of water of the treated water storage tank would avoid mishaps.

CASE 20: BED COIL FAILURE

- Problem: The bed coil failed in a new installation. The Customer had complained the tube had swollen and failed. But there was no blockage in the failed tube.
- Diagnosis: The boiler was not provided with provided with hand holes for cleaning. After the alkali boil out, it was not possible to clean the bottom headers. Introduced hand hole stubs for all the headers and cleaned the boiler fully.
- Lesson: After alkali boil out a thorough cleaning of the boiler is a must. Many boilers had failed due to negligence of a thorough cleaning after the boil out.

CONCLUSION:

Boiler users experience varieties of problems in the installations. The problems arise due to basic design defects and technology gap of the O&M personnel. A regular training program / interaction with manufacturer could help to find solutions.

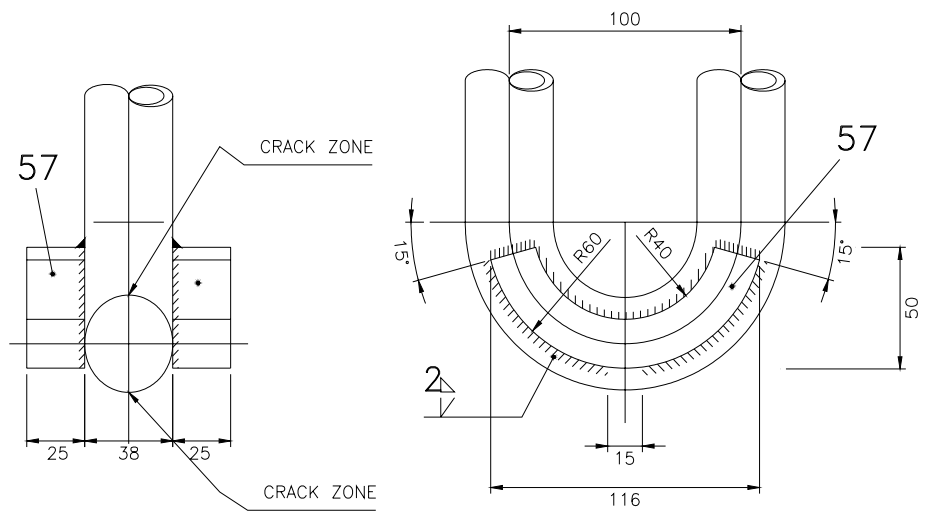
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LOCATION OF FAILURE IN EVAPORATOR

FIGURE 1



FIGURE 2

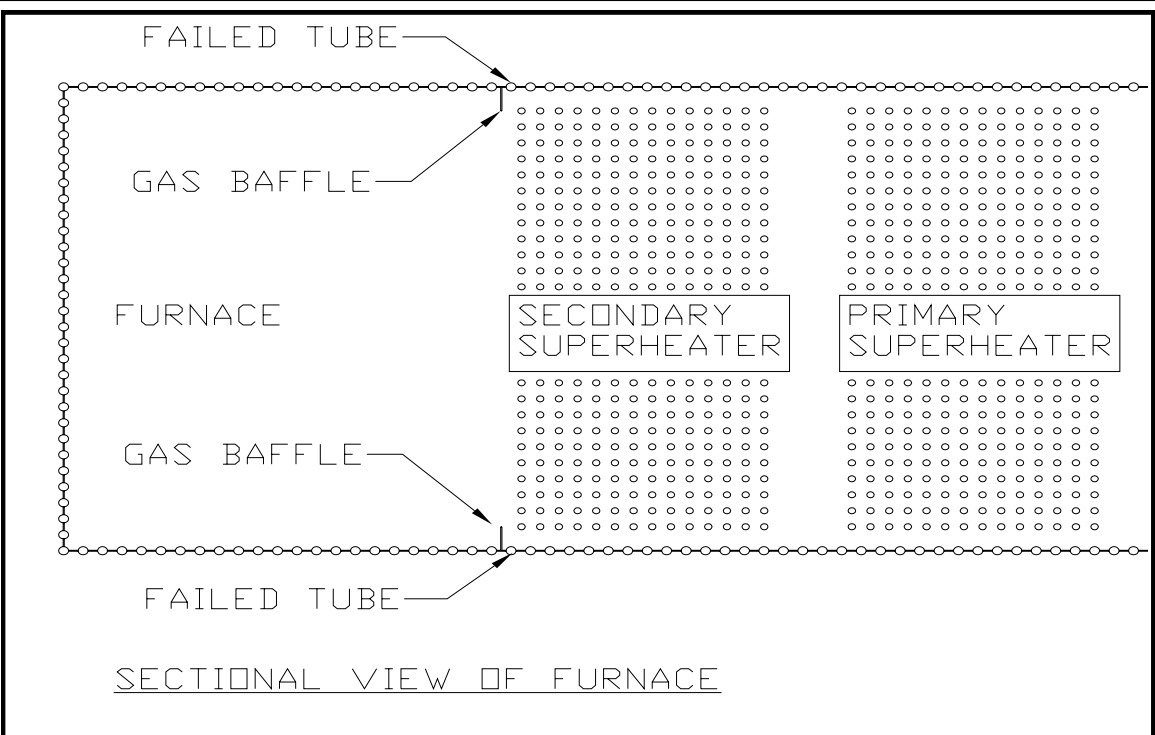


FIGURE 3



FIGURE 4



FIGURE 5



FIGURE 6



FIGURE 7

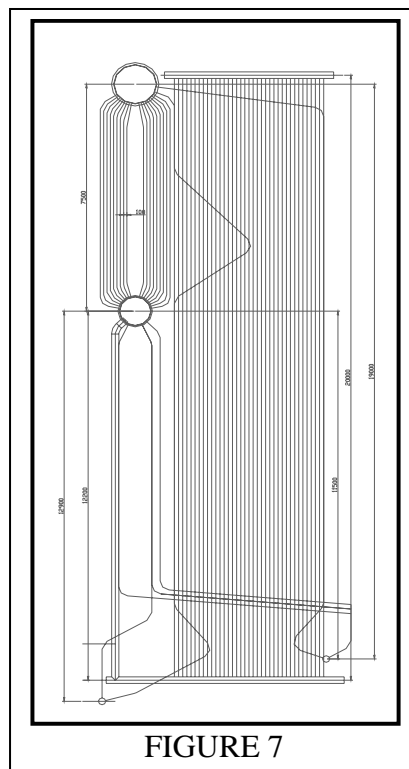


FIGURE 7

IBR weld fig no XII/67/A i

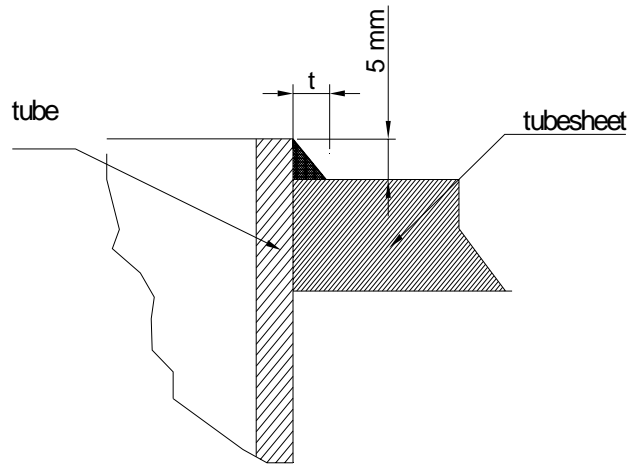
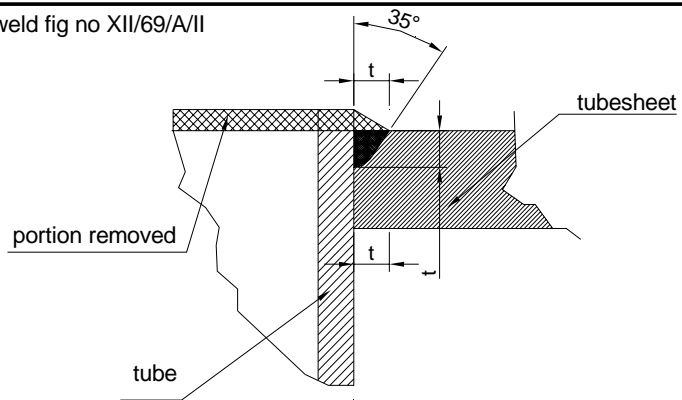


FIGURE 8 Not for high temp zone

IBR weld fig no XII/69/A/II



1. The tube ends should be lightly expanded to fill the holes.
2. The tube ends and weld projecting beyond the weld shall be grounded off.

FIGURE 9 Correct weld figure

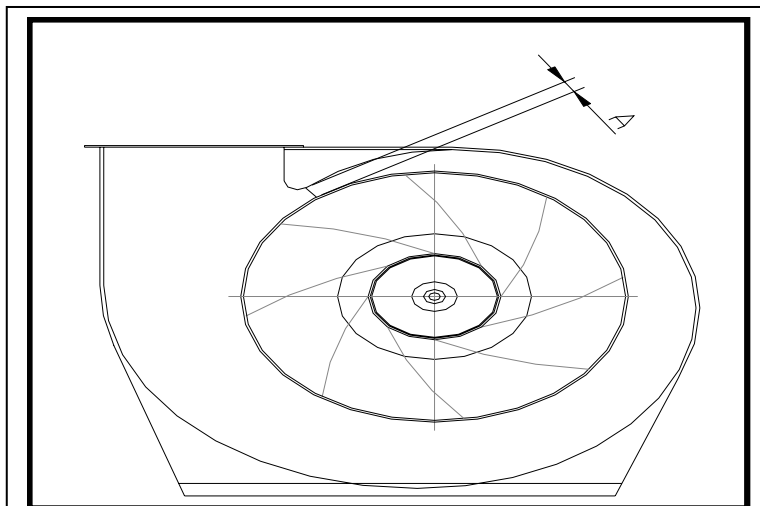


FIGURE 10

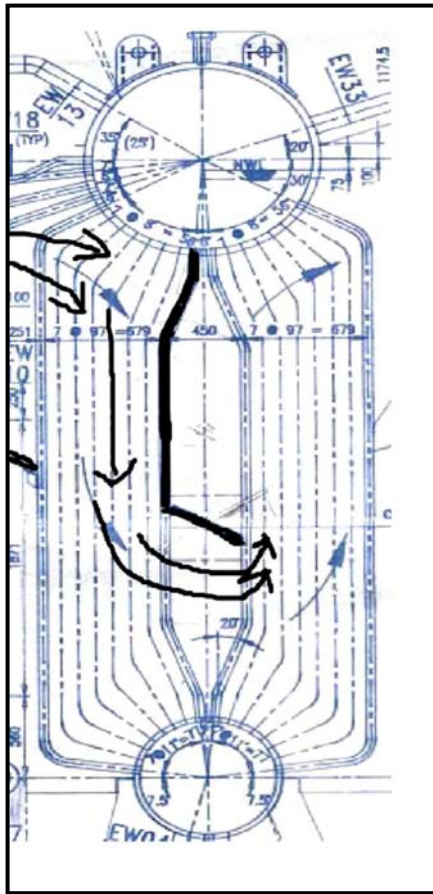


FIGURE 11

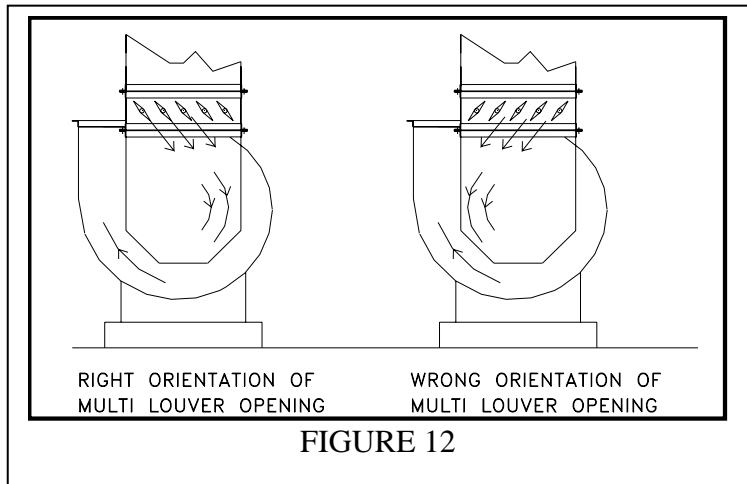


FIGURE 12

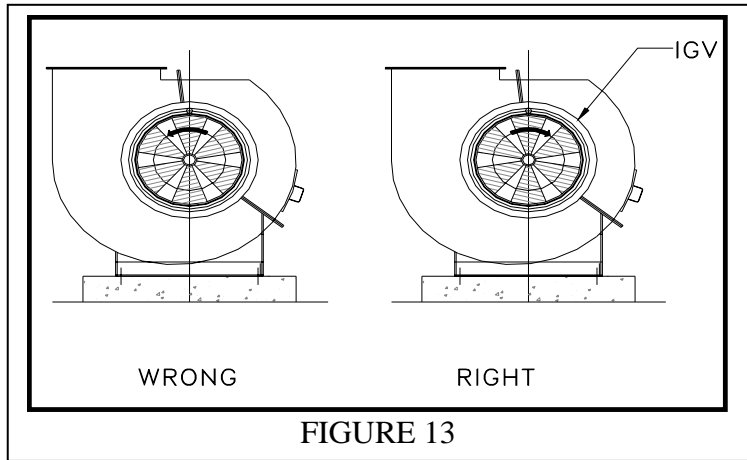


FIGURE 13

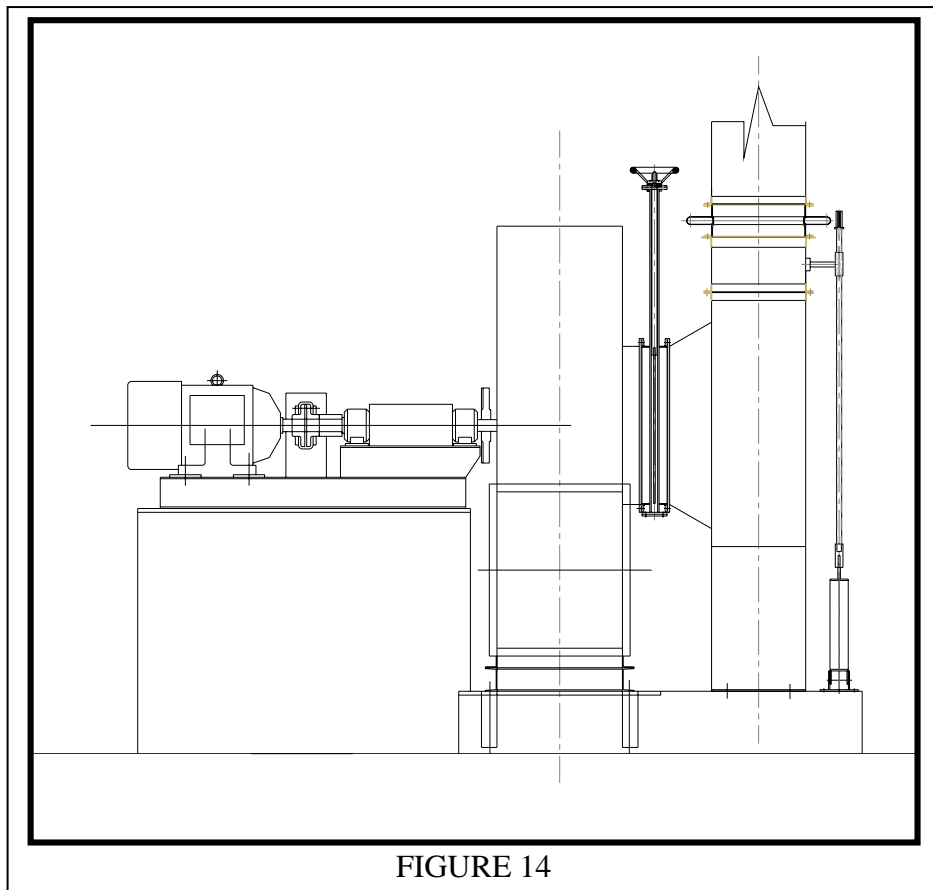


FIGURE 14

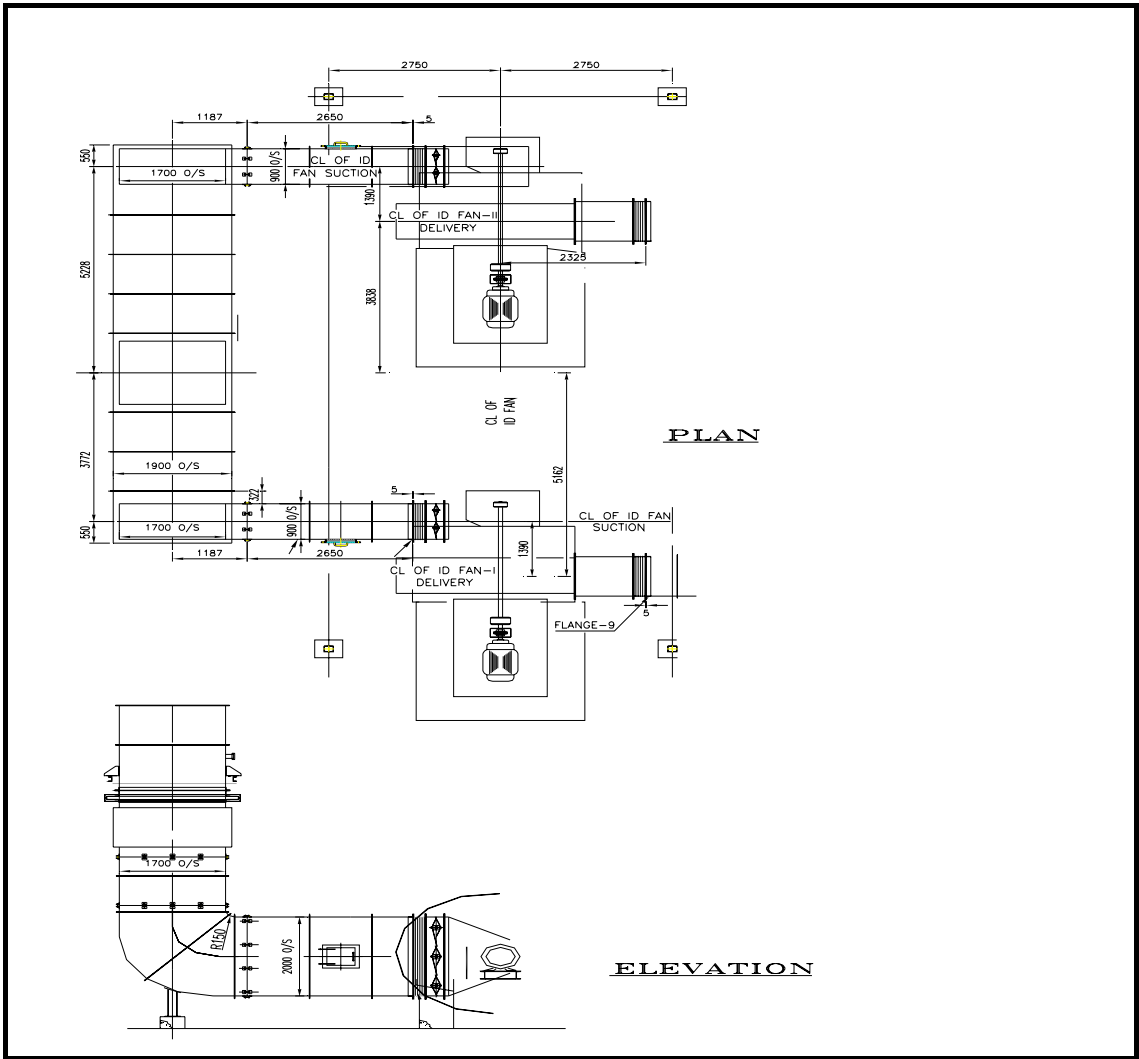


FIGURE 15

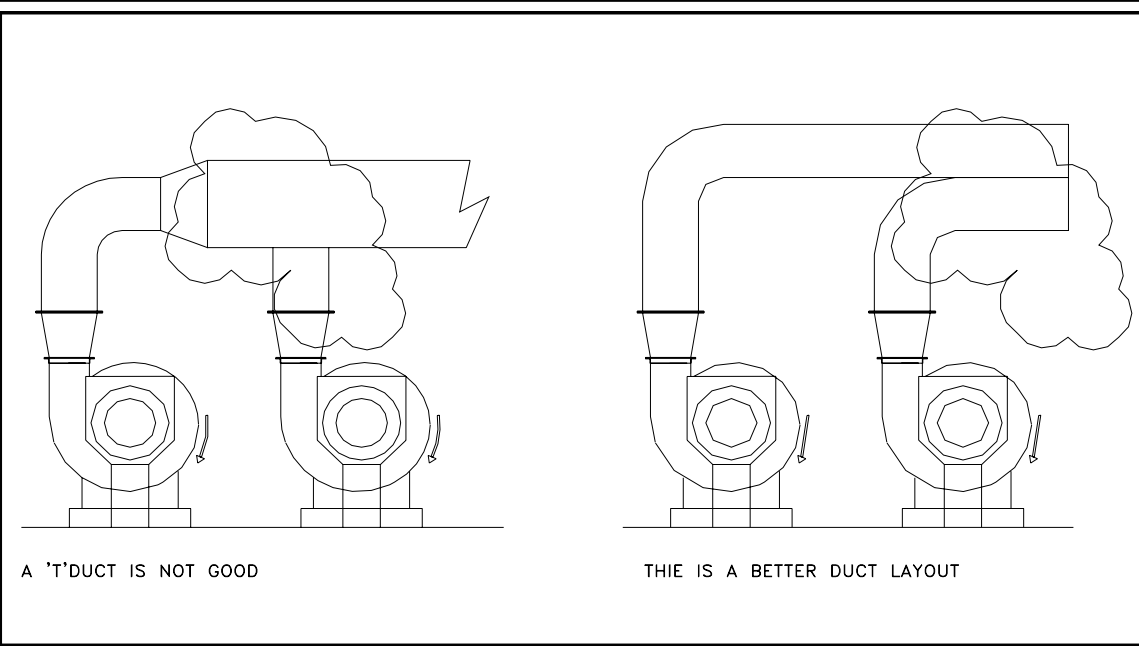


FIGURE 16