



Steam Report Supplemental - Temporary Boilers

February 7, 2024

EXECUTIVE SUMMARY

This Steam Report Supplemental for installation of Temporary Boilers is intended to compliment the "Steam Report" dated July 21, 2023 and is issued by Shell Chemical Appalachia LLC ("Shell") in compliance with its May 24, 2023 Consent Order and Agreement ("COA") with the Pennsylvania Department of Environmental Protection ("PaDEP"). The purpose of this supplemental is to provide an explanation of the intent and function of the recently installed temporary boilers at Shell Polymers Monaca ("SPM" or the "Site") and to further describe how these temporary boilers will interact with the overall SPM steam system.

1. TEMPORARY BOILERS

1.1 Purpose of the Temporary Boilers

The primary function of the temporary boilers is to deliver reliable steam into the SPM site steam system during a temporary period until mechanical deficiencies of the steam turbine generators (STGs) can be resolved or otherwise mitigated. SPM Cogen Unit heat recovery steam generators (HRSGs) generate super high pressure (SHP) steam which must be reduced or "let-down" to high, medium, and low pressure (HP, MP, LP) steam for various site functions. STGs generate electricity using HP steam and are designed to provide let-down LP steam by extraction valves after HP steam has passed through. These are new generation steam turbines and have novel designed steam extraction valves (which are more efficient). However, high temperature gradients around the extraction valves have caused metal deformation and a physical binding between rotating and stationary parts of the valve. This deformation and binding causes the extraction valve to not function nor operate as designed, leaving a deficiency of LP steam.

Secondarily, filters are needed to be added upstream of preheaters for boiler feedwater deaeration to reduce site LP steam demand. Temporary boilers will supply additional LP steam that will provide balance to the overall system by maintaining steam supply to all critical steam-supplied functions of the site. This includes direct LP steam provided for boiler feedwater deaeration and polyethylene unit operation and indirectly allowing for sufficient let-down MP steam provided to the high-pressure elevated flare (HPEF) to maintain smokeless flare operation.

1.2 Operation of Temporary Boilers

The temporary boilers fire pipeline quality natural gas already supplied to SPM and have a design heat input of 99.94 million British Thermal Units per hour (MM Btu/hr) and producing capabilities of 75,000 pounds per hour (lbs/hr), each. Two (2) of the boilers will be operated at one time, while the third boiler will be used for stand-by purposes only. Alternately, all three (3) boilers may be operated at one time at two-third capacity to enable quicker load shifting in case the third boiler were to trip offline or need maintenance. Each boiler is equipped with Selective Catalytic Reduction (SCR) for NO_x reduction and operate at 0-5% flue gas recirculation (FGR) for CO control. SCR controls are expected to be supplied with anhydrous ammonia contained in 150 lb bottles and eight (8) bottles per boiler with one spare rack of bottles on site. All emissions from these temporary sources will be included in SPM site totals and reported monthly and annually as required by PADEP. It is expected that SPM Cogen

Units will operate duct burners less frequently during this period and those actual emissions will be reduced.

1.3 Timing/Location of Temporary Boilers

Shell anticipates that this temporary period will be nine (9) months and not to exceed one (1) year to allow time to correct the mechanical and operational issues with the STGs, improve heat distribution and/or replace steam extraction valves as needed, and/or otherwise modify the steam system to make it reliable and sustainable at all levels of steam. These boilers will be staged on trailers near the permanent STGs and will be removed from site once the above corrections have been made. There is no permanent footprint at the SPM site for these temporary boilers which are not part of the permanent facility design.

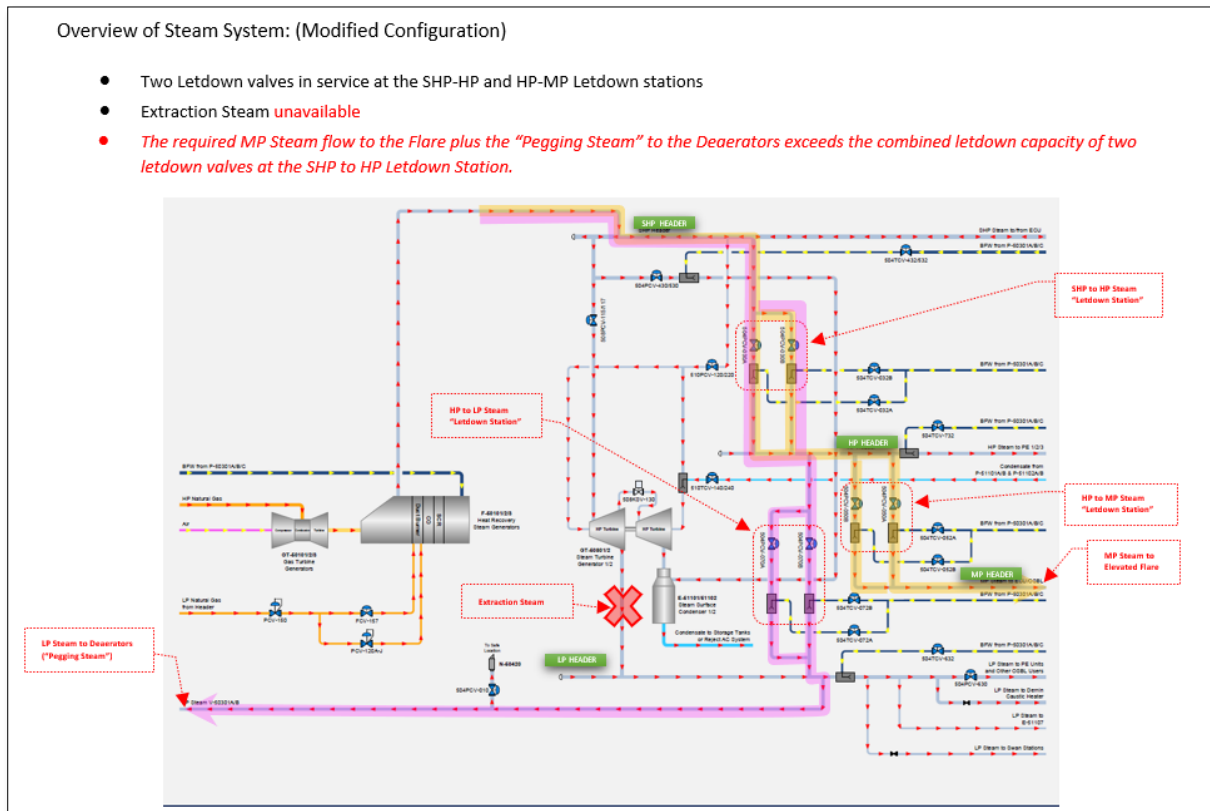
2. UPDATE ON STEAM SYSTEM SOLUTIONS

2.1 Loss of STG Extraction Challenge

As described in the "Steam Report Supplemental", Section 4.2:

The term extraction refers to the LP steam that is "extracted" from the STG when the steam exits the turbine. Having a "loss of STG extraction" means that the STG is not producing LP steam. Operating with loss of LP steam generation (or loss of extraction) is an abnormal state for the STG. For completeness, the scenario was evaluated for its impact in delivering steam to the flare. In the abnormal event of loss of LP steam extraction from the STG, there are some operating scenarios where there is no negative impact to MP steam delivery to the flare. There are other operating scenarios where MP steam to the flare could be limited if the STG loses extraction capability. If the plant is operating the abnormal situation of loss of STG extraction and in one of the operating scenarios where MP steam is limited, one mitigation to increase MP steam during flaring is to temporarily stop LP steam from going to LP steam consumers. One of the main users of LP steam is the boiler feed water deaerators. The deaerators use LP steam injected into water in a process to remove air bubbles from the water. This LP steam injected to the deaerators is called "pegging steam". Steam flow to the deaerators can be reduced temporarily, though removal of the steam must be done in a controlled way to maintain equipment integrity of the deaerators. Engineering evaluations are ongoing to understand how much steam, if any, can be curtailed from the deaerators and the most reliable way to automatically reduce pegging steam during this abnormal situation of elevated flaring during a loss of extraction steam. The final solution referenced in "Steam Report" section 4.4 is related to when the STG loses "extraction".

Schematic of Loss of Extraction:



Following engineering evaluations to understand how much steam can be curtailed from the Deaerators (as referenced above), it was determined that in order to maintain equipment integrity of the Deaerators and the Boiler Feed Water pumps, cutting pegging steam must be limited, tightly controlled and utilized as a last option during loss of STG extraction.

Due to the limitations on cutting pegging steam to the deaerators and the mechanical issues causing unreliable operation of the STG extraction valve, it was necessary to add temporary boilers as a primary source of supplemental LP steam during loss of STG extraction and provide balance to the overall steam system. Since the temporary boilers directly supply steam to the LP header, this will also reduce the demand for LP steam via the HP-LP let-down station and instead allow HP steam to be redirected to the flare (MP Steam header) during the abnormal situation of elevated flaring and loss of extraction.

The control system has been modified in the field to automatically cut a specific amount of pegging steam when the system drifts into an abnormal operating regime where there is loss of STG extraction and/or if any of the temporary boilers trip offline unexpectedly.

To summarize, the operating philosophy is to utilize STG extraction as the primary supplier for LP steam, however if the extraction valve fails and is unable to meet the LP steam

demand, the temporary boilers together with the HP-LP steam let-down station will supply the necessary LP steam demand. Lastly, cutting of pegging steam is an available option for LP steam supply in the special case the temporary boilers suddenly are not able to provide LP steam.

While the combination of operating with temporary boilers and implementing automated controls to curtail pegging steam do provide a high level of assurance for reliable LP steam during loss of STG extraction cases, these are not considered as optimal nor sustainable long-term solutions for reliable operation of equipment and the steam system as a whole. These temporary mitigations provide time needed to evaluate and execute a more robust solution that will address mechanical and operational deficiencies to the STGs and the SPM steam system.

3. FINAL REMARKS / CONCLUSION

This temporary LP steam supply and mitigations indicated in this supplemental are in addition to the Steam Report provided to PADEP in response to the May 24, 2023 Consent Order and Agreement which addresses adequate supply of MP steam to the High Pressure Elevated Flare.

Shell has requested and received approval for permit to operate the boilers as of December 1, 2023. The temporary boilers are currently operating as intended.

Currently, there are engineering evaluations being carried out to identify feasible and sustainable steam system design improvements which can be implemented within the period that has been permitted to operate the temporary boilers.