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Research Article

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Successful Practical Case Studies Solved at our P&U, NRL

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Abstract

In our day-to-day plant operations, we come across various problems, issues & mysterious cases which compel us to brainstorm ourselves to come out with befitting solutions and solve them and once again make our plants smooth and trouble free.

In line with that, our P&U, NRL we have encountered numerous such problems, difficulties, issues, etc., leading to disturbances in the smooth operations of the plants, reducing the reliability and flexibility of the operations, loss in energy and money, …… reduction in the overall productivity & efficiency of the running plants.

This paper highlights those such very important and successful case studies carried at our P&U, NRL which have enriched our practical work experiences, boosted our confidence and helped to conserve and recover the lost energies and last but not the least increased the safety aspects of the operations and manpower involved. Also in the process, we have been able to develop a few best practices during those successful case studies.

Sl. No.	Sucessful Studies of Mysterious Cases at P&U NRL	Problems solved	Remarks
1	Interesting, peculiar and mysterious observations ...... of STG CT H2SO4 acid overhead dosing tank	Mysterious case solved	Cleared the confusions of the mysterious observations.
2	UB tripping on SCAF pr. low-low trip alarm actuation during Total Power Failure scenario (Blackout conditions)	Root cause of UB tripping identified and solved	Improved the safe shutdown & reliabilty of the sustenance of the UB during Total Blackout
3	Heavy hammering problem of CPP De-aerator	Root cause identified and solution planned	Improved the safety aspects of the De-aerator

Abbreviations

- NRL: Numaligarh Refinery Limited,
- P&U: Power & Utility
- CGP: Co-Generation Plant
- CPP: Captive Power Plant
- GTG: Gas Turbine Generator
- STG: Steam Turbine Generator
- UB: Utility Boiler
- SCAF: Scanner Cooling Air fan
- AC SCAF: Alternating Current SCAF
- DC SCAF: Direct Current SCAF
- PSL: Pressure Switch Low
- PSLL: Pressure Switch Low-Low
- CT: Cooling Tower
- LP steam: Low Pressure steam
- DMW: De-mineralized Water

Let us see all the above mentioned Mysterious Case Studies one by one in details

2. Case Study-I : "A Very Interesting, Peculiar and Mysterious Observations .... of STG CT H2SO4 Acid Overhead Dosing Tank"

Abstract

This paper describes about the case study of a very Interesting, Peculiar and Mysterious observations .... of STG CT H2SO4 acid overhead dosing tank. It highlights the various possible reasons of that observation with supporting logics during the STG CT H2SO4 Dosing System. After taking shutdown of H2SO4 Dosing System for the Inspection of the H2SO4 Storage Tank and subsequent opening of the suspected faulty and passing valves for their maintenance jobs; our logics were found to be practically correct. Finally, the problem is solved and now the *system is healthy.*

"A Very Interesting, Peculiar & Mysterious Observations ……………" :-

• To whatever level we top up (100%, 98%, 80%,50%,30%, any level above 22%), the level of the overhead H2SO4 acid dosing tank (located at about 13 metres above the Ground level) suddenly decreases and comes down to approx. 22% within 20 to 30 minutes after the stoppage of the H2SO4 acid top-up or transfer pumps. To what amount of H2SO4 level is decreased in the overhead dosing tank, exactly the same amount of H2SO4 comes back into the storage tank located at the Ground level (Ground floor).

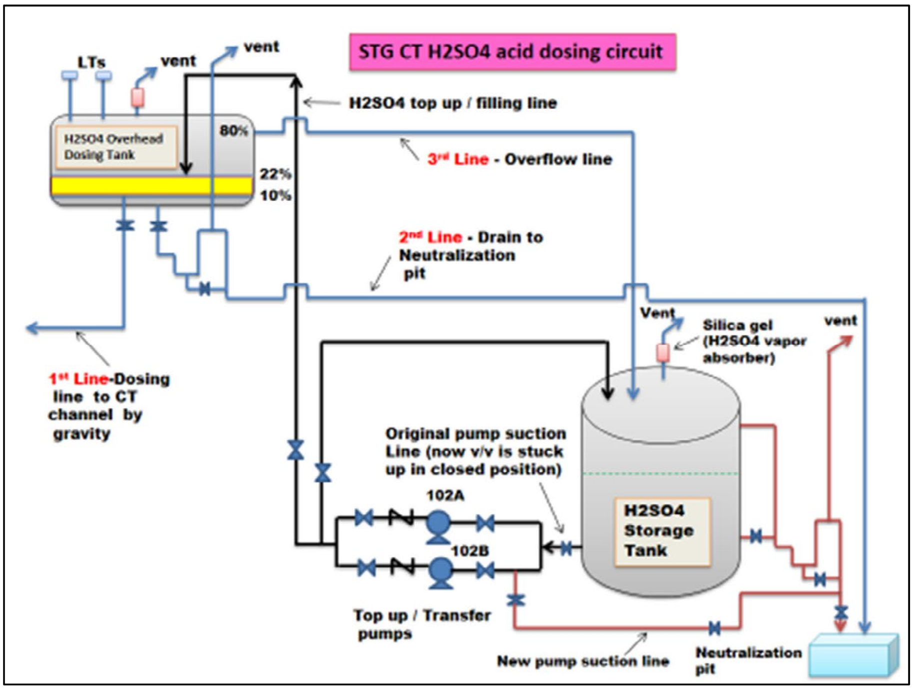

Figure 1: STG CT H2SO4 acid dosing circuit

2.1 Brief Description of the STG CT H2SO4 Acid Dosing System:

At Steam Turbine Generator (STG) Cooling Tower (CT), we have sulphuric acid (H2SO4) dosing system to maintain Cooling water pH. The overhead dosing tank located at about 13 metres height from the ground level is topped up by two nos. of top-up or transfer pumps (102A & 102B) from the H2SO4 storage tank allocated at ground level. The original pump suction root isolation valve is stuck-up in closed condition. So, a new pump suction line is fabricated which is shown and indicated by maroon colour line in the above picture Fig-1.

The overhead dosing tank has 3 main outlets viz. - 1st line is the dosing line going to CT channel by gravity; 2nd line is the drain line to the Neutralization pit and the 3rd line (taken from about 80% level of the dosing tank) is the overflow line going back to the storage tank.

Description of Observations

Diagram (Fig-1) is Attached Above for Reference.

• Since the last few months or so, the level of STG CT H2SO4 dosing tank level decreases suddenly just after the stoppage of the top up/transfer pump.

• To whatever level we top up (100%, 98%, 80%,50%,30%, any level above 22%), the level of the overhead dosing tank suddenly decreases and comes down to approx. 22% within 20 to 30 minutes. The same amount of H2SO4 level decreased in the overhead dosing tank, exactly the same amount comes back into the storage tank.

• On 02.11.2018, H2SO4 acid overhead dosing tank level was topped up through top-up/transfer pumps (102A/102B) from the ground level H2SO4 acid storage tank.

• The overhead dosing tank level was topped up to 95% level from initial approx.10% level (two LTs are available 25LT1105 & 25LT1106 in the overhead dosing tank).

• Just after the stoppage of the top-up/transfer pumps, the overhead dosing tank level started to decrease fast from 95% and reached to about 22% level in about 20 to 30 minutes time. The level reduced in the overhead dosing tank is reflected in the rise of the storage tank level.

• The next day on 03.11.2018, again overhead dosing tank was topped up from that 22% up-to 95% to see and cross check the observation. Exactly similar observation was noted. The overhead dosing tank level started to decrease fast from about 95% level and reached to about 22% level in about 20 to 30 minutes time.

• The dosing tank level lasts for about a week and it's level comes down to about 9% to 10% at which the dosing gets stop in the channel (dosing is done by gravity force) and then we need to again top up the dosing tank after one week.

• There is no change in the dosing rate of H_2SO_4 into the STG PCT channel (just at the outlet of Cell-09).

• Rate of H_2SO_4 dosing in the STG CT channel is same in both the days as earlier rate.

• Similar activities carried out in different days with the same rate of H_2SO_4 dosing throughout the activities and the same observations noted in every activity.

• *Earlier, the dosing tank level when topped to about 95% to 100% (full), it lasts for about 20 to 25 days (at the same rate of dosing); but nowadays it last only for a week and needs again top up.*

2.2 Following Very Interesting and Peculiar ……. and Mysterious Questions Arises in our Minds……???

• Why there is a change in the observations?
• Where does the overhead H_2SO_4 dosing tank level goes?
• How exactly the same amount of H_2SO_4 which is decreased in the overhead dosing tank (located at a height of approx. 13 metres from ground level) exactly the same amount comes down/back to H_2SO_4 Storage Tank (at Ground Floor)
• Through which path the H_2SO_4 comes back to the Storage Tank?
• Why it decreases only up-to 22% …. after it's top to any % of level beyond 22%?

2.3 Step-by-Step Analysis and Solutions/Answers to the above Queries and Mysteries

• From Overhead H_2SO_4 Dosing Tank, there is one inlet (filling line from the transfer/top up pumps discharge lines). This filling line enters into the dosing tank at the top portion of the dosing tank.
• From Overhead H_2SO_4 Dosing Tank, there are three outlets – 1st is dosing line into the STG CT channel through gravity, 2nd is drain line going into the neutralization pit at the ground floor (both of these lines are from the bottom of the dosing tank, 3rd is the over flow line from overhead dosing tank (comes out from about 80% level of the dosing tank and has no valve) goes back into the storage tank (located at ground floor through the top portion of the tank).
• After stoppage of transfer/top up pumps, all the pumps inlet (suction lines) and outlet (discharge lines) are isolated. Above mentioned 2nd drain line is also isolated.
• No H_2SO_4 is observed coming out through the 2nd drain line. So, 2nd line is nullified.
• No chance of H_2SO_4 flowing back through overflow line into the storage tank (through siphonic and gravity forces/actions) as it is found that to whatever level the overhead dosing tank is topped up, the level comes down to approx. 22% in the dosing tank and the same amount of level decrease is reflected in the same amount of rise of the storage tank level. The over flow line could only force back the level to and beyond 80%. Below it, the overflow line will suck the air, not the H_2SO_4. So, there is no chance of H_2SO_4 going back into the storage tank through overflow line of the dosing tank. So, 3rd line is also nullified.
• Only option left behind is the pump discharge line and it's related lines if any …… the pump recirculation line at the discharge line which goes into the storage tank.
• The H_2SO_4 dosing tank could not go back through pump discharge and suction lines as it has go through many hurdles – individual discharge NRVs & isolation valves, suction valves and finally tank last valve. No chance through pump discharge and suction lines, so these two lines are also nullified.
• The last option is the pump recirculation line. There is confirmed 99.99% chance of H_2SO_4 of overhead dosing tank going back into the storage tank through this pump recirculation line. For this to happen, the recirculation line isolation valve should be passing and also the pump discharge common header line isolation valve should also be passing. So these two valves passing are the main reason of back flow.

• Now, why overhead dosing tank level comes down only to approx. 22% ......and how??? …….
• Reason: The H_2SO_4 transfer/top pumps discharge line/filling line which enters into the overhead dosing tank is extended inside the overhead dosing tank approx. to about 22% level of the dosing tank. When the pumps are in service, the H_2SO_4 goes to the overhead dosing tank and also simultaneously to the storage tank through the pump re-circulation line due to passing valve. So, as soon as the transfer pumps are stopped, the liquid column pressure build up inside the overhead dosing tank due to rise in liquid level inside it; results in the siphonic action on the already filled in H_2SO_4 in the filling line/pump discharge line and pump re-circulation line, the H_2SO_4 automatically goes back to the storage tank till 22% is reached at the Overhead dosing tank by the siphonic action and further aided by the gravity force (which is because the overhead dosing tank is situated at a higher position of about 13 metres than the storage tank at ground floor). After that 22% level, the level of H_2SO_4 comes below the final discharge point of the pump filling line. So air enters into the filling line and breaks the siphonic action and breaks the automatic continuity of H_2SO_4 flow through the siphonic and gravity forces/actions and thus we could see that the overhead dosing level comes down and become stable at 22%.

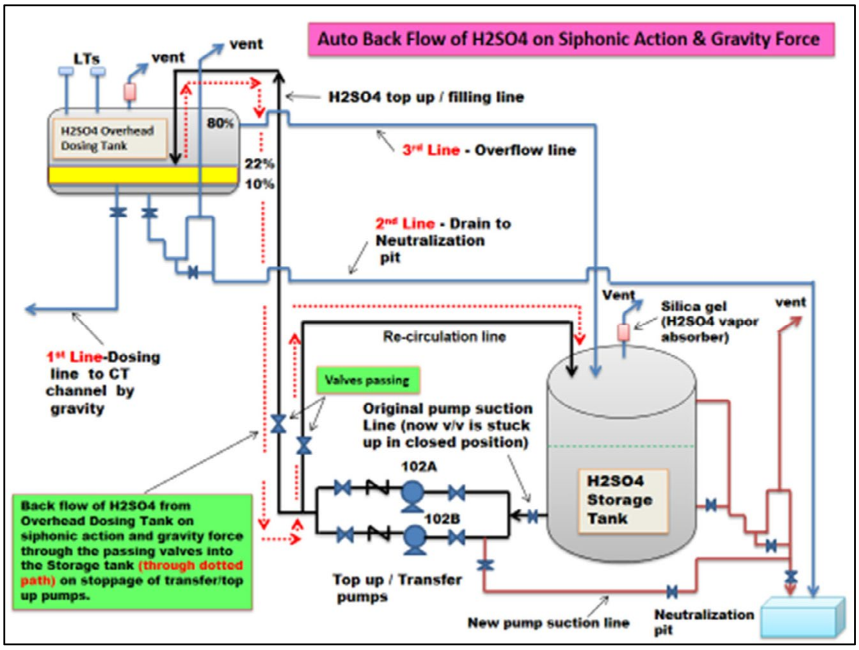

Figure 2: Automatic back flow of H2SO4 from Overhead Dosing Tank to Storage Tank

2.4 Final Inference and Conclusions from the Above Study and Activities Carried Out

• The H2SO4 of the overhead dosing tank flows back into the storage tank till 22% level of the overhead dosing tank is reached; through the pump filling line's common valve passing and through the pump recirculation line valve passing and finally into the storage tank; by the siphonic action and gravity force; caused by the rise in the liquid column inside in the overhead dosing tank on filling and positive difference in the height of the overhead dosing tank and the storage tank.

• There is no loss of H2SO4 as the exactly whatever amount is reduced in the overhead dosing tank comes back to the storage tank. Only that we need to top up the overhead dosing tank at a faster rate (once in a week which earlier was once in 20 to 25 days).

• The dosing of H2SO4 takes place inside the overhead dosing tank by gravity action only from 22% till 10% as beyond 22% level, H2SO4 flows back into the storage tank as stated above. And below 10%, the dosing line going into the channel does not take suction as it's suction point is at or above 10%.

2.5 Corrective Actions Taken During Suitable Opportunity Shutdown of the H2SO4 Dosing System

• On opening for checking and maintenance purposes, both the recirculation line isolation valve (fig-4 below) and also the pump discharge common header line isolation valve were found passing (fig-3 below) as the gates of these valves were found corroded and damaged due to the H2SO4 acidic corrosion.
• Both these damaged and passing valves of the pump discharge/filling common line valve and recirculation line valve were replaced with the new isolation valves.
• The original pump suction line connected to the pump suction root isolation valve or the storage tank root isolation valve gate was found stuck up while opening for it's checking. It's gate was found detached with the valve spindle. It could not be opened or closed. It was found heavily jammed. This damaged and jammed root isolation valve was also replaced with a new isolation valve.
• The Pump-102B damaged discharge iso valve (fig-6 below) was also replaced.

Figure 3: Pump common discharge iso valve

Figure 4: Pump recirculation iso valve

Figure 5: Pump suction root iso valve

Figure 6: Pump-102B discharge iso valve

2.6 Best Practices developed

• The H2SO4 acid valves are operated on a regular periodic basis to check and maintain the healthiness of the valves and offer to the maintenance groups if any problem is encountered.

• Till date, we have not faced any problems regarding the acid isolation valves.

2.7 Conclusion

Finally, after the **replacement** of the **both the recirculation line isolation passing valve** and also the **pump discharge common header line isolation passing valve our very "Interesting, peculiar and mysterious observations and problem"** were permanently solved.

Now there is no more back flow of H2SO4 from Overhead Dosing Tank into the Storage Tank located at the Ground Floor and the whole system is now functioning well till date.

3. Case Study-II: A Study on "UB tripping on SCAF pr. low-low trip alarm actuation during Total Power Failure scenario"

3.1 Brief Description of UB SCAF circuit observation during Total Power failure:

• Normally one AC SCAF runs when UB is in service.
• When Total Power failure occurs, running AC SCAF trips, SCAF pr. switch low PSL3535 gets actuated.
• Stand by 2nd SCAF also does not run as there is no power.
• So, as per logic DC SCAF gets started in Auto.
• Even if DC SCAF runs, but SCAF pr. does not build up, instead low-low pr. switch PSLL3536 further gets actuated.
• But DC SCAF continues running practically. This is confirmed by UB Boiler EA at field & at control room DCS during the Total Power Failures.
• Ultimately UB trips on actuation of UB SCAF low-low pr. switch PSLL3536.

3.2 Explanation of actuation of above PSL3535 & PSLL3536 actuation though DC SCAF is running healthy:

• From the UB SCAF circuit diagram (Fig-1 below), the DC SCAF gives discharge to only UB Burners scanners so that sufficient cooling air is ensured to the flame scanners during Total Power failure and tripping of AC SCAF to protect the flame scanners from damage.

• There is a NRV towards SCAF AC header. This does not allow the DC fan flow from going towards AC SCAF circuit where the SCAF pr. switches are located.
• The DC SCAF must go towards this AC SCAF circuit to normalize back the pr. switch low PSL3535.
• As the NRV obstructs the DC SCAF towards the AC SCAF circuit, so the PSL3535 does not get reset, instead further actuates the low-low pr. switch PSLL3536 even though the DC SCAF is running perfectly healthy. This ultimately leads to UB tripping on SCAF pr. switch low-low actuation.
• Similar UB tripping on Total Power failure is encountered a couple of times.

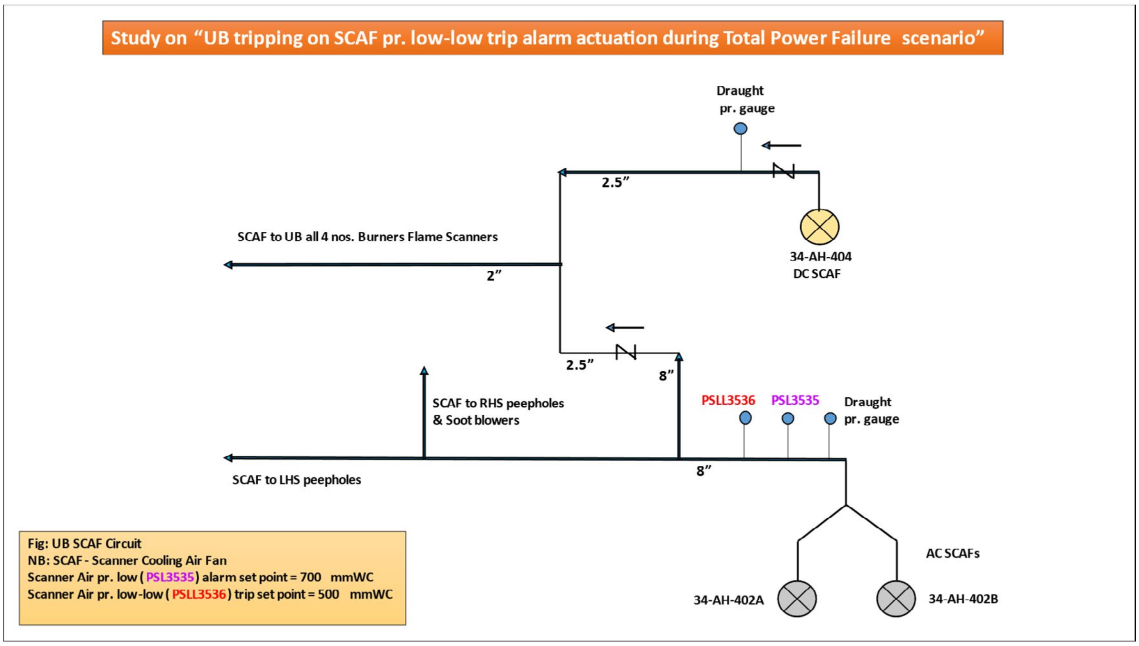

Figure 1: UB SCAF Existing Circuit

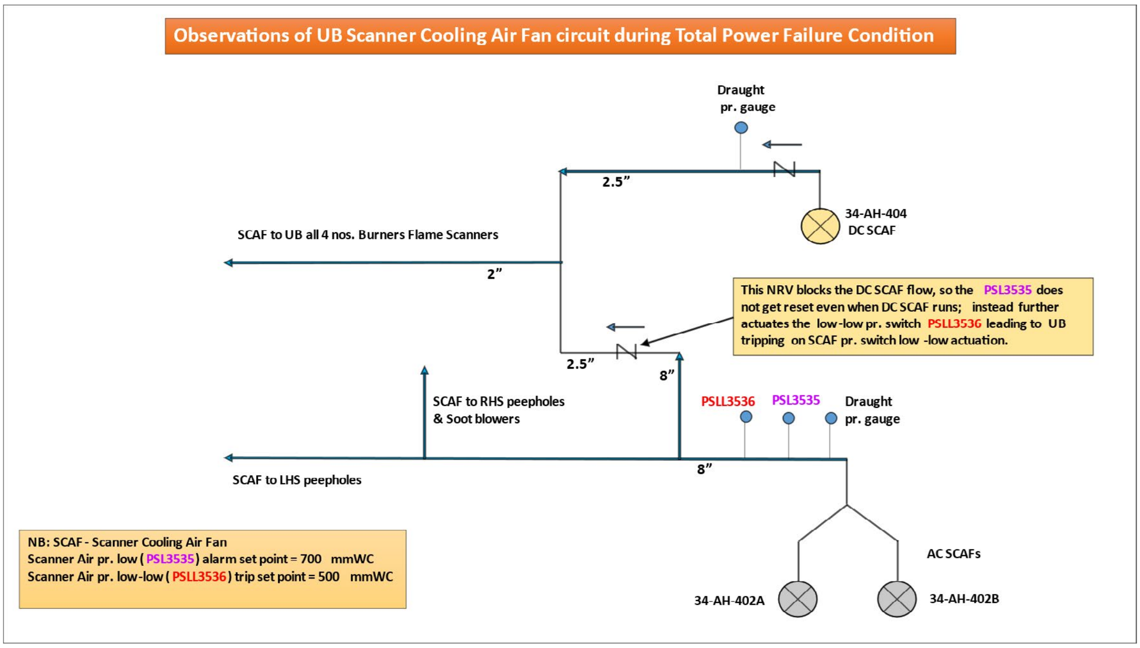

Figure 2: Explanation or Cause of UB Tripping on Tripping of AC SCAF

3.3 Suggestions to Avoid UB Tripping on Similar Problem in the Future:

• To install those low & low-low pr. switch on DC SCAF header just near it's discharge draught pr. gauge before it's NRV (or downstream of the DC SCAF NRV, shown in the fig-3).
• This will help to instantly normalize the low pr. switch PSL3535 which then get reset whenever the DC SCAF gets auto started. Thus, this prevents the actuation of low-low SCAF pr. switch PSLL3536 and thus prevents the UB tripping.

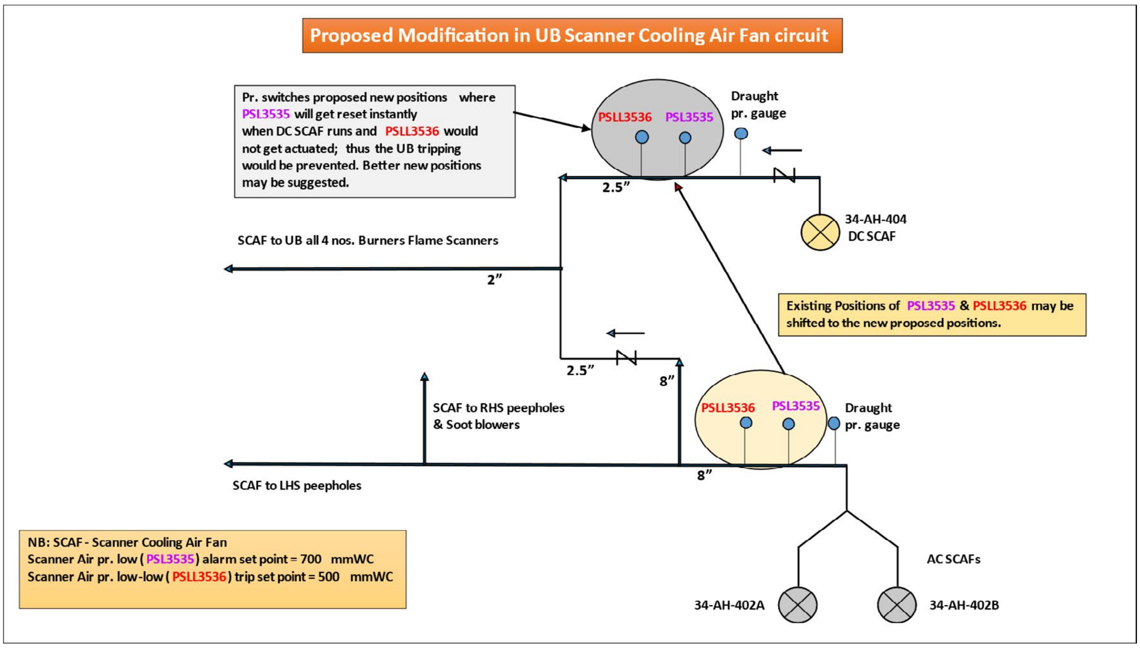

Figure 2: Modifications to avoid UB Tripping on Tripping of AC SCAF

4. Case Study-III: Study of "Cause of Heavy hammering problem of CPP De-aerator and subsequent solution to root out the problem"

4.1 Problem

Huge Hammering problem in the whole De-aerator assembly is experienced since it's commissioning when the Original LP Pegging steam header is charged or taken into service into the Spurger of the De-aerator. Even in the minimum opening of the LP Pegging steam control valve or even if the CBD Tank flash steam goes into the De-aerator Spurger, we encounter very heavy hammering of the whole De-aerator assembly along with the building structure.

4.2 Findings of the Cause of Hammering & Solution to Avert the Problem:

• Inside the Spurger of the De-aerator storage tank, there is a Direct contact of superheated LP steam (180 deg C) with hot DMW (avg. 85 to 90 deg C). The discharge point of the Original LP pegging steam remains submerged in the DMW inside the Spurger.

• Due to this direct mixing or spray of high temperature LP steam with cooler DMW, results in the Huge Hammering in the whole De-aerator assembly including the Chemical dosing floor structure. This was experienced in many years back. Also hammering is observed when the flash steam from the CPP CBD Tank goes into the Spurger.

• In this RTA-19, new Flash Steam recovery header hook up with the above Flash steam outlet header from the CPP CBD Tank. So, in future, when this flash steam from the process units will be coming, then this would again lead to the hammering of the De-aerator assembly which may lead to some untoward incidents or an emergency situation.

• To avoid this hammering problem, we need to avoid the direct contact or spray of high temperature LP steam with cooler DMW.

• This could be accomplished by "shortening the length of the Original LP Pegging steam header of 10" at such length that the direct contact of the LP steam and DMW does not take place.

• The whole problem and the case study is depicted in the pictures depicted below.

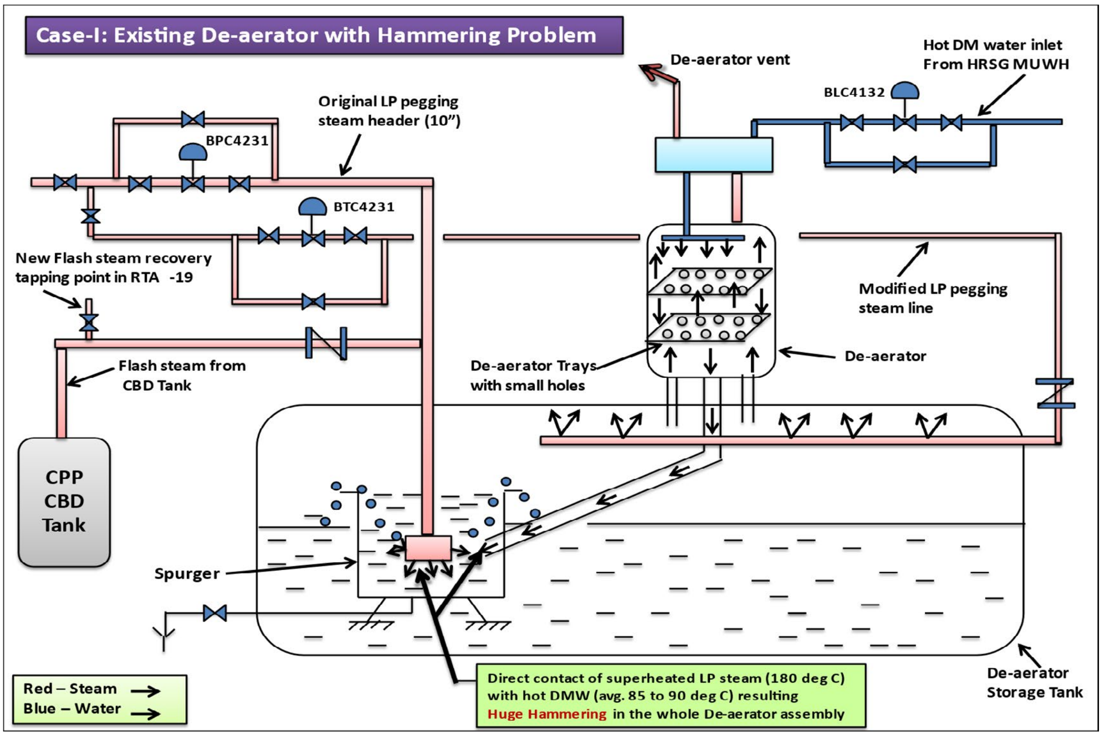

Figure 1: Cause of Hammering problem inside the CPP De-aerator

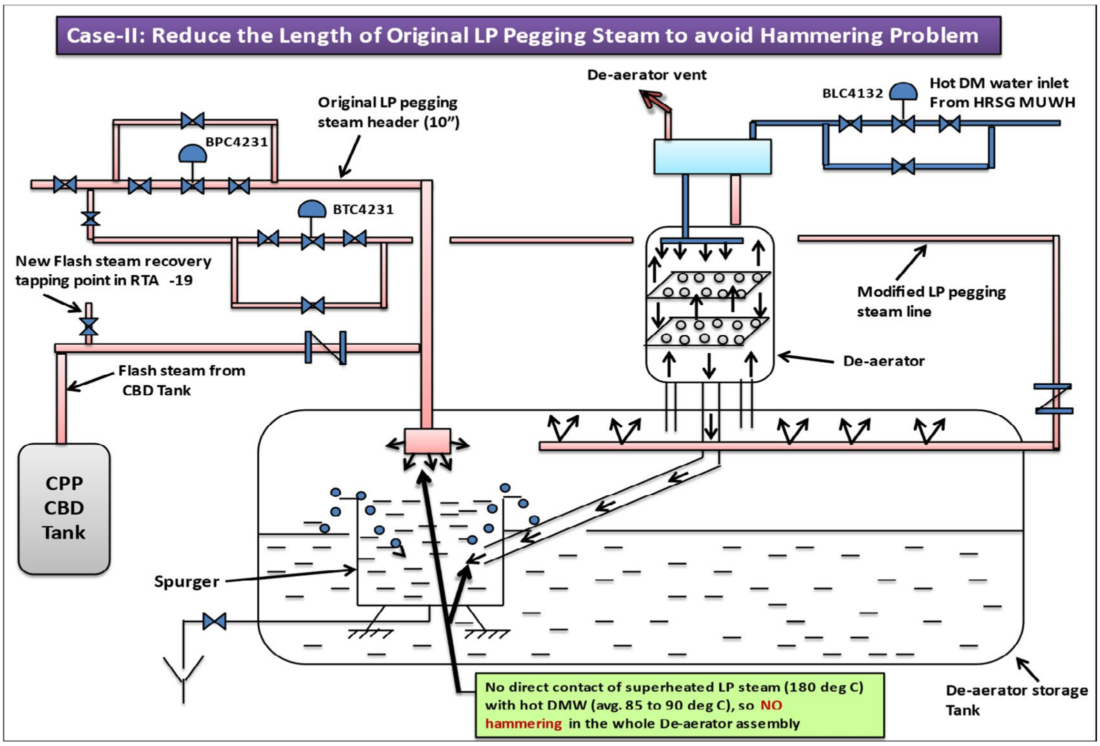

Figure 2: Solution to prevent the Hammering problem inside the CPP De-aerator