**Recommended Guidelines for the Incineration of Waste Streams in Black Liquor Recovery Boilers.**

**Proposed Changes**

This is the second phase to the approved changes in Chapter 5 approved in the October 2015 meeting. The remaining topic was to address the statement concerning use of the continuous igniter during normal boiler operation with the MCR (steam) greater than 50%.

Comments and/or questions should be sent to:

**Paul Seefeld, Chairman, Waste Streams**
A.H. Lundberg Assoc., Inc.
(904)614-6492  
Paul.seefeld@lundberg-us.com

Submitted Date: 1/25/2016
Proposed Changes to Chapter Five – April 2016

1. Section 5.3.2:
   a. Paragraph regarding following BLRBAC recommendations was moved to the end after other changes, but not modified. (approved in the October 2015 meeting)
   b. Statement of visual inspection clarified to include the word operator.  (approved in the October 2015 meeting)
   c. Added recommendation to allow the disengagement of CNCG igniter during stable operation above 50% MCR. This does not include SOG igniters.
1.  

RECOMMENDED GOOD PRACTICE

THERMAL OXIDATION OF WASTE STREAMS
IN
BLACK LIQUOR RECOVERY BOILERS

THE BLACK LIQUOR RECOVERY BOILER ADVISORY COMMITTEE

April 2013
CHAPTER 5 GUIDELINES FOR THERMAL OXIDATION OF CNCG AND SOG

5.1 Introduction

This Recommended Good Practice presents the use of the recovery boiler as the control device for thermal oxidation of CNCG and SOG.

5.1.1 Safety

During the thermal oxidation of CNCG and SOG, the safety hazards for both personnel and equipment have to be considered.

The equipment for thermal oxidation as well as collection and treatment of CNCG should be designed and controlled such that:

- CNCG cannot escape into the recovery boiler building area.
- Condensate cannot carry into the recovery boiler.
- Fire and explosion in equipment and pipe systems is prevented.
- Positive ignition of gases entering the furnace is provided.

In no case shall the safety requirements be less restrictive than those presented in the following BLRBAC publications:

- Recommended Good Practice for the Safe Firing of Auxiliary Fuel in Black Liquor Recovery Boilers.
- Recommended Good Practice for the Safe Firing of Black Liquor in Black Liquor Recovery Boilers.
- BLRBAC Recommended Rules for Personnel Safety for Black Liquor Recovery Boilers.

5.1.2 Sources

5.1.2.1 CNCG

The main sources of concentrated noncondensible gases (CNCG) are:

- Noncondensible gases from black liquor evaporation
- Vents from foul condensate tank, turpentine decanter, turpentine tank, methanol tank and various pumping tanks.
- Vents from flash tanks, condensers and specialty process equipment--these need to be evaluated on an individual basis concerning classification as a dilute or concentrated NCG. The digester chip bin vent gases cannot be included in the CNCG system because of high air content.
5.1.2.2 SOG

SOG from a foul condensate steam stripper is handled in a separate and independent system for introduction into the recovery furnace for thermal oxidation. These gases generally are the gas product from the stripper reflux condenser and reflux tank, and consist principally of water vapor, methanol, reduced sulfur components and potentially small amounts of turpentine and other hydrocarbons. An additional process step is incorporated in some mills to condense the methanol from the gases and handle the methanol liquid stream separately.

Vents from a high solids concentrator system are similar in nature to the SOG from a stripper column and should be handled in a gas system similar in design to that used for SOG. The system should be independent of other NCG systems from the source to and including the burner gun.

As an option, SOG can be modified by removing its methanol content. The remaining gas is a low volume CNCG. When liquefying the SOG stream, there will be a residual CNCG component that will need to be collected as part of the CNCG system.

5.1.3 Dedicated Burner

A dedicated burner should be used for thermal oxidation of CNCG and SOG in the recovery boiler. The burner should be equipped with an NFPA Class 1 continuous igniter and igniter flame scanner. This arrangement will provide more stable and safer firing of the gases than arrangements that depend on the heat from black liquor combustion to sustain the thermal oxidation of the NCG. This arrangement further considers that there is not a reliable means of detecting a loss of black liquor flame to shut off the NCG flows to the recovery boiler.

5.1.4 The Recovery Boiler as Primary Control Device

When the recovery boiler is used, it should be the primary control device. In the recovery boiler the sulfur compounds in the NCG are captured back into the process. When the recovery boiler is the primary control device, the effect of the NCG on the recovery boiler sodium-sulfur balance will be constant. This balance would be changing will change if the recovery boiler were is used as a secondary control device with the NCG being thermally oxidized in the boiler intermittently, or if a single recovery boiler is used at a facility with multiple recovery boilers.

5.2 Collection and Transfer of CNCG and SOG

A thorough sampling and evaluation study of all components of the CNCG and SOG should be performed to determine temperature, volumetric flow, moisture content and percentage UEL of each individual source. That study should include both normal steady state operation and maximum rate with upset conditions. This data should be used by a
qualified specialist to determine the operating condition and properties of the combined CNCG streams and the SOG stream at the recovery boiler.

Consider locating motive equipment for collecting gases and the diversion system in an area outside the recovery boiler area so they can be accessed even at times when the recovery boiler area is evacuated. Where facilities are subject to winter climates with temperatures below freezing, consideration should be given to locating the equipment in a warm enclosure. Control of the system should be from the recovery boiler control room.

The engineer should give highest priority to the selection of the ejector and other control components to maximize the best control and safety of the CNCG system.

5.2.1 CNCG

The sources of gases connected to the CNCG system must be of such nature that air cannot enter the system.

The CNCG from the common collection point to the waste streams burner can be handled in two different ways.

- Vapor phase transfer system (no gas conditioning involving any change in component concentration)
- Conditioned gas transfer system

5.2.1.1 Vapor Phase Transfer System

After the common collection point the gases are moved by means of a steam ejector or water ring blower directly to the waste streams burner system. No conditioning involving any change in component concentration is done.

The piping system starting at the steam ejector (water ring blower) typically includes the following equipment.

Figure 5 - Equipment Outside the Recovery Boiler Area

- Steam ejector or water ring blower
- Pressure transmitter for monitoring with high and low alarms located after the steam ejector (water ring blower)
- Mist eliminator(s) (with pressure drop monitoring and high pressure drop alarm)*
- Flow transmitter with interlock function
- Main header vent line with automatic valve, drain function included
- Recovery boiler line automatic shut-off valve*
- Tie-in to alternate thermal oxidation device (optional)
- Steam purge connection

Figure 6 - Equipment Inside the Recovery Boiler Area
- Recovery boiler vent line with automatic valve, drain function included
- Automatic double block and bleed valves (located close to burner)
- Mist eliminator(s) (with pressure drop monitoring and high pressure drop alarm)*
- Recovery boiler line automatic shut-off valve*
- Pressure and temperature switches/transmitters for interlock functions located before the automatic double block and bleed valves
- Flame arresters or detonation arresters (with pressure drop monitoring and high pressure drop alarm) located as close to the burner as possible.

Items with an (*) may be placed inside or outside the recovery boiler area, depending upon the final piping design.

The following equipment will be located in the system as required.

- Pressure relief devices such as rupture disk(s)
- Low point drains
- Steam heat tracing and /or indirect steam preheater (not shown in figures)

The intent of the design for the system is to ensure that no condensates of the condensible components--methanol, water or turpentine--can collect and cause upsets to the waste streams burner system or the recovery boiler. The CNCG piping should be heavily insulated from the source to the waste streams burner to minimize condensation formation in the line. Depending on local conditions, heat tracing may be considered.

5.2.1.2 Conditioned Gas Transfer System

The following components are included in addition to those used in a vapor phase transfer system.

- Gas cooler / condenser
- Indirect steam preheater with auxiliaries

A concentrated NCG system with a seal pot is considered to be a conditioned gas transfer system. The seal pot is used to isolate lines and prevent flashback. It will act as a quench cooler and thereby will perform partial condensation.

The intent of the Conditioned Gas Transfer System is to reduce the amount of water vapor and condensible gases and increase thermal efficiency by reducing the loss due to water vapor. The condensate would be typically transferred to a foul condensate treatment system which may include a steam stripper.

The gas analysis needs to be carefully evaluated before and after the condenser with regard to explosion range and combustion characteristics to determine the impact of conditioning on the gas. Condensing of large amounts of water vapor, methanol and turpentine may shift the resulting gas mixture into the explosive range depending on the
residual amount of infiltration air and the combustible gas concentrations. The heating value and combustion characteristics may also be changed due to condensing of turpentine and methanol.

When the CNCG cooler is located downstream of the steam ejector, it is recommended to heat the gas after the cooler and/or heat trace the downstream piping to raise the operating temperature of the gas burner system to well above the dewpoint and thereby protect it from upsets due to condensates.

5.2.2 SOG

SOG is primarily a mixture of TRS compounds, methanol and steam at saturated steam conditions that can be hotter than other CNCG. Frequently, the pressure of the gas at the stripper condenser discharge is much higher than that of other CNCG streams. The SOG must be handled in lines separate from the other CNCG to prevent condensation of the SOG constituents in the collection system and to handle the differences in pressure. The SOG handling system does not provide conditioning involving any change in component concentration with the exception of a stripper system where methanol may be condensed and recovered transferred as a liquid.

Upset conditions caused by black liquor carryover or evaporator boilout can result in generating foam in the condensate stripper. This foam can then be transported with the SOG to the recovery furnace. Provisions must be made to prevent foam carryover into the SOG to preclude introducing foam into the furnace.

The SOG piping should be heavily insulated from the source to the waste streams burner to minimize condensation formation in the line. Steam tracing of the stripper off-gas piping should be considered in cold climates.

If the stripper off-gases at the source are at an adequate pressure to provide the motive force to transport them to the waste streams burner, then the piping system leading to the burner typically would include the following equipment. This arrangement would also apply to CNCG from a high solids concentrator.

Figure 5 - Equipment Outside the Recovery Boiler Area

- Pressure transmitter for monitoring with high and low alarms
- Mist eliminator(s) (with pressure drop monitoring)
- Flow transmitter with interlock function
- Main header vent line with automatic valve, drain function included
- Recovery boiler line automatic shut-off valve
- Tie-in to alternate thermal oxidation point (optional)
- Steam purge connection

Figure 6 - Equipment Inside the Recovery Boiler Area
• Recovery boiler vent line with automatic valve, drain function included
• Automatic double block and bleed valves (located close to burner)
• Pressure and temperature switches for interlock functions located before the automatic double block and bleed valves.
• Monitoring pressure and temperature transmitters with high and low alarms located before the automatic double block and bleed valves.
• Flame arresters or detonator arresters (with pressure drop monitoring and high pressure drop alarm) located as close to the burner as possible.

The following equipment will be located in the system as required.

• Pressure relief devices such as rupture disk(s)
• Low point drains
• Heat tracing and/or indirect steam preheater (not shown in figures)

If the SOG at the source is not at an adequate pressure to provide the motive force to transport it to the waste streams burner, then the piping system leading to the burner typically would include the previously mentioned equipment and a steam ejector.

5.2.3 CNCG and SOG Piping System and Auxiliary Equipment

CNCG and SOG should be handled in completely independent collection systems due to temperature and pressure differences between the two streams being handled. There is a risk of condensing methanol from SOG with the cooler CNCG stream.

Due to system pressure differentials, it is recommended that the SOG system and CNCG system not share any common auxiliary equipment such as condensate collection vessels. There is a risk of one system discharging into the other.

The piping system and steam ejector or water ring blower should be sized so that minimum transport velocities for gases are maintained.

Gas piping should be designed to prevent accumulation of condensate and should be designed with the shortest possible pipe run inside the recovery boiler building. The piping should not be routed close to critical areas such as the dissolving tank or the corners of the furnace or near areas likely to be occupied by personnel such as normal accessways.

CNCG and SOG should be securely isolated when shutting down the thermal oxidation system, therefore valves in the system should be chosen carefully with attention given to shutoff classifications. Automatic valves should have position switches to confirm valve position status.

Piping downstream of the mist eliminator should be insulated and heat traced to prevent condensate formation in the line. Consideration should be given to sloping the piping in the direction of gas flow for drainage rather than having horizontal lines. This avoids the
accumulation of a quantity of water, which could be suddenly released into the furnace as well as the likelihood of accumulating flammable organic deposits. The designer should proceed on the basis that there will be condensate in the pipe from time to time and that it must be removed.

Each vent line should have one shut-off valve with “fail open” actuator that will open automatically when waste stream firing to the recovery boiler is stopped.

Each gas line to the recovery boiler should have a flame arrester. There should be a differential pressure transmitter across the flame arrester to alarm high differential pressure. Provision can be made to clean the flame arrester using steam or inert gas.

Any water or steam connections to the system should have double block and bleed valves or removeable spool pieces per BLRBAC Recommended Good Practice for Safe Firing of Black Liquor in Black Liquor Recovery Boilers. Automatic valves should have position switches to confirm valves position status. Steam piping should be properly designed and trapped to prevent condensate collection. Air should not be used as a purge medium due to the possible risk of creating an explosive gas mixture.

If a seal pot (for isolation and flashback prevention) is used, it should be constructed and controlled so that water cannot carry into the recovery boiler through the waste stream line. Therefore there should be two (2) independent protective systems such as switches with alarm and interlock functions. It is imperative that the seal pot not overflow into the CNCG transport line to the recovery boiler.

The condensate collection system should be designed so that it cannot be pressurized causing condensate to back flow to the transport line. As an example, an overflow to a closed sewer system could cause pressurization.

Drains in the system are prone to plugging and should be of a size to reduce that possibility, with consideration given to at least 1-1/2” drain lines.

Materials of construction for ductwork, piping and equipment in contact with CNCG and SOG should be AISI type 304L or 316L stainless steel, or other metals with equivalent or better corrosion resistant and strength properties.

Material containing iron that might turn into FeS in contact with NCG should not be used. Under certain conditions in the presence of air, FeS can oxidize and create heat with explosions or fire as a result.

The system designer must take into account the movement of the waste streams burner due to the expansion of the furnace, and make sure that the movement does not induce unacceptable stresses in the piping.

Piping must meet the required service conditions and be acceptable to the authorities which may have jurisdiction.
5.3 Thermal Oxidation

5.3.1 Burner

The waste stream burner(s) should be mechanically suited for installation and operation in a recovery boiler.

The waste stream burner(s) should have a dedicated air system. The combustion air can be supplied from a separate fan or from the recovery boiler secondary air or tertiary air fan. Proof of adequate combustion air flow is required as proven by a flow switch or other suitable means.

CNCG and SOG should be conveyed to the burner through independent lines and injected into the flame zone separately. A separate system to feed fuel to the continuous igniter is required.

The burner should be placed in the high heat zone of the furnace at or below the tertiary air level. It should be placed in such a manner that disturbances in the continuous flame of the igniter are avoided so as to not create difficulty with detection.

Example of equipment for monitoring and controlling a single burner installation for CNCG and SOG is shown in Figure 6. Multiple burner installations should follow multiple burner standards.

When the NCG system is down, the second automatic shut-off valve should be locked in the closed position. The connections in the CNCG and SOG piping downstream of the shut off valve at the gun should be designed and installed to allow ease of maintenance and inspection on a routine basis.

Cooling of a CNCG/SOG nozzle that is not in use can not be accomplished by injection of air into the CNCG/SOG nozzle.

5.3.2 Continuous Igniter

An NFPA Class 1 igniter (NFPA 8501) is a key element in the thermal oxidation of CNCG and SOG. The capacity of the igniter should be large enough to provide safe ignition and be at least 10 percent of the maximum energy release of the gases being thermally oxidized. The igniter shall be continuous. The igniter should have proof of adequate ignition energy using a low pressure switch on the igniter fuel header.

The igniter can have a common air duct with the burner for CNCG and SOG. Air feed to the igniter should provide stable ignition and operating conditions.

The oil or gas system to the igniter as well as flame monitoring should, in all aspects, follow the BLRBAC Recommended Good Practice for Safe Firing of Auxiliary Fuel.
Light-off of the igniter must be initiated at the burner front, and then only after an operator visually inspects the burner opening in the furnace wall to ensure that there is no plugging.

If the Boiler is operated above 50% MCR, with stable liquor firing and CNCG has been safely introduced, the igniter may be disengaged (i.e. fuel shut off and igniter interlock suspended/disengaged). Once the igniter has been disengaged, a drop in boiler loading below 50% of MCR or the loss of stable liquor firing should result in a system trip. SOG incineration should still use a continuous igniter.

The oil or gas system to the igniter as well as flame monitoring should, in all aspects, follow the BLRBAC Recommended Good Practice for Safe Firing of Auxiliary Fuel.

5.3.3 Combustion Air

The recovery boiler secondary or tertiary air fan can be used. If the combustion air is supplied by the secondary air fan, a booster fan may be necessary to provide minimum air pressure to the waste stream burner. The system design should be such that uninterrupted air flow to the recovery boiler for black liquor combustion is first priority.

The following instrumentation for monitoring and control of combustion air should be provided.

- Local pressure indicator
- Suitable means for proving adequate air flow
- Indicating pressure transmitter
- Booster fan running—signal from motor starter, speed switch, etc.

5.4 Safety System

The waste streams burner should have a flame safety system complying with the BLRBAC Recommended Good Practice for the Safe Firing of Auxiliary Fuel. The system design should comply with NFPA standards and insurance carrier recommendations. The waste streams burner flame safety system can be integrated with the auxiliary fuel’s burner management system or can be stand-alone.

The permissive starting logic and protective tripping logic contain the logic of Safe Firing of Auxiliary Fuel plus additional requirements. The additional requirements pertain to the quality of the NCG.

Care must be taken to never allow the waste streams burner to maintain purge credit. In other words, the waste streams burner cannot be counted as an auxiliary fuel burner when the burner management system checks if there is an auxiliary burner in service.
5.4.1 Permissive Starting Logic - CNCG

To start thermal oxidation of CNCG in the waste streams burner the following conditions must be fulfilled.

- Purge credit established and maintained
- Firing liquor stably or steam flow greater than 50% of the steam flow at MCR
- Combustion air fan for waste streams burner running
- Combustion air flow normal
- CNCG flow (velocity) above minimum
- CNCG temperature above minimum
- CNCG pressure not high
- CNCG pressure not low
- Seal pot level not high (if used)
- Burner switch in START position
- Igniter has been in stable operation for minimum one minute
- Igniter interlocks satisfied

Staging of injection of multiple streams into a waste stream burner should be part of the Start Permissives.

Permissive Starting Logic for thermal oxidation of CNCG in the waste streams burner is shown in Figure 7.

5.4.2 Protective Tripping Logic - CNCG

Any of the following conditions will cause the waste streams burner to shut down thermal oxidation of CNCG.

- Master Fuel Trip (purge credit lost)
- Not firing liquor stably or steam flow less than 50% of steam flow at MCR
- CNCG pressure high
- CNCG pressure low
- Combustion air fan for waste streams burner off
- CNCG temperature below minimum
- CNCG flow (velocity) below minimum
- Combustion air flow not normal
- Igniter interlocks not satisfied
- Burner switch in STOP position
- Seal pot level high (if used)

Protective Tripping Logic for thermal oxidation of CNCG in the waste streams burner is shown in Figure 8.
5.4.3 Permissive Starting Logic - SOG

To start thermal oxidation of SOG in the waste streams burner the following conditions must be fulfilled.

- Purge credit established and maintained
- Firing liquor stably or steam flow greater than 50% of the steam flow at MCR
- Combustion air fan for waste streams burner running
- Combustion air flow normal
- SOG flow (velocity) above minimum
- SOG temperature above minimum
- SOG pressure not high
- SOG pressure not low
- Seal pot level not high (if used)
- Burner switch in START position
- Igniter has been in stable operation for a minimum of one minute
- Igniter interlocks satisfied

Permissive Starting Logic for thermal oxidation of SOG in the waste streams burner is shown in Figure 9.

5.4.4 Protective Tripping Logic - SOG

Any of the following conditions will cause the waste streams burner to shut down thermal oxidation of SOG.

- Master Fuel Trip (purge credit lost)
- Not firing liquor stably or steam flow less than 50% of steam flow at MCR
- SOG pressure high
- SOG pressure low
- Combustion air fan for waste streams burner off
- SOG temperature below minimum
- SOG flow (velocity) below minimum
- Combustion air flow not normal
- Igniter interlocks not satisfied
- Burner switch in STOP position
- Seal pot level high (if used)

Protective tripping logic for thermal oxidation of SOG in the waste streams burner is shown in Figure 10.

5.5 Personnel Safety

Operational problems, which have to do with collecting, treatment and destruction of CNCG can lead to accidents and serious injury.
CNCG contain among other things, \( \text{H}_2\text{S} \), organic sulfides and methanol, and at certain times, even high level of turpentine. In addition to the health risk, there is also a risk of a gas explosion.

Regarding the risks with hazardous compounds present in CNCG and SOG, see OSHA Guidelines concerning these compounds.

Areas containing NCG piping and equipment should be monitored in accordance with applicable safety codes.

Daily inspection and control is needed to check for leaks in systems for CNCGs and SOGs. Leaks in the system should be corrected immediately.

5.6 System Description and Operation

This section is included to illustrate the application of Chapter 5 guidelines. It is for information purposes only and is not to be considered as additional guidelines.

The arrangement of piping and equipment as shown on the flow sheets (Figures 5 and 6) are the same for both CNCG and SOG. For the purposes of this discussion, the CNCG system is used.

5.6.1 Description

Steam to the gas transport steam ejector has a double block and bleed valve arrangement consisting of valves S1, S2 and S3. This steam connection and other steam connections on Figures 5 and 6 are shown with double block valves and a bleed (or “free blow”) valve because they are potential sources of water injection into the furnace. The double block and bleed valve set provides secure sealing plus, with proper sequencing of valve opening, collected condensate can be blown out the bleed line before steam is routed to the gas line.

Downstream of the steam ejector and outside the recovery boiler area, the CNCG line will have a vent to atmosphere controlled by an automated shutoff valve, CG2. Following this vent connection there is an automated valve, CG1, which isolates the branch line to the recovery boiler. If required, there can be a tee ahead of CG1. The tee will allow the gas to be transported to an alternate thermal oxidizer through valve CG3.

It is important that valves CG1, CG2 and CG3 be located outside of the recovery boiler area or in the case of indoor installations in a “designated safe area” so that they are accessible at all times, even in the event of an ESP. Being located outside of the recovery boiler area does not preclude the valves from being in another building.

Immediately downstream of valve CG1 is an automated steam connection consisting of valves S5, S6 and S7. It purges and preheats the next “leg” of CNCG line.
Located immediately before valve CG4 is a line size vent isolated by valve CG7. This vent line serves the CNCG line from valve CG1 to valve CG4. It is used for steam preheating, CNCG venting in anticipation of CNCG firing, and purging after ceasing CNCG firing. The steam for preheating and purging is supplied by the previously mentioned valves S5, S6 and S7.

The vent discharges to the outside of the boiler area. Both this vent and the previously mentioned vent controlled by valve CG2 must be above roofs and away from air intakes. The outlets of these vents must be arranged in such a way that ice plugs are avoided.

A condensate drain from the CNCG line must be included at both vent locations to ensure removal of liquid that is swept along by the venting gases. The drain function can be included with the vent, or two connections can be used; one to vent and the other to drain the line.

A CNCG line double block and bleed valve arrangement represented by valves CG4, CG5 and CG6 provides the final isolation of CNCG from the furnace. The “bleed”, CG5, must be designed so that vapor can be vented from the isolated portion of CNCG line while liquid is drained from out of the bottom of the line. Valve CG5 could be two valves, one for venting and the other for draining. The vent from CG5 can be connected to the main vent on the discharge of valve CG7.

The CG4, CG5 and CG6 valve set must be located as close to the burner as possible to minimize the retained CNCG volume from these isolation valves to the burner.

If the volume of CNCG that is retained is small and the piping system has the mechanical integrity to sustain a burn back after the isolation valves shut, then purging of the piping from the isolation valves to the burner is not necessary. Not purging the line avoids the possibility of water introduction to the furnace if steam is used for purging.

There are, however, system designs and maintenance safety issues that make purging of this piping run an attractive consideration; for example, large CNCG systems that have a substantial volumetric capacity in this last piping leg. Section 5.2.3, Piping System and Auxiliary Equipment, discusses line sloping, steam supply requirements, and insulating and heat tracing waste gas lines. An important part of this concept is the use of a burner design that is drainable, that is, a burner that cannot retain liquid. The purge must be done immediately after firing the CNCG system is terminated, while the piping is still hot, and with the igniter in service.

If steam purging is used, special attention must be given to keeping the steam free of condensate, thus avoiding introduction of water into the furnace. A steam line that is only occasionally used has a high probability of containing condensate and therefore injecting that condensate into the CNCG piping when the steam line is opened. The system design and operation must ensure that the purging steam is dry. As an alternative to steam, another inert gas can be used as a purging medium. For any purging medium (steam or an
inert gas), the purge should displace the volume of gas contained in the piping between the last isolation valve and the furnace.

A flame arrester is located in the CNCG line as close to the burner as possible. The flame arrester physical location must be convenient for isolation and maintenance.

5.6.2 Operation

The CNCG/SOG thermal oxidation system is put into service from a local panel board by and operator who is in contact with the control room. Discontinuing thermal oxidation under normal circumstances is also done locally.

The CNCG transport system is put into operation with branch line isolation valve CG1 closed and vent valve CG2 open. At this point the double block and bleed CNCG valves, CG4, CG5 and CG6, are shut meaning the shutoff valves are closed and the bleed valve (providing vent and drain service) is open.

Next, the steam purge and preheat valves, S5, S6 and S7, are opened along with the vent/drain valve(s), CG7. This provides preheating of the CNCG line from the branch isolation valve outside of the boiler building to the vicinity of the burner. The branch valve CG1 remains closed. Admission of steam preheats the line and exits through the vent/drain.

Adequate preheating of the line will be determined by an operator observing the temperature indicator on the DCS. Once the line between the CG1 and CG4 is heated, the preheat steam is shut off, the branch valve CG1 is opened and vent CG2 is closed allowing gas to be vented out of the second vent, CG7. Upon satisfying all permissives, the final gas block and bleed valves are opened, vent CG7 is closed and CNCG gases will be admitted to the furnace for thermal oxidation.

For a normal shut down, CNCG shutoff valves CG4 and CG6 and branch valve CG1 are closed, and both vent valves, CG7 and CG2, are opened as is bleed valve CG5. In addition, steam purge is immediately initiated. After adequate time for thorough purging, the steam purge is shut off.

Table 5 shows the actions that constitute a burner shutdown, both MFT and ESP. The valve positions for “normal operation” and “fail” status are also shown. If an ESP is activated, a MFT will be exercised as well as isolating all steam and water sources. An ESP will not initiate automatic purging of the CNCG line to the burner.
Table 1 Valve status and Actions at MFT and ESP; Figures 5 and 6

<table>
<thead>
<tr>
<th>Valve #</th>
<th>Description</th>
<th>MFT</th>
<th>ESP</th>
<th>Operating status</th>
<th>Fail status</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>EJECTOR STEAM BLOCKVALVE</td>
<td>NA</td>
<td>NA</td>
<td>OPEN</td>
<td>OPEN</td>
</tr>
<tr>
<td>S2</td>
<td>EJECTOR STEAM BLEED VALVE</td>
<td>NA</td>
<td>NA</td>
<td>CLOSE</td>
<td>CLOSE</td>
</tr>
<tr>
<td>S3</td>
<td>EJECTOR STEAM BLOCK VALVE</td>
<td>NA</td>
<td>NA</td>
<td>OPEN</td>
<td>OPEN</td>
</tr>
<tr>
<td>S4</td>
<td>STEAM EJECTOR CNTR VALVE</td>
<td>NA</td>
<td>NA</td>
<td>MOD</td>
<td>LAST P</td>
</tr>
<tr>
<td>S5</td>
<td>PURGE STEAM BLOCK VALVE</td>
<td>OPEN</td>
<td>OPEN</td>
<td>CLOSE</td>
<td>CLOSE</td>
</tr>
<tr>
<td>S6</td>
<td>PURGE STEAM BLEED VALVE</td>
<td>CLOSE</td>
<td>CLOSE</td>
<td>OPEN</td>
<td>OPEN</td>
</tr>
<tr>
<td>S7</td>
<td>PURGE STEAM BLOCK VALVE</td>
<td>OPEN</td>
<td>OPEN</td>
<td>CLOSE</td>
<td>CLOSE</td>
</tr>
<tr>
<td>S8</td>
<td>PURGE STEAM BLOCK VALVE</td>
<td>OPEN</td>
<td>OPEN</td>
<td>CLOSE</td>
<td>CLOSE</td>
</tr>
<tr>
<td>S9</td>
<td>PURGE STEAM BLEED VALVE</td>
<td>CLOSE</td>
<td>CLOSE</td>
<td>OPEN</td>
<td>OPEN</td>
</tr>
<tr>
<td>S10</td>
<td>PURGE STEAM BLOCK VALVE</td>
<td>OPEN</td>
<td>OPEN</td>
<td>CLOSE</td>
<td>CLOSE</td>
</tr>
<tr>
<td>CG1</td>
<td>CNCG SHUT OFF VALVE</td>
<td>CLOSE</td>
<td>CLOSE</td>
<td>OPEN</td>
<td>CLOSE</td>
</tr>
<tr>
<td>CG2</td>
<td>CNCG MAIN VENT VALVE</td>
<td>OPEN</td>
<td>OPEN</td>
<td>CLOSE</td>
<td>OPEN</td>
</tr>
<tr>
<td>CG3</td>
<td>ALTERNATE SYSTEM SHUTOFF</td>
<td>NA</td>
<td>NA</td>
<td>CLOSE</td>
<td>NA/CLOSE</td>
</tr>
<tr>
<td>CG4</td>
<td>BURNER SHUT OFF VALVE</td>
<td>CLOSE</td>
<td>CLOSE</td>
<td>OPEN</td>
<td>CLOSE</td>
</tr>
<tr>
<td>CG5</td>
<td>BURNER VENT VALVE</td>
<td>OPEN</td>
<td>OPEN</td>
<td>CLOSE</td>
<td>OPEN</td>
</tr>
<tr>
<td>CG6</td>
<td>BURNER SHUT OFF VALVE</td>
<td>CLOSE</td>
<td>CLOSE</td>
<td>OPEN</td>
<td>CLOSE</td>
</tr>
<tr>
<td>CG7</td>
<td>CNCG VENT VALVE</td>
<td>OPEN</td>
<td>OPEN</td>
<td>CLOSE</td>
<td>OPEN</td>
</tr>
<tr>
<td>SG1</td>
<td>SOG SHUT OFF VALVE</td>
<td>CLOSE</td>
<td>CLOSE</td>
<td>OPEN</td>
<td>CLOSE</td>
</tr>
<tr>
<td>SG2</td>
<td>SOG MAIN VENT VALVE</td>
<td>OPEN</td>
<td>OPEN</td>
<td>CLOSE</td>
<td>OPEN</td>
</tr>
<tr>
<td>SG3</td>
<td>ALTERNATE SYSTEM SHUTOFF</td>
<td>NA</td>
<td>NA</td>
<td>CLOSE</td>
<td>NA/CLOSE</td>
</tr>
<tr>
<td>SG4</td>
<td>BURNER SHUTOFF VALVE</td>
<td>CLOSE</td>
<td>CLOSE</td>
<td>OPEN</td>
<td>CLOSE</td>
</tr>
<tr>
<td>SG5</td>
<td>BURNER VENT VALVE</td>
<td>OPEN</td>
<td>OPEN</td>
<td>CLOSE</td>
<td>OPEN</td>
</tr>
<tr>
<td>SG6</td>
<td>BURNER SHUT OFF VALVE</td>
<td>CLOSE</td>
<td>CLOSE</td>
<td>OPEN</td>
<td>CLOSE</td>
</tr>
<tr>
<td>SG7</td>
<td>SOG VENT VALVE</td>
<td>OPEN</td>
<td>OPEN</td>
<td>CLOSE</td>
<td>OPEN</td>
</tr>
<tr>
<td>D1</td>
<td>AIR CONTROL DAMPER</td>
<td>LAST P</td>
<td>CLOSE</td>
<td>MOD</td>
<td>LAST P</td>
</tr>
<tr>
<td>IGNITER GT</td>
<td>IGNITER GAS TRAIN</td>
<td>CLOSE</td>
<td>CLOSE</td>
<td>OPEN</td>
<td>CLOSE</td>
</tr>
</tbody>
</table>

**GREY BLOCK** OPERATIONS ARE ACTIVATED VIA A TIMER TO ALLOW FOR PURGING OF THE CNCG AND SOG LINES.
Figure 1 CNCG and SOG Transfer Systems.
Figure 2 CNCG & SOG Single Burner for Thermal Oxidation in Recovery Boiler.

NOTE:
This Figure is for General Reference Only. It Is Not Intended To Be Used As a Basis For Design.
Figure 3 Waste System Burner Permissive Starting Logic for CNCG

NOTE:
1. Logic Applies to Each Gas Stream Entering the Burner
2. Staging of Injection of Multiple Streams Into the Burner Shall Be Part of the Start Logic
3. Purge Credit - Reference Figure 2 of BLRBAC Recommended Good Practice for Safe Firing of Auxiliary Fuels
4. Igniter Interlocks - Reference Figures 4 and 17 of BLRBAC Recommended Good Practice for Safe Firing of Auxiliary Fuels
<table>
<thead>
<tr>
<th>LOGIC BLOCK</th>
<th>PURPOSE</th>
<th>HAZARD PROTECTED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boiler Purge Credit Maintained (From Figure 2 Common</td>
<td>Ensure firing permissive.</td>
<td>Prevent introduction of NCGs while</td>
</tr>
<tr>
<td>Permissive Starting Logic in Safe Firing of Auxiliary</td>
<td></td>
<td>boiler is not being fired.</td>
</tr>
<tr>
<td>Fuel Guidelines).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firing liquor stably or steam flow &gt;50% MCR.</td>
<td>Ensure furnace combustion is stable and heat input is adequate.</td>
<td>Explosion or improper oxidation of gases.</td>
</tr>
<tr>
<td>Combustion air fan for waste stream burner - proven</td>
<td>Ensure proper combustion air to burner.</td>
<td>Potential explosion from improper or impaired air flow.</td>
</tr>
<tr>
<td>CNCG/SOG temperature above minimum.</td>
<td>Ensure proper gas properties.</td>
<td>Introduction of liquid.</td>
</tr>
<tr>
<td>CNCG/SOG pressure not high.</td>
<td>Ensure proper gas properties and injection at proper velocity.</td>
<td></td>
</tr>
<tr>
<td>CNCG/SOG pressure not low.</td>
<td>Ensure proper gas properties and emitted at proper velocity.</td>
<td></td>
</tr>
<tr>
<td>CNCG/SOG flow not low.</td>
<td>Ensure proper gas velocity.</td>
<td>Avoid plugged nozzle</td>
</tr>
<tr>
<td>Seal pot level not high.</td>
<td>Prevent liquid back up.</td>
<td>Possible explosion due to moisture introduction to boiler</td>
</tr>
<tr>
<td>Combustion air flow normal.</td>
<td>Ensure air flow through burner.</td>
<td>Potential explosion from improper or impaired air flow.</td>
</tr>
<tr>
<td>Combustion air pressure normal.</td>
<td>Ensure proper combustion air properties.</td>
<td>Potential explosion from improper or impaired combustion air supply.</td>
</tr>
<tr>
<td>Ignition system in operation - minimum of one minute.</td>
<td>Ensure stable ignition system operation.</td>
<td>Possible explosion due to CNCG/SOG gas burner introduction cycling.</td>
</tr>
<tr>
<td>Burner switch in start position.</td>
<td>Allow start after interlocks satisfied.</td>
<td>By operator.</td>
</tr>
<tr>
<td>Igniter interlocks satisfied.</td>
<td>Interlocks from Auxiliary Fuel Guidelines 4</td>
<td>Explosion from improper or delayed ignition.</td>
</tr>
<tr>
<td>Start approval.</td>
<td>All burner/igniter interlocks satisfied.</td>
<td></td>
</tr>
<tr>
<td>Energize CNCG/SOV SSV.</td>
<td>Admit gas to furnace.</td>
<td></td>
</tr>
<tr>
<td>CNCG/SOG burner in operation.</td>
<td>Verify oxidation.</td>
<td>Operator function</td>
</tr>
</tbody>
</table>
Figure 4 Waste Stream Burner Protective Tripping Logic for CNCG.

NOTE:
1. Logic Applies to Each Gas Stream Entering the Burner
2. Purge Credit Loss/Master Fuel Trip - Reference Figure 3 of BLRBAC Recommended Good Practice for Safe Firing of Auxiliary Fuel
3. Igniter Interlocks - Reference Figures 5 and 18 of BLRBAC Recommended Good Practice for Safe Firing of Auxiliary Fuel
### Table 3 Logic Explanation Chart for Figure 8 Protective Tripping Logic - Waste Stream Burner

<table>
<thead>
<tr>
<th>LOGIC BLOCK</th>
<th>PURPOSE</th>
<th>HAZARD PROTECTED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boiler Purge Credit Lost Master Fuel Trip (From Figure 2 Common Permissive Starting Logic in Safe Firing of Aux Fuel Guidelines).</td>
<td>Stop CNCG introduction when boiler firing permissives not met.</td>
<td>Prevent introduction of CNCG while boiler is not being fired.</td>
</tr>
<tr>
<td>Not firing stably or steam flow &lt;50% MCR.</td>
<td>Stop CNCG firing when furnace heat input is low.</td>
<td>Explosion or improper oxidation of gases.</td>
</tr>
<tr>
<td>Combustion air flow not normal.</td>
<td>Stop CNCG firing in the event of air flow upsets to burner.</td>
<td>Potential explosion from improper or impaired air flow.</td>
</tr>
<tr>
<td>Combustion air fan for waste stream burner not running.</td>
<td>Stop CNCG firing when no combustion air to burner.</td>
<td>Potential explosion from improper or impaired air flow.</td>
</tr>
<tr>
<td>CNCG/SOG pressure low or high.</td>
<td>Ensure proper gas properties and injection at proper velocity.</td>
<td>Flash back up piping or poor ignition beyond igniter.</td>
</tr>
<tr>
<td>CNCG/SOG flow low</td>
<td>Ensure proper velocity</td>
<td>Plugged nozzle</td>
</tr>
<tr>
<td>Combustion air pressure not normal.</td>
<td>Ensure proper combustion air properties.</td>
<td>Potential explosion from improper or impaired combustion air supply.</td>
</tr>
<tr>
<td>Igniter Interlocks not satisfied.</td>
<td>Interlocks from Auxiliary Fuel Guidelines 4 and 17 not met.</td>
<td>Explosion from improper or delayed ignition.</td>
</tr>
<tr>
<td>Seal pot level high.</td>
<td>Prevent liquid back up.</td>
<td>Possible explosion due to moisture introduction to boiler.</td>
</tr>
<tr>
<td>Close CNCG/SOG SSV.</td>
<td>Shutdown CNCG/SOG burner.</td>
<td></td>
</tr>
</tbody>
</table>
Figure 5 Waste Stream Burner Permissive Starting Logic for SOG.
### Table 4 Logic Explanation Chart for Figure 9 Permissive Starting Logic for SOG - Waste Streams Burner

<table>
<thead>
<tr>
<th>LOGIC BLOCK</th>
<th>PURPOSE</th>
<th>HAZARD PROTECTED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boiler Purge Credit Maintained</td>
<td>Ensure firing permissive.</td>
<td>Prevent introduction of SOG while boiler is not being fired.</td>
</tr>
<tr>
<td>(From Figure 2 Common Permissive Starting Logic in Safe Firing of Auxiliary Fuel Guidelines).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firing liquor stably or steam flow &gt;50% MCR.</td>
<td>Ensure furnace combustion is stable and heat input is adequate.</td>
<td>Explosion or improper oxidation of gases.</td>
</tr>
<tr>
<td>Combustion air fan for waste stream burner - proven running.</td>
<td>Ensure proper combustion air to burner.</td>
<td>Potential explosion from improper or impaired air flow.</td>
</tr>
<tr>
<td>SOG temperature above minimum.</td>
<td>Ensure proper gas properties.</td>
<td>Introduction of liquid.</td>
</tr>
<tr>
<td>SOG pressure not high.</td>
<td>Ensure proper gas properties and injection at proper velocity.</td>
<td></td>
</tr>
<tr>
<td>SOG pressure not low.</td>
<td>Ensure proper gas properties and emitted at proper velocity.</td>
<td></td>
</tr>
<tr>
<td>Seal pot level not high.</td>
<td>Prevent liquid back up.</td>
<td>Possible explosion due to moisture introduction to boiler</td>
</tr>
<tr>
<td>SOG flow not low.</td>
<td>Ensure SOG line velocity is adequate</td>
<td>Prevent flame propagation back through SOG line</td>
</tr>
<tr>
<td>Combustion air flow normal.</td>
<td>Ensure air flow through burner.</td>
<td>Potential explosion from improper or impaired air flow.</td>
</tr>
<tr>
<td>Ignition system in operation - minimum of one minute.</td>
<td>Ensure stable ignition system operation.</td>
<td>Possible explosion due to SOG gas burner introduction cycling.</td>
</tr>
<tr>
<td>Burner switch in start position.</td>
<td>Allow operator to start burner after all other interlocks satisfied.</td>
<td>By operator.</td>
</tr>
<tr>
<td>Igniter interlocks satisfied.</td>
<td>Interlocks from Auxiliary Fuel Guidelines 4 and 17.</td>
<td>Explosion from improper or delayed ignition.</td>
</tr>
<tr>
<td>Start approval.</td>
<td>All burner/igniter interlocks satisfied.</td>
<td></td>
</tr>
<tr>
<td>Energize SOV SSV.</td>
<td>Admit gas to furnace.</td>
<td></td>
</tr>
</tbody>
</table>
Figure 6 Waste Stream Burner Protective Tripping Logic for SOG.

NOTE:

1. Logic Applies to Each Gas Stream Entering the Burner

2. Purge Credit Loss/Master Fuel Trip - Reference Figure 3 of BLRBAC Recommended Good Practice for Safe Firing of Auxiliary Fuel

3. Igniter Interlocks - Reference Figures 5 and 18 of BLRBAC Recommended Good Practice for Safe Firing of Auxiliary Fuel
### Table 5 Logic Explanation Chart for Figure 10 Protective Tripping Logic for SOG - Waste Stream Burner

<table>
<thead>
<tr>
<th>LOGIC BLOCK</th>
<th>PURPOSE</th>
<th>HAZARD PROTECTED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boiler Purge Credit Lost Master Fuel Trip</td>
<td>Stop SOG introduction when boiler firing permissives not met.</td>
<td>Prevent introduction of SOG while boiler is not being fired.</td>
</tr>
<tr>
<td>(From Figure 3 Common Permissive Starting Logic in Safe Firing of Aux Fuel Guidelines).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not firing liquor stably or steam flow &lt;50% MCR.</td>
<td>Stop SOG firing when furnace heat input is low.</td>
<td>Explosion or improper oxidation of gases.</td>
</tr>
<tr>
<td>Combustion air flow not normal.</td>
<td>Stop SOG firing in the event of air flow upsets to burner.</td>
<td>Potential explosion from improper or impaired air flow.</td>
</tr>
<tr>
<td>Combustion air fan for waste stream burner not running.</td>
<td>Stop SOG firing when no combustion air to burner.</td>
<td>Potential explosion from improper or impaired air flow.</td>
</tr>
<tr>
<td>SOG pressure low or high.</td>
<td>Ensure proper gas properties and injection at proper velocity.</td>
<td>Flash back up piping or poor ignition beyond igniter.</td>
</tr>
<tr>
<td>SOG flow low.</td>
<td>Ensure SOG line velocity is adequate.</td>
<td>Prevent flame propagation back through SOG line.</td>
</tr>
<tr>
<td>Igniter Interlocks not satisfied.</td>
<td>Interlocks from Auxiliary Fuel Guidelines 5 and 18 not met.</td>
<td>Explosion from improper or delayed ignition.</td>
</tr>
<tr>
<td>Seal pot level high.</td>
<td>Prevent liquid back up.</td>
<td>Possible explosion due to moisture introduction to boiler.</td>
</tr>
<tr>
<td>Close SOG SSV.</td>
<td>Shutdown SOG burner.</td>
<td></td>
</tr>
</tbody>
</table>