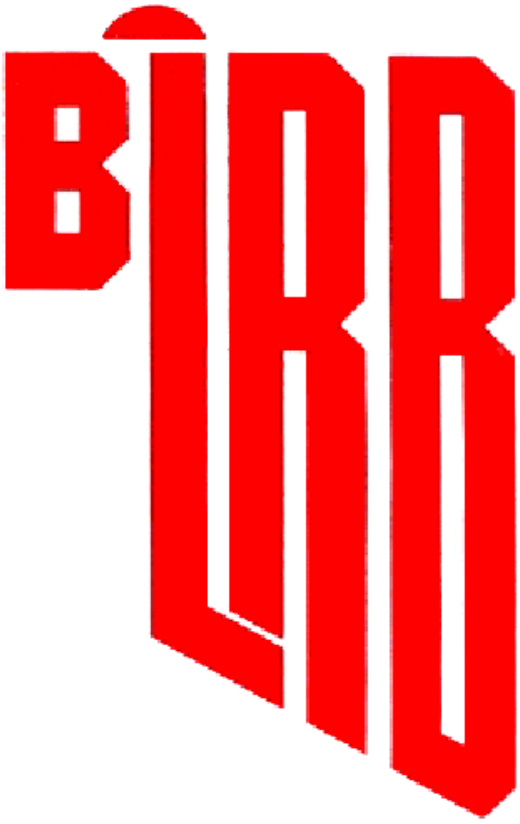

RECOMMENDED GOOD PRACTICE

RECOMMENDED GUIDELINES FOR PERSONNEL SAFETY BLACK LIQUOR RECOVERY BOILERS

THE BLACK LIQUOR RECOVERY BOILER ADVISORY COMMITTEE

April 2018

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FOREWORD

The necessity to protect personnel from injuries that can occur during the operation, maintenance and repair of black liquor recovery boilers, prompted the Black Liquor Recovery Boiler Advisory Committee to appoint a Subcommittee on Personnel Safety. The original subcommittee was requested to formulate guidelines that could be used by the pulp and paper industry in the development or upgrading of facilities, operating procedures and repair procedures. The original document was published in April of 1971. The following is a revision of the original document to incorporate new technologies, equipment, procedures, and process improvements that hopefully will make the recovery boiler area a safer place to work.

The subcommittee recognizes that these guidelines are only one small facet to the safe operation of Black Liquor Recovery Boilers. No set of guidelines can cover all situations or specific problem areas encountered at individual mill locations.

It is neither the intent of the subcommittee nor the purpose of this document to impose unreasonable or impractical restrictions on existing operations. The original intent was to have the document be used as a guideline in the design and early operating stages of the Black Liquor Recovery Boiler. Presently, many mills are running older boilers that were built and operating before many of the more recent BLRBAC Recommendations were published and some may even have been built prior to the formation of the BLRBAC organization in 1962. This document may be helpful in the upgrading or retrofitting of older boilers but it still should be used as a guide only. It is not the intent of this subcommittee to force major design or operational changes to existing black liquor recovery boilers.

It is recognized that the black liquor recovery boiler has certain inherent operating hazards and difficulties that should be respected. To operate and maintain a black liquor recovery boiler safely, much effort has to go into plant design. This responsibility has to be clearly placed on our engineers, vendors, and operators. Management must devote the resources necessary to accomplish this.

It is important to note that these are generic guidelines and only through efforts by the owner/operator in conjunction with designers, suppliers, and engineers, can these guidelines be customized to your specific location(s). There are many areas in this document where “it is suggested or for your consideration.” Each of these sections needs to be clearly adapted to your needs. We have purposely been vague in giving exact numbers to design issues because each situation needs to be reviewed by professional engineers (i.e., such as blast wall thickness).

The subcommittee would like to thank all of the many contributors to the original document and this revised edition. It has taken the hard work and cooperation of operating mill personnel, consulting engineers, loss prevention specialists, equipment

suppliers and chemical suppliers, based on their many years of experience on a worldwide basis to complete this goal.

CHANGES

April 2015

Added a sentence to paragraph 1.1.6 to reference Appendix B containing a generic letter for obtaining a variance to allow exit doors to open into the Recovery Area.

Added to last sentence in paragraph 1.3.2, to clarify reference to local building codes.

Added a new paragraph, 2.2.3 regarding structural and pressure part integrity.

Added a new section, 2.2.5 on Pressure Part Ruptures.

Added a new paragraph, 2.10.6 on Management of Change.

Added a new paragraph, 2.10.7 on Boiler Blowdown Line

Added a new section, 4.4 providing guidance for mills to use/consider when establishing a set of Recovery Boiler Safety Guidelines.

For a summary of prior changes to this document refer to Appendix A, Document Revision History

SECTION I DESIGN AND CONSTRUCTION OF BUILDINGS AND EQUIPMENT

CHAPTER 1 BUILDINGS

1.0 General

These guidelines are intended to be applied for the design of new buildings, but can also serve as a guide for increasing the safety in existing buildings.

1.0.1 All national, state, and local building codes should be followed where applicable in the design and construction of the facility. This should include but not be limited to, earthquake, wind and flood, fire protection, smoke, noise, electrical, normal and emergency personnel egress, and wall and floor penetrations. One exception to this is section 1.1.6 of this document.

1.0.2 In keeping with the restricted access concept, the recovery boiler building should be located within the mill complex, such that access is limited and the building is not a thoroughfare for personnel.

1.0.3 Good mill layout and design should include considering where new boilers are located in relation to existing boilers and critical utilities to minimize involvement of either or both during an emergency.

1.1 Pressure Resistant Construction

1.1.1 Roof and floor decking should be securely anchored in place to minimize the possibility of being dislodged and falling as the result of an explosion. Solid, leak resistant flooring should be installed where there is the possibility of spills from hot liquids, hazardous chemicals, hot ash, or smelt. Curbing should be installed with the exception of personnel access points where it should be gradually sloping upward (ramped) to contain hazardous spills.

1.1.2 Building frame should be designed to minimize the possibility of the building collapsing in the event of an explosion. It is recommended that the building be designed to allow pressure relief in the event of an explosion, with consideration for outside pedestrian traffic.

1.1.3 Any enclosures that are normally occupied should be protected from the potential pressure forces of an explosion. This could include, but not be limited to control rooms, elevators, protected stairwell, restrooms, motor control centers, rack rooms, break rooms, laboratories, maintenance and supervisory offices. If the enclosures are not equipped with emergency exits away from the boiler, they

should either be fire and smoke proof or be equipped with escape respirators. Work stations or open labs should not be located near the boiler.

1.1.4 The area beneath and around the furnace floor is especially hazardous. This area should be chained off or guardrails installed with appropriate warning signs to prevent unauthorized entry. If possible, auxiliary equipment should be located away from the recovery boiler furnace bottom.

1.1.5 The use of glass or other glazing materials near the recovery boiler area is not recommended. If it must be used, the thickness of the glass or other glazing materials should be such that the window will resist the same design explosion pressure as the wall.

1.1.6 Doors leading to and from protected areas should be pressure resistant and open into the recovery boiler area. This arrangement is necessary to prevent the doors from being blown open during an explosion. This may be different from some local building codes, but is necessary to ensure a safe protected area. They must be normally closed in order to prevent the propagation of pressure, flame, projectiles and hot gases into the protected areas. These doors should be self-closing, but not lockable. (See Appendix B for a generic letter requesting a variance for these doors from the requirements in NFPA 101, *Life Safety Code* and/or local building codes. Also see paragraph 1.3.2.)

1.2 Control Rooms

If possible, the control room should be located away from the recovery boiler so as not to be affected by an explosion (Reference Section 1.1 Pressure Resistant Construction). If the control room is to be located inside the recovery boiler building, the following applies:

1.2.1 The control room should be a reasonable distance from the boiler and should not be located inline with the corners of the boiler.

1.2.2 The floors, walls, and ceiling facing the boiler should be constructed of reinforced concrete or comparable strength material. Typically, a pressure of 100 pounds per square foot is used as a minimum design value.

1.2.3 The doors accessing the control room from the recovery boiler area should open outward into the boiler building, be self-closing and should be of pressure resistant design as discussed in Section 1.1.

1.2.4 Windows are not recommended, but if used, the construction should be such that the window will resist the same design explosion pressure as the wall.

1.2.5 An emergency exit from the control room, other than through the recovery boiler area, should be provided. Ladders should not be used as an emergency exit. (Refer to Section 1.3).

1.2.6 The control room should be equipped with an air-conditioning system with the air intake from a suitable location outside the recovery boiler building. The control room should be under positive pressure, equipped with air lock entrances and exits and should be protected against fire or smoke contamination to ensure a good supply of breathing air. An air purification system is recommended to keep corrosion damage due to air born sulfur and chloride compounds to a minimum.

1.2.7 The control room should be soundproofed in accordance with local, state, and federal standards.

1.3 Exits

1.3.1 Two separate means of egress should be provided from each operating level (including the smelt deck). An elevator is not considered a means of egress in this context. At least one of the escape routes from each operating level should consist of a fire and smoke-proof stairwell that is protected from the hazards of a recovery boiler explosion. This escape stairwell should not be used to run utility piping, electrical or instrument cabling or other process connections. It should be located a reasonable distance away from the boiler. The protected stairwell should exit to a safe area (usually outside the building).

1.3.2 Doors leading to the protected stairwell should open out into the boiler building so in the event of pressurization the doors would not be forced open. They should be pressure resistant and be self-closing, but not lockable. (See Appendix B for a generic letter requesting a variance for these doors from the requirements in NFPA 101, *Life Safety Code* and/or local building codes. Also see paragraph 1.1.6.)

1.3.3 The escape route should be via the protected stairwell and extend the full height of the building or alternately the neighboring buildings. Escape stairs should have metal tread or concrete filled steps and handrails, protected barriers, and emergency lighting.

1.3.4 Escape routes should be well-marked using directional signs with proper illumination.

1.4 Elevators

1.4.1 The elevator should be located away from the corners of the boiler. It should be behind the pressure resistant barrier walls next to the protected stairwell. The elevator should be equipped with emergency phone and fire extinguisher. Escape

respirators should be maintained inside the elevator with at least one for each of the rated number of occupants. Or, as an alternative, provide a self-contained breathing apparatus system. The elevator is not to be used in an emergency evacuation.

1.4.2 The landing levels for the elevator should be positioned a minimum of 4 inches above the level of the connecting floor in order to prevent water, liquor or other liquids from flowing into the elevator shaft.

1.5 Alarms and Warnings

1.5.1 An emergency plan, complete with evacuation routes and alarms should be part of the recovery boiler warning system. The BLRBAC Emergency Shutdown Procedure and Post-ESP procedures should be considered when developing mill specific policies.

1.5.2 Warning lights and sirens should be seen and heard, preferably both, from all locations within the recovery boiler building.

1.5.3 Warning lights and signs should be placed at each entrance to the recovery boiler building informing personnel not to enter if lights are flashing.

1.5.4 ESP warning sirens should be controlled such that they may be shut off after a period of time (after personnel have evacuated). Warning lights are to be kept flashing during the entire emergency.

1.5.5 The existing ESP warning lights and sirens can be used to evacuate the building in the event of a Recovery Boiler emergency other than an actual ESP. A Recovery Boiler emergency may include, but not be limited to an actual ESP, conditions that suggest an ESP may be initiated within a short period of time, or other emergency such as a potential for a dissolving tank explosion.

1.6 Emergency Lighting

1.6.1 Emergency lighting should be provided for critical control areas, such as control stations or valve stations.

1.6.2 Emergency exit or escape routes and directional signs should be visible during power failures.

1.6.3 Stairwells and hallways should also be equipped with emergency lighting.

1.7 Miscellaneous

1.7.1 There should be a sufficient number of stairs, platforms, and ladders so that boilers and auxiliary equipment can be properly inspected, serviced, and maintained.

1.7.2 If the recovery boiler building houses any systems that contain acids (i.e., demineralizers) or low pH solutions, these should have a separate sewer, storage, and drainage system to prevent the formation of hydrogen sulfide (H_2S) gas when liquor containing wastes mix with acids. Acid and caustic storage should be separately diked according to OSHA Standards. Areas where hydrogen sulfide may be present should be equipped with continuous monitors and alarms.

1.7.3 Eye wash and safety showers should be provided at all areas where personnel may come in contact with chemicals. This may be defined as anything that could cause thermal or chemical burns, skin or eye irritation. This should include, but not be limited to, the dissolving tank area, spout deck, liquor firing floor, liquor sampling stations, water treatment areas, evaporator and precipitator areas and ash hopper clean-out stations. The temperature of the water used in eye wash stations and showers should be such so as to not cause further injury.

1.7.4 Combustible construction materials should be avoided.

1.7.5 The boiler house should not be used for bulk storage of combustible materials.

CHAPTER 2 BOILER PROCESS SYSTEMS AND EQUIPMENT

This section highlights some of the process and auxiliary systems that affect the recovery boiler. Much effort needs to go into the design, placement and materials of construction of these systems to ensure personnel safety around the recovery boiler during operation and maintenance.

2.1 Emergency Shutdown and Rapid Drain System

2.1.1 Controls and equipment should be in place to facilitate the immediate shutdown whenever an emergency exists as defined by the "Black Liquor Recovery Boiler Advisory Committee Recommended Emergency Shutdown Procedure (ESP) and Procedure for Testing ESP System for Black Liquor Recovery Boilers" document.

2.2 Explosion Protection

2.2.1 Determine through the Original Equipment Manufacturer (O.E.M.) if your recovery boiler(s) has (have) explosion corners ("zipper corners," "break-a-way"). If so, which corner(s) and between which elevations are they located.

2.2.2 Boiler explosion corners should be identified in a highly visible manner on each elevation. Signs should be posted identifying these areas as points for explosion relief.

2.2.3 Studies have shown that there are a number of areas that may rupture in addition to explosion corners. These areas include all remaining corners of the furnace (for example, the junction of the floor and sidewalls, the junction of the nose arch and side walls and junction of the roof and sidewalls). Operator and/or maintenance workstations should not be exposed to these locations.

Owner/operators of recovery boilers should consult with OEMs about potential upgrade recommendations for older design recovery boilers to improve structural/pressure part integrity.

2.2.4 The operator-training program should include information clearly explaining the purpose, hazards, locations, and limitations of areas listed in Items 2.2.1 and 2.2.3. Personnel should be given this information when initially trained and in refresher courses. Evacuation routes should avoid these locations as much as practically possible.

2.2.5 In November 2001 a report was issued to the American Forest & Paper Association by Thomas M. Grace and John L. Clement. The report is titled "Phase II, Investigation of the Relationship Between Recovery Boiler Furnace Design and Explosion Damage." We encourage owner operators to review this report and OEM

recommendations as resources to assist in deciding what design elements, if any, relating to minimizing the potential for pressure part ruptures in the event of an explosion should be incorporated in their Recovery Boilers.

2.3 Black Liquor System

2.3.1 Black liquor fuel systems should be installed in accordance with BLRBAC Recommended Good Practice – Safe Firing of Black Liquor in Black Liquor Recovery Boilers.

2.4 Auxiliary Fuel System

2.4.1 Auxiliary fuel systems should be installed in accordance with BLRBAC Recommended Good Practice – Safe Firing of Auxiliary Fuel in Black Liquor Recovery Boilers. Main shut offs for all auxiliary fuel supplies should be in remote locations that are operated either manually or automatically.

2.5 Smelt Spout Cooling System

2.5.1 Smelt spout cooling water systems should be installed and maintained according to BLRBAC Recommended Good Practice – Safe Firing of Black Liquor in Black Liquor Recovery Boilers.

2.5.2 If a condition develops that requires shutting off the cooling water to a spout, for any amount of time, it should not be turned back on under any condition. Refer to BLRBAC Recommended Good Practice – Safe Firing of Black Liquor in Black Liquor Recovery Boilers, Section 9.5, Item 1., Smelt Spout Leak or Flow Interruption.

2.6 Boiler Water System

2.6.1 All feedwater entering the boiler(s) should be of a quality meeting the minimum requirements of the boiler manufacturer. A properly designed and maintained boiler feedwater system for the recovery boiler is very important to ensure the safety of personnel working on and around the boiler. It is not the intent of this document to design the feedwater system, but to emphasize its importance. Some sources of information are ASME, TAPPI, the boiler manufacturer, publications and your professional chemical consultant. The following are a few minimum recommendations for consideration:

a. Provide continuous monitoring of feedwater conductivity, dissolved oxygen, and pH including established action levels, and shutdown levels.

b. Properly design and maintain pre-treatment system and boiler water chemical addition system

c. Properly design feedwater and boiler water sample systems for analysis and control

d. Properly design sampling systems for both saturated and superheated steam. This should include the correct sample nozzle location and sample piping

e. Provide an adequate feedwater laboratory to ensure the proper analysis of feedwater and boiler water

f. Provide a source of treated water at the correct temperature to fill the boiler for hydrostatic testing. Check the boiler manufacturer's requirements (such as pressure change rate) and/or water treatment specialist's recommendations.

g. Backfill the superheater for hydrostatic testing to prevent solids carryover from the boiler steam drum to the superheater.

2.7 Water Washing

2.7.1 A system for water washing the boiler with warm/hot water should be designed with connections to a water system such as sootblowers for washing of the boiler for operational reasons or prior to entrance for inspection or maintenance. Refer to the BLRBAC Recommended Good Practice – Safe Firing Black Liquor in Black Liquor Recovery Boilers for proper precautions for non-operating water sources.

2.7.2 Additional access doors in upper furnace areas for hand washing or extra sootblowers may be necessary for good cleaning.

2.7.3 It is also important to provide a means of drying out the boiler after water washing to minimize out of service corrosion. Depending on the configuration of your boiler consider drying the boiler with fans, steam coil air heaters and/or gas firing. Fuels such as oil and waste gas should be avoided for drying out boilers. In addition, the OEM of your boiler may have more specific recommendations.

2.7.4 It is important to reduce or burn the bed out of the boiler as much as possible prior to shutting down the boiler for water washing: this will reduce the cooling time and will help ensure there is no hidden molten smelt remaining before washing. The time required for burning the bed down will vary depending on bed height and other operating variables. Reducing liquor flow prior to burning the bed out may reduce the time needed to accomplish this. Auxiliary fuel and adjusting air (primary and/or secondary) can be used to control smelting while the bed is being burned down.

2.7.5 The ESP or other boiler interlock systems can be tested during the cool down period. If there is molten smelt remaining in the boiler, it is suggested that the boiler be closely inspected by operator walk down for any signs of a possible tube leak prior to valving out the rapid drain lines for the ESP functional test.

2.7.6 After the bed has been burned as low as possible, shutdown the boiler to cool down the remainder of the bed. Maintaining air flow through the boiler may facilitate cooling. It may be helpful to isolate the air heater heat source to minimize air temperature entering the boiler. The amount of time necessary to cool the bed prior to initiating water washing will vary depending on the amount of bed remaining in the furnace.

It is critical to safety that no molten smelt be present in the boiler when the water wash is started. Each mill should follow their own proven procedure to ensure there is no molten smelt present. If char bed burn down is incomplete compared to past mill experience, additional steps should be added to prove no molten smelt is present.

Though not required, some plants establish a minimum time requirement before initiating water washing following a normal shutdown including burning the bed as low as possible; 12 hours for decanting beds and 8 hours for sloping floors is common unless a history of data proves differently. Also, though not required, some plants establish a maximum bed temperature, typically 800°F (427°C) prior to introducing water into the furnace. Thoroughly probing the smelt bed with thermocouples in as many places as possible can help to establish no molten smelt remains. Refer to Recommended Post-ESP Procedure for Black Liquor Boilers, Chapter 8, Char Bed Cool-Down and Chapter 9, Water Washing. (Testing of beds with water is prohibited by BLRBAC).

2.7.7 Follow manufacturer guidelines for cool down rates, venting superheaters and venting the steam drum. If not specified, superheaters are vented or drained when the boiler comes off line and steam flow (cooling) stops and steam drum pressure is between 50 and 25 psig (3.4 and 1.7 barg).

2.7.8 Verify that auxiliary fuel is isolated from the boiler. Also, consider removing or protecting gas burners, oil guns, ignitors/scanners, bed cameras, ESP valves, burner cabinets, electrical and instrumentation boxes, oxygen sensors (or any water sensitive electronic equipment) prior to initiating a water wash.

2.7.9 Secure liquor systems to the boiler and weak wash systems to the dissolving tank and scrubber as necessary. Liquor guns may be used to wash the furnace provided proper interlocks are used to prevent introducing water to molten smelt. Refer to the BLRBAC Recommended Good Practice – Safe Firing of Black Liquor in Black Liquor Recovery Boilers (October 2007), Chapter 8, Black

Liquor and Water Piping Systems, item 13, Use of a Keyed interlock switch for the Lower Furnace Water Wash.

2.7.10 Prepare ash hoppers (ash hoppers are not designed to support the weight of a full hopper of water), ash conveyors, dissolving tank(s), ducts, breechings or sluice systems for water washing by opening appropriate covers, drains and blanks. Temporary drains may need to be installed to direct wash water to appropriate drain points in the building.

2.7.11 Some mills operate fans while water washing. As needed, drain lines should be opened to ensure water does not accumulate in fan housings.

2.7.12 Some mills isolate precipitators before water washing. If this is done, venting water wash vapor from the boiler via an alternate system should be considered.

2.7.13 If sootblowers are used for water washing, isolate the steam to the sootblowing system and hook up water to the sootblower system by following the guidelines established in BLRBAC Recommended Good Practice – Safe Firing Black Liquor in Black Liquor Recovery Boilers. Consider isolating the sootblower system steam traps or thermal drain systems to help maintain water pressure in the system and prevent contamination of the condensate system.

2.7.14 Wash water temperature should not exceed manufacturer recommendations. Most manufacturers' recommend that the water temperature be within 100°F (56°C) of any metal temperature. Recommended sources of wash water are condensate, treated water, mill water, or feedwater (this may need to be tempered to prevent flashing). Use of water from untreated sources may increase corrosion potential on the fireside of the boiler.

2.7.15 Water used to wash the boiler with sootblowers will typically be hot and can leak from packings. Ensure that personnel in the building are aware of this hot water hazard. Rope off, barricade or keep people clear of hazard areas as necessary.

2.7.16 When water is first introduced to the boiler furnace, areas such as the lower furnace, all furnace openings and explosion relief corners should be cleared of all personnel to ensure no one is near these locations in the event of a smelt water reaction. Mills should establish a “safe boundary” in the recovery boiler area until water washing has been done in the furnace long enough (typically 30 minutes) to ensure that no explosion hazard exists.

2.7.17 Periodically check the spout openings and other drain points on the boiler, as noted in 2.7.10, to ensure that wash water is not accumulating in the furnace cavity, ducts, breechings or hoppers.

2.7.18 Water leaking from boiler ports, manways, or from non-membrane boiler tubes will be alkaline and can cause chemical burns. Ensure people are properly trained in the hazards and use protective equipment as necessary.

2.7.19 When water is introduced to the boiler through the sootblower system, steps should be taken to ensure that water-hammer does not occur as sootblowers start and stop. Methods include parking a sootblower with a poppet open, overlapping sootblower operation, or continuous flow of water from the header.

2.7.20 It is not uncommon, following the water washing procedures(s), to still have deposits (clinkers) remaining in some areas, such as around the furnace roof, under the arch/bull nose, between and within the superheater elements, etc. It is of prime importance to inspect all such areas within the furnace where these deposits, sometimes quite heavy in nature, may accumulate and remain, as these areas may produce a personnel safety issue when people enter the furnace. Extra caution must be taken to assure their safety and that such deposits are completely removed.

As described in section 2.7.2, additional access or inspection doors should be considered for installation in any areas where deposits are known to accumulate for additional cleaning and removal.

The furnace should be inspected, externally, through any access doors to determine that as much of the deposits as possible have been removed. This should be followed by an internal inspection from as high in the unit as feasible (such as entering the superheater area, boiler generating bank, etc.) to more completely ensure that deposits have been removed and that it is safe for personnel to enter the furnace. Additional access doors may be required to adequately accommodate this internal inspection/access.

Assure that adequate fall protection procedures and criteria are in-place for personnel entering and inspecting the upper furnace area(s.)

2.7.21 If additional washing is done manually, the following precautions are suggested:

- Evaluate the area to be cleaned manually to ensure other hazards do not exist
- Personnel should be trained on the hazards involved with manually water washing sections of the boiler
- Perform appropriate lockout of the adjacent sootblowers in the area to be cleaned manually
- Wear appropriate PPE
- Be aware that ash can fall from the boiler impacting the cleaning devices causing injury.

2.7.22 Ensure that the following areas are drained after water washing:

- Sootblower wallbox purge air system
- Air ducts
- Breechings
- Fan housings
- Startup burner plenums
- Load burner plenums
- Waste stream ducting and burners
- Ash hoppers
- Ash conveyors
- Mixtanks
- Sootblower steam supply traps/thermal drains
- All other areas where water can accumulate.

2.7.23 Additional consideration:

- Saltcake accumulations remaining in the furnace along the walls can react quickly when liquor is reintroduced into the boiler resulting in smelt runoff into the primary windbox. Ensure this area is clear following water washing.

2.8 Sootblowing System

2.8.1 A properly designed sootblowing system that incorporates the following should be provided:

a. Properly sloped steam piping and condensate removal system

b. Properly aligned and maintained sootblowers to minimize tube wastage

c. Properly designed and maintained seal boxes to prevent gases and dust from being discharged outside the boiler.

2.8.2 Protective devices such as end shields and flange wraps should be installed at the poppet valve and steam piping flanges to prevent personnel from being burned by steam leaks as they walk or stand nearby for all sootblowers. The protective devices should be installed where burn hazards exist and designed in such a manner to divert steam away from personnel.

2.8.3 Consideration should be given to installing local individual electrical and steam shutoff/lockout devices for ease of maintenance on each unit without shutting the entire system down. In addition, isolation and drain valves should be installed to be able to properly lockout systems.

2.8.4 If an alternate supply of steam is used so that sootblowing can be conducted during boiler outages, care must be taken to assure that this system (alternate steam source) is properly locked out before personnel are allowed into the boiler.

2.8.5 If oil/grease leakage is a problem, drip pans should be installed on sootblower gearboxes. Oil and grease can be a hazard to personnel and a potential fire hazard.

2.8.6 Individual sootblower poppet valve pressures should be adjusted to the recommended pressure and confirmed on a regular basis for the specific location and for the nozzle design installed. Excessive pressure, producing high impact forces, has been shown to damage pressure parts.

2.9 Dissolving Tank and Green Liquor System

2.9.1 Dissolving tank agitators can be either side-mounted or top-mounted. Top-mounted dissolving tank agitator motors and gearboxes should be as compact as possible so as not to be obstacles to personnel egress. These top mounted gearboxes should be located such that normal spout rodding and maintenance are unobstructed.

2.9.2 A method of emergency agitation in case of mechanical agitator failure should be considered. This could be direct steam injection into the dissolving tank.

2.9.3 The smelt shattering system is very important to the safe operation of the recovery boiler, yet often overlooked or under-designed. The following should be considered when designing:

a. Adequate steam pressure and flow.

b. Auxiliary or additional shatter jets for emergency or heavy smelt flow conditions.

c. Method of cleaning and on-line repair as the nozzles become worn, plugged or damaged.

2.9.4 Smelt spout cleaning tools and implements to restrict smelt flow (templates/flow restrictors) during emergency conditions should be kept on the smelt spout deck.

2.9.5 Methods to cross check dissolving tank density and level should be considered. Green liquor, due to its propensity to scale, often plugs up sample lines and density and/or tank level instruments.

2.9.6 To prevent injury to personnel and damage to equipment, adequate explosion relief devices directing pressure forces away from dissolving tank should be installed and maintained.

2.9.7 The deck over the smelt dissolving tank should be designed to withstand a smelt dissolving tank explosion. This can be either concrete or steel decking, provided it is secured to the structural steel. The deck should be free of any tripping hazards and be designed with unobstructed exits in the event of a heavy smelt run-off. If the boiler is equipped with a platform to access windbox ports or hearth burners over the spouts, it should be solid to prevent smelt or liquor from hitting personnel.

2.9.8 Provide emergency water makeup system in accordance with BLRBAC Recommended Good Practice – Safe Firing of Black Liquor in Black Liquor Recovery Boilers.

2.10 Miscellaneous

2.10.1 Identify all tanks, piping systems and valves by color coding and labeling (material and direction of flow).

2.10.2 When steam turbines are used for ID fan drives, steam should be provided from a source other than the same boiler involved ensuring a supply of steam to the turbine during an emergency shutdown.

2.10.3 Consideration should be given to use of mass balance, chemical balance and/or acoustic detection, as operator aids for leak detection.

2.10.4 Boilers should be equipped with an adequate number of manways large enough to accommodate a stretcher in the event of an emergency. Suggested locations for these stretcher size openings are the lower and upper furnace entries, such as maintenance platform access, and the boiler and economizer hoppers where routine maintenance must take place.

2.10.5 All boiler areas, systems and equipment should incorporate provisions for inspection and repair. This should include a means of safely accessing the inspection openings.

2.10.6 Management of Change – A “Management of Change” policy is recommended. Management of Change should be communicated to all involved parties in the mill and the changes should be documented in hard copy or electronically. How a management of change is structured, implemented and revised is up to the individual mills and those person(s) responsible for recovery boiler operation.

2.10.7 Boiler Blowdown Lines – Boiler blowdown lines including header, drum, water column, etc. drains are subject to external corrosion. Often these lines are covered with insulation and lagging. The lines generally have little to no pressure on the lines until they are in use. Lines that have corroded and lost

significant wall thickness have leaked or burst when blowdown valves are opened pressurizing these lines. Generally the corrosion process is slow and occurs over extended periods of time. Mills should periodically evaluate the lines. The interval at which evaluations are performed will be determined by the mill as corrosion rates vary due to numerous variables.

CHAPTER 3 CONSTRUCTION AND WELD QUALITY

This section references codes that are applicable to new construction and repair of recovery boilers. It also highlights some of the considerations when making pressure part welds and performing nondestructive testing.

3.1 Construction Codes and Guidelines

3.1.1 Due to the hazards of a smelt-water reaction and/or explosions, extraordinary precautions must be taken in the design, fabrication, construction, operation, inspection and repair of the recovery boiler to guard against the possible introduction of water into the furnace. As a minimum, the following codes and guidelines (or equivalent local jurisdictional codes and guidelines) should be used:

a. Section I of the ASME Boiler and Pressure Vessel Code for new construction.

b. National Board Inspection Code (NBIC) for any welded repairs or alterations in addition to any local jurisdictional requirements.

c. American Forest & Paper Association's (AF&PA) Guidelines and Checklist for Specification and Construction of New Black Liquor Recovery Boilers.

d. AF&PA Recovery Boiler Reference Manual, Volume II, Maintenance and Repair Analysis and Repair Guidelines and Practices.

3.1.2 The use of welded attachments to tubes should be minimized and where used, the welds should be either circumferential or longitudinal to tubes with adequate wall thickness. The use of members welded tangent to tubes either inside or outside the furnace should be prohibited. Careful attention should be given to possible high stresses in welds and subsequent cracking of tubes due to differential expansion. One method to minimize problems is the use of intermediate pads welded on both sides of the tube with longitudinal welds.

3.1.3 Backing rings should not be used in butt welds exposed to the fireside.

3.2 Weld Quality

3.2.1 One of the most important parameters which need to be controlled to prevent smelt-water reactions is weld quality. All pressure containing welds in the furnace should be performed in accordance with Section I and IX of the ASME Boiler and Pressure Vessel Code as well as the National Board Inspection Code.

3.2.2 All pressure containing butt welds in the furnace area, or any weld that could admit water into the furnace, should be examined by radiography (RT) and/or ultrasonic (UT) examination methods. All other pressure containing welds, at a minimum, should be examined visually.

3.2.3 Radiography or ultrasonic examination methods for pressure containing welds should be applied in accordance with Section V of the ASME Boiler and Pressure Vessel Code. Acceptance standards stated in ASME Section I should be used to determine acceptability of welds.

3.2.4 Qualification of personnel conducting these examinations should be in accordance with SNT-TC-1A, "Recommended Practice for Nondestructive Testing Personnel Qualification and Certification," published by the American Society for Nondestructive Testing (ASNT).

3.2.5 Records of any pressure part repairs should include documentation of all NDE that was performed.

3.2.6 Manufacturer Data Report Forms (P-3 or P-3A forms) document design and material used in the drums, tubes, headers, etc. This information is vital for selecting the correct material and welding procedure specification (WPS) when repairs are required. Special attention is needed for all material and WPS selections, but is especially necessary when high temperature conditions of the superheater or dissimilar metals are involved.

3.2.7 Due to the variety of repair situations involved, no attempt is made within this document to address specific repair procedures. However, if it is permitted by the authority having jurisdiction, and is the policy of plant management to make repairs with in-house personnel, specific repair procedures that meet the requirements of Section 3.2.1 should be established. Repair/Alteration Forms (Form R-1 Report of Repair or Form R-2 Report of Alteration) should be used to provide a history of any changes made since the original manufacture. Guidelines for a wide variety of repairs are contained in the American Forest & Paper Association (AF&PA), "The Recovery Boiler Reference Manual, Volume II", and various publications of the Technical Association of the Pulp and Paper Industry (TAPPI).

3.2.8 The original code of construction should be referenced to ensure specific requirements, such as post weld heat treatment, are considered in planning repair procedures.

3.2.9 The required qualifications and repair procedures for all outside contractors should be reviewed prior to the start of any repair, as well as notification of the Authorized Inspection Agency (Jurisdiction and/or Insurance Company).

SECTION II PERSONNEL SAFETY GUIDELINES AND PROCEDURES

CHAPTER 4 SAFETY GUIDELINES FOR "NORMAL OPERATING" CONDITIONS

The following is intended to assist in developing safety guidelines and standard operating procedures for the recovery boiler area. No attempt is made within this document to address every system, procedure, situation, or condition at each mill associated with individual recovery boilers. These guidelines have purposely been developed in a generic form and should be customized to the individual mill location, type of equipment and operation.

4.1 Safety Training

The responsibility for developing, implementing and maintaining a safety-training program should be with recovery department supervision. Every person entering the recovery boiler area should have a minimum level of training. Specialized training should be provided for the specific groups of individuals interacting within the recovery boiler area including but not limited to outside emergency response personnel. The Training Program should include, but not be limited to the following:

a. Safety training should be customized for each operating, maintenance and engineering group working in and around the recovery boiler area.

   Safety training may include:

   - Route of egress, what not to use i.e. elevators, manlifts.
   - Primary and secondary gathering points.
   - Accounting for all possible people in the recovery boiler building.
   - Building re-entry policy.

b. A minimum basic training session for visitors who are not escorted by trained personnel to the recovery boiler area, that will familiarize them with the hazards of the recovery boiler and potential smelt-water reactions, highlighting the alarms and escape routes. This training should be done prior to entering the recovery boiler area and should be refreshed on a periodic basis.

c. All non-routine personnel should be trained to check (log) in/out of the recovery boiler area, so that in the event of an emergency requiring evacuation, personnel can be accounted.

d. Continuing education or retraining of operating personnel as to the updates in technology, case studies of mishaps or near misses.

e. Training for mill emergency response teams, including mill and/or public fire departments that may be called into the recovery boiler area during an emergency.

f. Training as to the correct use of safety equipment for personal protection such as self contained breathing apparatus or escape respirators.

g. Documentation as to the type of training completed, attendance, instructor and course hours should be kept up to date for all personnel.

h. Training for confined space entry per OSHA Standard 29 CFR 1910.146.

4.2 Safety Equipment

4.2.1 Safety equipment should be available for all operating, maintenance, and engineering personnel, as well as visitors to the department. It must be stressed that specialized safety equipment use such as toxic/flammable gas monitors or self contained breathing apparatus, should be limited to personnel who have been trained in the use of this specialized equipment. The proper fit, application and operation is extremely important for safe use. Department rules and procedures requiring protective equipment use must be strictly enforced for all mill and contractor personnel.

Some mills have gone to an emergency response team concept where professionally trained individuals respond to emergencies. In that case some safety equipment may be kept on the emergency vehicle rather than in the local area. The following partial list of safety equipment is recommended. (Refer to OSHA, Federal laws and/or local jurisdiction.)

a. Fire fighting equipment

b. Safety ropes and harnesses

c. Self-contained breathing apparatus

d. Approved escape respirators

e. Toxic/flammable gas detection devices

f. Face and eye protection

g. Hearing protection.

4.2.2 Safety equipment will require regular and periodic inspection and/or refurbishment. Documentation as to the date of inspection, condition and any repairs or replacements should be maintained.

4.3 Explosion Protection

4.3.1 For boilers equipped with explosion corners, all qualified personnel who have access to the recovery boiler building should be trained that these corners are designed to split open in the event of a significant explosion. This may result in large quantities of hot flue gas and/or steam entering into the boiler building. Personnel should refrain from spending unnecessary time in the corner areas.

4.4 Recovery Boiler Safety Guidelines

4.4.1 A set of Recovery Boiler Safety Guidelines should be developed with the objective of improving safety and establishing a more formalized guideline process. These guidelines may exist in several different locations as opposed to under common cover, and their content is up to the mill and person(s) responsible for the operation of the recovery boiler. Topics to consider in the development of recovery boiler safety guidelines are listed below. This is by no means an all-inclusive list, and it is up to the individual mills to determine specific elements to include along with governing protocols. Many of these suggested topics are addressed in more detail in other BLRBAC documents but are listed here as they relate specifically to personnel safety.

Personnel Protection

Develop a recovery boiler area PPE matrix with minimum PPE for specific tasks or activities based upon the hazard assessment.

Evaluation criteria to determine suitability of protective equipment and clothing for specific tasks.

Establishment of “restricted or limited access areas” such as smelt spout decks and other areas of elevated risk.

Establish safe and accepted behaviors, possibly using Job Hazard Analysis, for working around the recovery boiler.

Ergonomics and heat stress should be considered in selection and/or design for PPE and tools.

Smelt Deck

Facilities should consider engineered solutions where practical to minimize employee exposure to smelt splashes such as mini-hoods, doghouses, enclosed hoods, hinged access doors, chainmail shields, automatic spout rodders.

Layout and design should facilitate an unrestricted egress route from the smelt deck.

Consider remote monitoring of the spout deck such as a camera displayed in the control room.

Use of a properly designed spout rod, such as one with a blunted end or properly capped hollow rod.

How to deal with plugged spouts such as using a properly designed gas torch and/or use of rods.

Specify items that are considered unsafe and should not be used such as hollow uncapped rods.

Hoppers

Specify precautions/procedures/checklists when working around ash hoppers such as use of chain restrictors on doors. Early detection systems should be employed such as use of thermocouples, level indicators, etc.

Ports

Specify precautions/procedures when working around or inspecting the furnace through the ports.

Restricted Areas

Access to the smelt deck, areas under the floor vestibule and other areas deemed to have elevated risk should be identified and restricted to only those personnel needing to enter these areas.

Signage and barriers (chain or other method) should indicate these areas are restricted.

Develop guidelines so information about the restricted areas is clearly communicated to operation and visiting personnel. Incorporate minimum training standards into orientation programs.

Management of Change

Changes to processes, equipment, procedures or facilities that could affect the risk assessment, and any additional tasks/activities that should be evaluated and should be managed using a defined/established form of "Management of Change" process.

CHAPTER 5 SAFETY GUIDELINES FOR "EMERGENCY" CONDITIONS

5.0.1 Operators should be trained to recognize the conditions that can lead to smelt-water contact. This emergency training should include how to properly activate the Emergency Shutdown Procedure as described in the BLRBAC Emergency Shutdown Procedure for Black Liquor Recovery Boilers and Post-ESP Procedures.

5.0.2 An emergency procedure manual should be developed to help facilitate a correct and swift response. This manual should incorporate a pre-determined plan for equipment utilization and shut down of associate equipment in the event of an emergency. The manual should include as a minimum:

a. How to initiate the correct emergency alarm

b. An up to date listing of appropriate personnel to be contacted along with the telephone, pager or radio contact information

c. Evacuation plan with emergency escape routes for each recovery boiler.

5.0.3 All non-essential personnel should leave the area when an emergency alarm sounds and report to a predetermined check-in location for a head count and further instructions. Consideration in defining this assembly point should be to minimize personnel to the direct exposure of an explosive blast, steam leaks and/or flying debris.

5.0.4 Visitors and/or unauthorized personnel should not be allowed in the area until an "all clear" is announced by department management. They should report to the designated check in location.

5.0.5 If the recovery boiler has been rapid drained, all personnel should be kept out of the evacuation area for a predetermined minimum time period. The minimum time period needs to be determined in advance. The actual length of the cool down is dependent upon a number of variables including, but not limited to, proper operation of the ESP system, bed size, load prior to incident, boiler floor design, and bed cooling techniques used. No person(s) should reenter the evacuation area until the "all clear" signal is given by the responsible person in charge, usually the department superintendent or manager.

5.0.6 Checklists to direct the operator in logging and observing critical parameters during the emergency should be included.

5.0.7 Specific topics for emergency procedures should include, but not limited to:

a. Loss of feedwater supply
b. Low drum level
c. High drum level
d. Contaminated feedwater/ boiler water
e. Loss of main steam header pressure
f. Inadequate combustion air
g. ID fan failure
h. Hot restart procedures
i. High furnace pressure
j. Low furnace pressure
k. Electrical power failure
l. Instrument air failure
m. Sootblower failure
n. Sootblower stuck in boiler
o. High superheater temperature
p. Low liquor solids
q. Black out
r. Liquor nozzle pluggage
s. Ash conveyor failure
t. Steam coil or water coil air heater leak
u. Plugged smelt spout(s)
v. Heavy smelt runoff
w. Smelt spout cooling water leak
x. Loss of spout cooling water supply
y. Loss of shatter spray
z. High dissolving tank density
aa. High/low dissolving tank level
bb. Pressure part leak
cc. Loss of dissolving tank agitation
dd. Loss of weak wash dilution supply
ee. Fire in the direct contact evaporator or associated duct work
ff. Floor smelt leak

5.0.8 Evacuation and emergency response drills should be conducted no less than annually for all personnel working in and around the recovery boiler area for emergency procedures outlined in 5.0.7.

5.0.9 Scenario training should be provided no less than annually for the emergency procedures outlined in 5.0.7 to ensure the operators will react correctly and quickly to events.

5.0.10 Consideration should be given to automated emergency notification and response systems that with only one phone call will set in motion a chain of events. This will free the operator to concern himself with the real problem or emergency.

CHAPTER 6 SAFETY GUIDELINES FOR "MAINTENANCE" OUTAGES

6.0.1 A shutdown procedures manual should be put together to guide the operator through the correct steps to safely shutdown and secure the recovery boiler. An excellent source of information is the American Forest & Paper Association Recovery Boiler Reference Manuals Volumes I & II. As a minimum, the procedures should include:

a. Bed burn out
b. Liquor system wash out
c. Boiler cool down time curve
d. Boiler isolation or lockout-tagout
e. Water wash instructions
f. Confined space entry procedures.

6.0.2 Certification procedures to allow entrance into the boiler for maintenance and repair. This should include inspection of the boiler to ensure there is no salt cake still left in the upper furnace that could fall on workers and a toxic/flammable gas check.

6.0.3 A pre-shutdown safety meeting with mill and contractor employees is recommended to discuss outage schedule, work scope, important changes to the boiler and/or process systems and special safety concerns.

6.0.4 Installation of a maintenance platform to access the upper furnace while personnel can safely work in the lower furnace is recommended. Platform design loading should be thoroughly reviewed to ensure adequacy and clearly marked at platform access openings.

6.0.5 Scaffold should be installed in the boiler to provide access for inspection and repair. OSHA approved scaffolding, ladders, platforms and planking should be used.

6.0.6 Personal safety equipment such as harnesses, hard-hats, glasses, etc. need to be provided.

6.0.7 Only ground fault protected or low voltage lighting systems should be used. If workers are using power tools, only ground fault protected or air powered tools should be used to prevent electrical shock.

6.0.8 Air movers, blowers or fans should be used to provide adequate ventilation as necessary.

SECTION III PERSONNEL TRAINING GUIDELINES

The following is intended to assist in developing a training program for the recovery boiler area. No attempt is made within this document to address every aspect of an entire training program. These guidelines have purposely been developed in a generic form and will need to be customized to the individual mill location, type of equipment and operation.

CHAPTER 7 TYPES OF TRAINING

The training program can be broken down into two levels. Each of the levels should be accompanied with some form of evaluation or certification. The levels of training should include:

a. Recovery overview.
b. Recovery operations.

7.1 Recovery Overview

This training should be completed by anyone entering the department to visit or do work as discussed in section 4.1.2 of this document. It is a minimum level of training required to perform work and know the evacuation procedures in the event of an emergency. This training may not be required for visitors who are accompanied by a trained escort. Overview training should include at least the following:

a. A brief introduction and orientation of the recovery boiler area.
b. Location and layout of area.
c. Brief overview to explain hazards inherent in the process.
d. Actions in case of alarms or other warnings.
e. Evacuation procedures and routes.

7.2 Recovery Operations

Recovery operation training should be designed for all newly hired or assigned personnel. Operation training should fall into the following categories:

a. Entry level training.
b. Advancement training.
c. Remedial, refresher, or follow-up training.

7.2.1 ENTRY LEVEL TRAINING - Entry level training consists of an introduction, orientation, and job skills program(s) for personnel newly assigned to the recovery area. This type of program should be designed to provide the new employee with the department operating information, basic knowledge and the job skills required for initial job performance. This should be completed prior to personnel working unaccompanied in the recovery area.

7.2.2 ADVANCEMENT TRAINING –Advancement training should be designed to provide employees with the foundation to advance to the next job position. This type of training should also provide information and “hands-on” experience for advancing job knowledge and skills to improve operating ability.

7.2.3 REMEDIAL, REFRESHER, OR FOLLOW-UP TRAINING - Remedial, refresher and/or follow-up training should be designed to upgrade an employee's knowledge or skills. This training includes any types of instruction, formal or informal. This training may be appropriate in the following situations:

a. Training needs analysis
b. Job performance evaluation
c. Periodic retraining on procedures or skills that are not often used (e.g. emergency procedures)
d. Installation of new equipment or process modification
e. Training of individuals who have been out of the work force or job assignment for an extended period of time.

7.3 Training Program Design

7.3.1 The training program should concentrate on operations personnel.

7.3.2 Selected portions should be given to maintenance, technical, engineering, and management personnel.

7.3.3 The operator-training program should be competency-based.

7.4 Responsibility for the Training Program

7.4.1 The training program should be under the direct responsibility of the recovery department management.

7.4.2 The program should be organized and supervised by one designated individual to ensure effectiveness.

7.5 Administration

The training program should follow formal, written procedures. All aspects of the program should be conducted according to established program organization and administrative guidelines as outlined below.

7.5.1 REVIEW AND REVISION –The training program should be reviewed and revised periodically so it remains accurate and effective. The mill should conduct periodic reviews of all training materials, schedules, and plans, especially when changes or modifications are made to the system.

7.5.2 DOCUMENTATION - The mill should have a system in place to maintain documentation of personnel training, training material reviews, and revisions. Documentation and records of all training conducted and test results should be maintained for all personnel in the department.

7.6 Basis of a Training Program

Written procedures are required for routine operations, upsets, and emergency situations. The training program should be based on these written procedures and supplemented with performance demonstrated proficiencies. A training program should include the following:

a. Personnel Qualifications
b. Task Definition
c. Minimum Procedure Requirements
d. Training methods
e. Self-study
f. Formalized Training
g. Simulation and Drills
h. One-on-one Training
i. Qualification or Certification.

7.6.1 PERSONNEL QUALIFICATIONS - Each operating position within the recovery area should have a documented task list of minimum duties for the position. This minimizes the time it takes to qualify by clearly delineating what is expected of the operator.

The documented task list and written procedures help prevent degradation of knowledge associated with informal on-the-job training where a senior operator is expected to train a junior operator based strictly on memory or past practices.

The program should provide standardized personnel qualification evaluations to be used when observing the performance of a task. This evaluation objectively ensures that the task is carried out safely and efficiently.

7.6.2 TASK DEFINITIONS - The mill should determine all tasks that require written procedures in order to properly and safely operate each recovery boiler.

7.6.3 MINIMUM PROCEDURE REQUIREMENTS - At a minimum, procedures should be developed for the following:

a. Start up
b. Shut down
c. Hot restart
d. Critical routine tasks
e. Upset and alarm response
f. Emergency shutdowns, including ESP.

7.6.4 TRAINING METHODS - Each employee is ultimately responsible for his or her own qualification. The employees should know what is expected of them. The information to gain the needed knowledge and skills should be made available. A training program should consist of a combination of the following training methods:

a. Self study
b. Formalized training sessions
c. Simulation and drills
d. One-on-one training.

7.6.5 SELF STUDY - To accommodate mill shift schedules, a portion of the training program should include individual study that can be assisted with written procedures, technical manuals, or interactive computers.

7.6.6 FORMALIZED TRAINING SESSIONS - Formalized training sessions with customized manuals and materials improve the effectiveness of the training program. This may include video programs, simulators, case histories, and field trips for verification.

7.6.7 SIMULATIONS AND DRILLS - Wherever possible, all performance tasks should actually be performed on the job by the trainee and monitored by a qualified individual.

If the action would normally be performed with a written procedure or other job aids, the trainee should not be required to perform the task without them. The procedure or job aid should be used. The qualified individual should intervene and stop the trainee if he/she is about to perform an action that would result in personal injury or equipment damage.

However, certain tasks are impractical to perform for training, such as emergency shutdowns of equipment. For items such as these, the trainee should demonstrate the ability to perform the task by simulation, drills, and talking through the required actions. For example, simulated actual rapid drain tests during the final stages of cool-down before an outage provide a good opportunity for training.

7.6.8 ONE-ON-ONE TRAINING - An effective training program should include one-on-one training with a qualified individual.

7.6.9 QUALIFICATION OR CERTIFICATION - The program should include standardized qualification or certification that is the demonstration of competent job knowledge through oral or written evaluation and field demonstrated ability to perform all the tasks required of the job. The completion of qualification or certification should be demonstrated under the supervision of a properly qualified expert or trainer. This serves three purposes:

a. Confirms the effectiveness of the training
b. Checks the skill level of individual objectively
c. Documents the individual's training and progress.

Qualification of personnel must be re-evaluated periodically to assess areas where new or refresher training is needed. Abrupt changes or reassignments of personnel may suddenly promote a person to a new job or responsibility. It is the responsibility of management to review and ensure that person is capable and properly trained before assigning work in a new job position.

SECTION IV ADDITIONAL RESOURCES

CHAPTER 8 RECOMMENDED REFERENCE LIST (Use Latest Approved Edition)

1. Black Liquor Recovery Boiler Advisory Committee:

    a. Recommended Good Practice – Safe Firing of Auxiliary Fuel in Black Liquor Recovery Boilers.

    b. Recommended Good Practice – Fire Protection in Direct Contact Evaporators and Associated Equipment.

    c. Recommended Good Practice – Installation Check List and Classification Guide for Instruments and Control Systems Used in Operation of Black Liquor Recovery Boilers.

    d. Recommended Good Practice – Safe Firing of Black Liquor in Black Liquor Recovery Boilers.

    e. Recommended Good Practice – Emergency Shutdown Procedure (ESP) and Procedure for Testing ESP System for Black Liquor Recovery Boilers.

    f. Recommended Good Practice – Guidelines for Post-ESP Procedures for Black Liquor Recovery Boilers.

    g. Recommended Good Practice – Thermal Oxidation of Waste Streams in Black Liquor Recovery Boilers.

2. "The Recovery Boiler Reference Manual for Owners and Operators of Kraft Recovery Boilers"; Sponsored by the Operations/ Maintenance Subcommittee of The Recovery Boiler Committee, Volumes 1, II, and III, AFPA.

3. The American Society of Mechanical Engineers Boiler and Pressure Vessel Code; Section I - Power Boilers, latest edition; Section VII - Recommended Rules for Care of Power Boilers; Section IX – Welding and Brazing Qualifications.

4. American Society of Non-destructive Testing Recommended Practice SNT-TC-1A.

5. Pulp and Paper Manufacturer, Third Edition, Volume 5, ALKALINE PULPING, The Joint Textbook Committee of the Paper Industry, 1989.

6. Combustion Fossil Power, 4th Edition, Joseph G. Singer, ed; Combustion Engineering, Inc., 1991.

7. Steam - Its Generation and Use 40th Edition. The Babcock and Wilcox Company, 1992.

8. "Guide to Preparation of a Preventive Maintenance Program for Black Liquor Recovery Boilers," Technical Association of the Pulp and Paper Industry.

9. "Consensus of Operating Practices for the Control of Feedwater and Boiler Water Quality in Modern Industrial Boilers," prepared by Feedwater Quality Task Group for Industrial Boiler Subcommittee of the ASME Research Committee on Water in Thermal Power Systems (1979).

10. CHEMICAL RECOVERY IN THE ALKALINE PULPING PROCESSES, Third Edition, G. Hough, ed., TAPPI, 1992.

11. KRAFT PULPING, A COMPILATION OF NOTES, A. Mimms, TAPPI Press, 1989.

12. KRAFT RECOVERY BOILER PHYSICAL AND CHEMICAL PROCESSES, Adams, T. N. and Frederick, W. J., The American Paper Institute, 1988.

13. CODE OF FEDERAL REGULATIONS, SECTION 29, PART 1910 (29 CFR 1910), General Industry Training Requirements; United States Department of Labor -- Occupational Safety and Health Act (OSHA); Office of the Federal Register, National Archives and Records Administration, July 1993.

14. Pulp and Paper Manufacture, Third Edition, Volume 4, SULFITE SCIENCE & TECHNOLOGY, Joint Textbook Committee of the Paper Industry, 1985.

15. HANDBOOK FOR PULP & PAPER TECHNOLOGISTS, G. A. Smook, Joint Textbook Committee of the Paper Industry, 1986.

16. National Board Inspection Code (NBIC), The National Board of Boiler and Pressure Vessel Inspectors, Columbus, OH.

APPENDIX A – DOCUMENT REVISION HISTORY

April 2018

Added Appendix C – Common Practices Section

February 2012

"Notice of Disclaimer of Liability" has been added to page 2.

Added a generic letter for requesting a variance from NFPA 101, *Life Safety Code*, for stairway doors as a new Appendix B.

October 2006

New material has been added to Section 2.7, Water Washing.

April 2004

This revision combined and superseded *Recommended Guidelines for Personnel Safety* (April 7, 1997) and *Recommended Training Program Guidelines for Black Liquor Recovery Boilers and Associated Systems (April 9, 1997).* The entire document was reformatted and renumbered. Grammatical and editorial changes made in the document are not identified in the following list.

1. Item 1.0, changed the word "older" to "existing."

2. Item 1.0.1, added "normal and emergency personnel egress."

3. Item 1.0.3, new item. Discusses layout design of new boiler installation relative to existing boilers.

4. Item 1.1.1, changed "a smelt-water reaction" to "an explosion."

5. Item 1.1.2, changed "a smelt-water reaction" to "an explosion."

6. Item 1.1.3, changed "a smelt-water reaction" to "an explosion." Added "control rooms" to the list.

7. Item 1.1.6, changed "a smelt-water reaction" to "an explosion." Reworded item for clarification. Added to the end of the last sentence, "but not lockable."

8. Item 1.2.1, changed "a smelt-water reaction" to "an explosion" in first paragraph. Deleted text from second paragraph "Many old boiler installations have control panels or workstations out in the open next to the boiler. This should not be allowed."

9. Item 1.2.2, added "a pressure of" ahead of "100 pounds per…..

10. Item 1.2.3, reworded for clarification;

11. Item 1.3.1, added language to provide additional clarification. Changed "smelt-water reaction" to "explosion."

12. Item 1.3.2, clarified language. Removed that doors should be capable of withstanding a smelt water reaction and added that they should be of pressure resistant design.

13. Item 1.3.3, deleted recommendation that escape route should be via the outdoors and replaced it with the recommendation that the escape route be via the protected stairwell.

14. Item 1.4.1, added wording to specify one escape respirator per number of rated occupants.

15. Item 1.5.1, added "and alarms" and "post ESP Procedures" to this item.

16. Item 1.5.5, new item. The use of the ESP warning lights and sirens to evacuate the recovery boiler building during an emergency other than an ESP is permitted.

17. Item 1.7.3, added sentence relating to the temperature of water for eye wash and shower stations.

18. Item 1.7.4, new item. Combustible construction material should be avoided in the building.

19. Item 1.7.5, new item. The boiler house should not be used for bulk storage of combustible materials.

20. Item 2.2, new section, Explosion Protection.

21. Item 2.4.1, addition of language specifying that there should be manual or automatic shut offs for all auxiliary fuels at remote locations.

22. Item 2.5.1, clarified language. Added "and maintained" regarding spout systems.

23. Item 2.5.2, new item. Added language that references BLRBAC Recommended Good Practice: Safe Firing of Black Liquor in Black Liquor Recovery Boilers, Section 9.5, Item 1., Smelt Spout Leak or Flow Interruption.

24. Item 2.6.1, clarified language. Added "and maintained" regarding feedwater systems; added additional sources for information.

a. Added language "including established action levels, and shutdown levels."

f. Clarified language. Provide a source of tempered, treated water to fill the boiler for hydrostatic testing. Check the boiler manufacturer's requirements and/or water treatment specialist's recommendations. Clarified language that treated water at the correct temperature be used to fill the boiler for hydrostatic testing.

g. New item. Backfill the superheater for hydrostatic testing to prevent solids carryover from the boiler steam drum to the superheater.

25. Item 2.7.1, changed "prevent" corrosion to "minimize out of service" corrosion in the last sentence. Added, "Also refer to Recommended Post-ESP Procedure for Black Liquor Boilers, Chapter 8, Char Bed Cool-Down, and Chapter 9, Water washing."

26. Item 2.8.2, language modified so that sootblower canopy end shields and/or flange wraps are installed where the potential for burn hazards to personnel caused by steam leaks exist.

27. Item, 2.8.4, clarified the language of this item. Changed the language to make it clearer that alternate steam sources for sootblowers need to be locked out properly.

28. Item 2.8.6, new item discussing the adjustment of sootblower poppet valve pressures.

29. Item 2.9.4, added "flow restrictors" regarding emergency spout operation.

30. Item 2.9.6, added language to specify that explosion protection dampers on dissolving tanks need to be maintained.

31. Item 2.10.1, added language that material and flow direction should be used when labeling systems.

32. Item 2.10.3, updated language to more accurately reflect leak detection system usage.

33. Item 3.1.1, altered language to allow following "local jurisdictional codes and guidelines." This document may be used outside of North America where different codes may apply.

34. Item 3.1.2, changed language to the original 1972 version that recommends prohibiting the use of tangent welds on either the fire or cold side of tubes.

35. Item 3.1.3, new item stating backing rings should not be used in butt welds exposed to the fireside.

36. Item 3.2.1, added Code references for pressure containing welds.

37. Item 3.2.2, removed language that "Backing rings should not be used in butt welds exposed to boiler water." New language to address this item is now in Item 3.1.3.

38. Item 3.2.5, new item. Document all NDE performed on pressure part repairs.

39. Item 3.2.6, corrected the names of the forms used in original construction.

40. Item 3.2.7, added the correct name of the alteration form to this repair-oriented item.

41. Item 3.2.8, new item. Reference original code of construction when planning repair procedures.

42. Item 4.1, added wording to include outside emergency response personnel in safety training.

43. Item 4.1.a, added language listing safety training considerations.

44. Item 4.1.b, added language that clarifies visitors who are not escorted by trained personnel must have basic safety training before entering the recovery area.

45. Item 4.1c., altered language, deleted "remote chance" and added "event." Deleted "a correct head count can be obtained" and added "requiring evacuation, personnel can be accounted."

46. Item 4.1.e, deleted reference to an audit program. Administration of training is covered in Section 7.5.

47. Item 4.3, Explosion Protection, added new section.

48. Item, 5.0.1, added language to include "and Post-ESP Procedures."

49. Item 5.0.3, added language to include considering establishing a check-in assembly point location that would minimize personnel to the effects of the direct exposure of a blast. Added language "when and emergency alarm sounds."

50. Item 5.0.5, added criteria to evaluate when establishing duration of evacuation after an ESP.

51. Item 5.0.7, seven emergency procedures were added to the list: Sootblower stuck in boiler, Loss of spout cooling water supply, High/low dissolving tank level, Loss of dissolving tank agitation, Loss of wash dilution supply, Fire in the direct contact evaporator or associated duct work, and Floor smelt leak. Slight changes to some wording of two emergency procedures: "Feedwater supply" is now "Loss of feedwater supply," "Air heater leak" is now "Steam coil or water coil air heater leak."

52. Items 5.0.9, new item. Discusses annual scenario training for emergency procedures.

53. Item 6.0.8, clarified use of air movers, fans, and blowers.

54. Section III, added opening paragraph.

55. Item 7.1, deleted “should” and added “may” with regard to training requirements for visitors if they are escorted.

56. Item 7.2.2, added that Advanced Training should include information and hands-on experience.

57. Item 7.2.3, deleted “will” and added “may” with regard to when refresher training is needed.

58. Item 7.5.1, added need to review training program any time modifications are made to the system.

59. Item 7.5.2, added maintain training documentation for all individuals in the department.

60. Item 7.6, the opening paragraph was rewritten to provide better clarification.

61. Item 7.6.6, added description and purpose of formalized training sessions.

62. Item 7.6.9, language was modified to include operator qualification under the direction of a competent subject matter expert. Also, it will be the responsibility of management to review and ensure that personnel who have been previously trained, or who have not worked regularly in a different job classification, are competently trained when they are moved into that position.

63. Chapter 8, references added as per body of document.

APPENDIX B – GENERIC STAIRWAY AND RECOVERY AREA EXIT DOOR VARIANCE LETTER

The purpose of this letter is to request a variance regarding the direction of door opening in enclosed stairwells in the mill's (such and such) boilers. Please note that this request refers only to doors providing access from the recovery boiler area to enclosed stairwells in recovery boiler buildings. This request does not refer to the bottom door going out of the building from a stairwell to the world or other building. NFPA 101, *Life Safety Code*, currently requires that the doors open into the stairwell. This is to prevent a group of people pushing at once against an emergency exit door in an attempt to escape a dangerous situation. In a pulp and/or paper mill recovery boiler, however, the situation is likely to be very different. In the event of a recovery boiler explosion, the viability of the enclosed stairwell as an emergency exit is more likely if the door frames prevent the doors from opening into the stairwell. Additionally the recovery boiler building is usually occupied by a small group of individuals who are regularly trained in the operation of recovery boilers and evacuation of the recovery boiler area. Visitors to the recovery boiler area are also trained in the proper emergency responses before being allowed in the recovery boiler building. In the event of a recovery boiler explosion, an enclosed stairwell is the primary exit. The smelt-water interaction can cause the release of high pressure steam and/or high temperature water and noxious fumes into the building due to the failure of tubes and/or piping. For these reasons the Black Liquor Recovery Boiler Advisory Committee (BLRBAC) *Recommended Guidelines for Personnel Safety,* Sections 1.16 and 1.32 recommends that the doors to the enclosed stairwell in a recovery boiler building open from the stairwell into the boiler area. It further requires these doors to be pressure resistant and self-closing, but not lockable. Based on this information, we are requesting a variance from NFPA 101, *Life Safety Code*, for the enclosed stairwells in (such and such) recovery boilers. This variance will apply only to these specific stairwells.

APPENDIX C – Common Practices

COMMON PRACTICES GUIDELINES DOCUMENT FORWARD

This section of the Personnel Safety Document "Common Practices Guidelines" contains ideas for procedures and system modifications that have been, or are currently in practice on operating recovery boilers. This document also is used to illustrate practices that have found to be unsafe.

This document represents a compilation of operating ideas and practices drawn from experiences of operating companies, boiler manufactures, insurance carriers and consultants. This document is not intended to be a "Standard" for operations and does not contain every possible operating scenario, standard or emergency. Rather, it presents peer reviewed practices that have been found to be helpful in protecting personnel when they are in close proximity to an operating recovery boiler performing operating and/or maintenance functions. The document contains the following elements:

- Condition or Topic
- Hazard Description Associated with the Condition or Topic
- Suggested Precaution(s)
- Photo if available or applicable (What works or does not work)

Suppliers continue to develop products and systems to improve safety in different areas of the recovery boiler. When made available to this subcommittee these products and systems may be included in this document as a reference resource. In all cases this subcommittee has not reviewed or evaluated the effectiveness of these systems. Contact the supplier's for detailed and updated information on their products.

Some products used in and around the recovery boiler may not have necessarily been manufactured with the recovery boiler process in mind such as work gloves and face shields. In an effort to provide useful information to recovery boiler end users, we have attempted to include generic information on certain products. Publication of this information is based solely on information provided by users and is not the result of tests performed by BLRBAC or at the request of BLRBAC. It is not BLRBAC's position to endorse one manufacturer's product over another. It has been found that certain safety products may work well in one particular situation but not in others and the end decision to use a particular product is the responsibility of those in charge of the recovery boiler operation.

Different ideas are presented in this document to address a similar problem. Conditions in your plant may vary and require adaptation beyond what is presented. Other factors such as mill location (northern or southern climate) may have a bearing on how you choose to address a particular safety situation.

Because of the unique operating environment and hazards associated with recovery boilers, it is not uncommon to find safety equipment being used beyond its tested and/or original intended purpose.

This document will be revised from time to time. Applicable codes and jurisdictional requirements shall take precedent over this document. This document is not intended to exclude alternative practices, procedures, codes and standards.

BLRBAC COMMON PRACTICES

Common Practices for Personnel Safety For Black Liquor Recovery Boilers

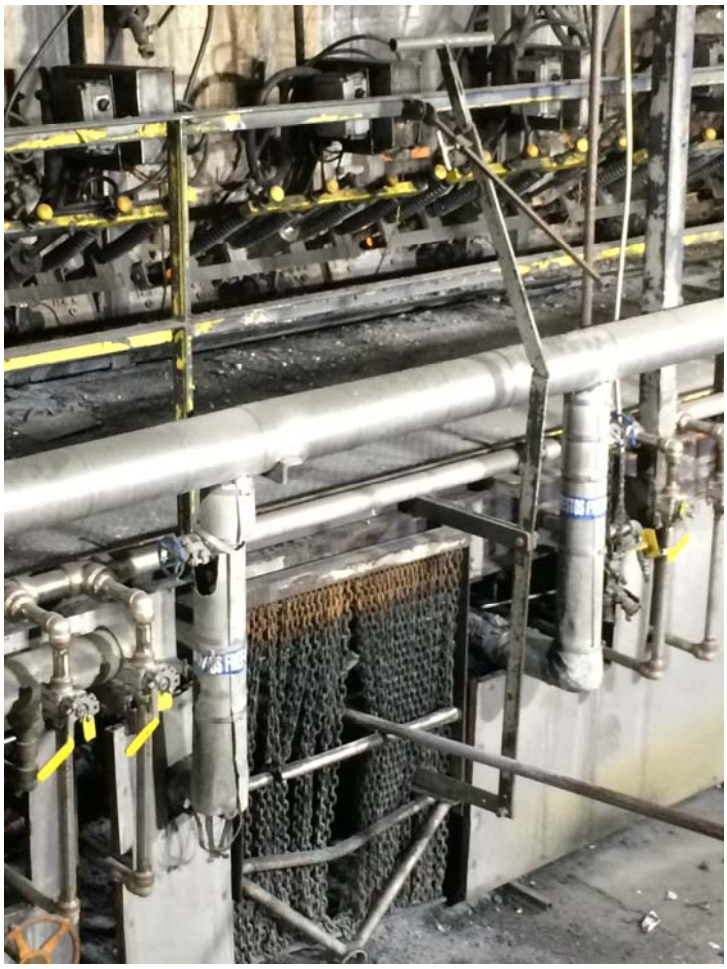
Chill & Blow Safety Considerations		
Condition	Hazard	Suggested Precautions
Generating Bank hopper doors	Hot flue gas and hot ash.	Install chain catches to limit opening of doors in case of blowback.
Saved for Photo		
Operational or maintenance work on boiler	Hot flue gas and hot ash can blow out of openings suddenly without warning.	Limit access to boiler house, explain hazards, rope off critical areas, hoppers, air ports, liquor ports etc.
Large ash/slag falls drop on floor	Hot flue gas and hot ash can blow out of openings.	Restrict access to boiler house around port openings and access doors of lower furnace.
Large ash/slag falls drop on floor splashing through spouts and PA ports	Hot flue gas, hot ash and molten smelt can blow out of openings.	Restrict access to boiler house around primary air and smelt spout port openings.
Plugged spouts while burning out bed, start-up	Auxiliary fuel in too quick, salt dams, smelting pools in bed cause rushes	Leave the spout plugged during the chill and blow and open following established mill procedures after the chill and blow
Pluggage of hoppers, conveyors, sluice lines, drain lines	Hot ash or hot liquor flowing out of conveyor openings (access doors, etc.)	Restrict access. Hot ash and/or liquid may flow out of conveyors to floors below.
Saved for Photo		
PPE and procedures for opening doors during chill & blow.	Hot ash, molten smelt	Protective clothing, gloves, faceshield in addition to other standard PPE. Different forms of PPE may be needed depending upon

		the tasks being performed.
Sootblower lance damage, large falls	Possible overload trip on sootblower motor, could hit tubes inside boiler.	Monitor sootblower operation and inspect the lances for damage after the chill and blow.
Reserved for Photo		

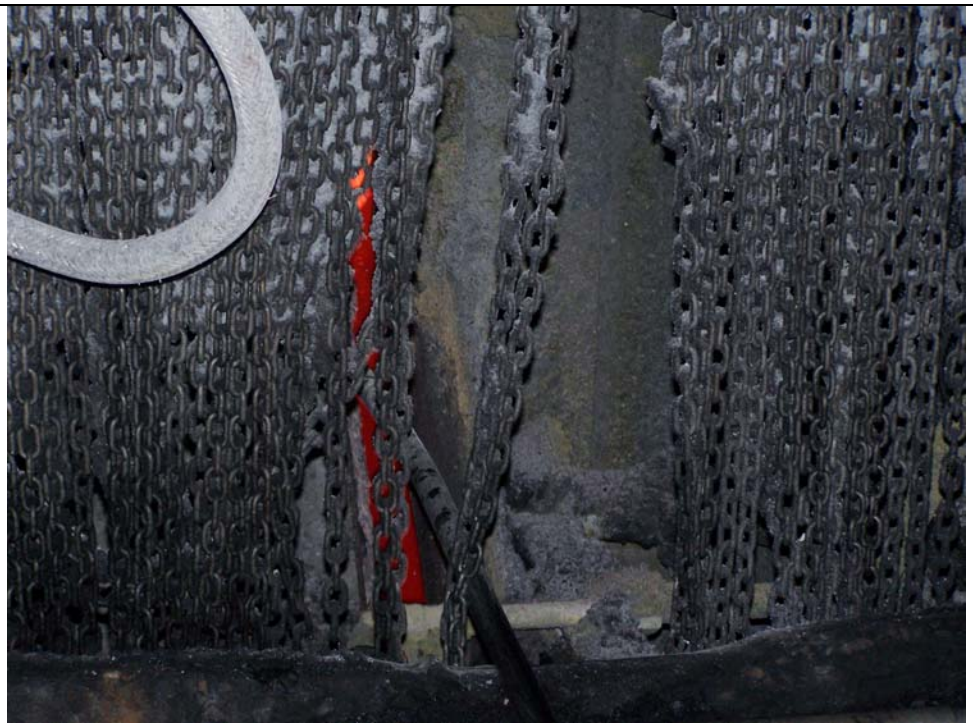
Port Rodding Safety Considerations		
Condition	Hazard	Suggested Precautions
Blowback during normal operation when the boiler goes positive pressure	Hot flue gas, ash, char and/or smelt resulting in burns.	Proper PPE when around an operating recovery boiler, keep a safe distance from openings (liquor ports)
Opening an observation port to view the fireside during operation.	Hot flue gas blowback onto the operator as port is opened.	Stand on the hinge side of the port as it is opened. The door will help deflect blowback should it occur. Wear proper PPE.
Changing or cleaning liquor gun	Hot flue gas blowback onto the operator while changing gun.	Consider ceasing sootblowing when changing liquor guns to minimize the chance of blowback. Consider ramping up ID fan. Wear proper PPE.
Moisture in or on smelt rod	Smelt blowback caused by moisture accumulation in or on smelt rod	Use solid or “capped” rod.

Smelt Spout Deck Safety Considerations		
Condition	Hazard	Suggested Precautions
Smelt splatter from spouts	Chemical and temperature burns caused by splashing out of spout.	Install a system/method to remotely adjust the angle of the shatter spray jet.
Smelt splatter from spouts	Smelt plugging of spouts.	Set smelt spout cooling water temperature, setpoints, alarms, etc. to proper limits to avoid smelting problems and early detection. Consider using remote cameras on spouts.
Smelt splatter from spouts	Chemical and temperature burns caused by splashing out of spout.	Adjust dissolving tank scrubber delta P to minimize air infiltration into hood to help keep spouts open.
Smelt splatter from spouts	Chemical and temperature burns caused by splashing out of spout and boiler blowing positive.	"Chain mail" to shield openings and minimize smelt splatter.

Chain Mail with Spout Rod Support



Chain Mail at Smelt Spout with Spout Rod Support
Note: Remote Adjustment for Shatter Spray Accessible from Walkway Above Spouts



Example "Chain Mail" - Smelt Spout Splatter Protection

Example "Chain Mail" - Smelt Accumulation on Chains

Example "Chain Mail" - Spout Rodding

Smelt splatter from Spouts	Chemical and temperature burns caused by splashing out of spout and boiler blowing positive.	Signage to warn of hazards on spout deck.

Smelt spatter from spouts	Chemical and temperature burns caused by splashing out of spout and boiler blowing positive.	Movable shield on trolley track to minimize smelt splatter to Operators on spout deck. Fixed shielding at smelt deck access points.

Movable Smelt Spout Shields on Track System

Movable Smelt Spout Shields on Track System

Movable Smelt Spout Shields on Track System

Movable Smelt Shield on "Trolley Track"

Shielding at Stairway Entering Smelt Spout Area

Smelt splatter from spouts	Chemical and temperature burns to head and face. Some shields melt or burst into flames when contacted by molten smelt.	Hot smelt resistant face shields and safety glasses. Each facility should test glasses and shields to ensure they provide proper protection.

Face Shield Exposed to Molten Smelt

Smelt splatter from spouts	Chemical and temperature burns to head and face. Some shields melt or burst into flames when contacted by molten smelt.	Hot smelt resistant face shields and safety glasses. Each facility should test glasses and shields to ensure they provide proper protection.

Polyester - Face Shield Exposed Horizontally to Molten Smelt
Note: This shield burst into flames when exposed to molten smelt

Propionate – After Two Molten Smelt Splashes
Note: This shield did NOT burst into flames when splashed with molten smelt

Smelt splatter from spouts	Chemical and temperature burns to body. A number of commonly used jackets do not provide effective protection	Hot smelt resistant jacket. Each facility should test jackets to ensure they provide proper protection.

Cotton Welders Flame Resistant – Before Molten Smelt Splash

Cotton Welders Flame Resistant – After Molten Smelt Splash

Cotton Welders Flame Resistant – After Molten Smelt Splash - Note Holes

Nomex Jacket – Before Molten Smelt Splash

Nomex– After Molten Smelt Splash

Nomex IIIA / FR Neoprene Jacket – Before Molten Smelt Splash

Nomex IIIA / FR Neoprene Jacket – After Molten Smelt Splash

Nomex IIIA / FR Neoprene Jacket – After Molten Smelt Splash

Reserved for Photo

Green Welder's Jacket – After Molten Smelt Splash
October 2005

Smelt splatter from spouts	Chemical and temperature burns to hands and wrists	Hot smelt resistant gloves
Smelt splatter from spouts	Chemical and temperature burns to neck	Hot smelt resistant neck protection.

Reserved for Photo

Smelt splatter from spouts	Chemical and temperature burns to legs	Hot smelt resistant pants

Reserved for Photo

Smelt splatter from spouts	Chemical and temperature burns to personnel who are not properly trained and equipped to enter the smelt spout deck.	Define the area “Limited Access”
Reserved for Photo		

Smelt splatter and build-up on spout hoods	Chemical temperature burns to personnel who are rodding spouts, hood warpage	Improvements in smelt spout hoods. "Overflow weir" design is intended to cool and wash the sides of the hood. Chain mail to help minimize smelt splatter
Reserved for Photo Internal Weir Water Trough Hood with Dual Shatter Jets & Chain Mail		
Smelt build-up on shatter jets and primary shatter jet failure	Inadequate shattering of smelt leaving spout	Dual shatter jet nozzle design and built in water cleaning system
Reserved for Photo Single or Dual Shatter Jet Assembly with Built in Nozzle Waterwash System		

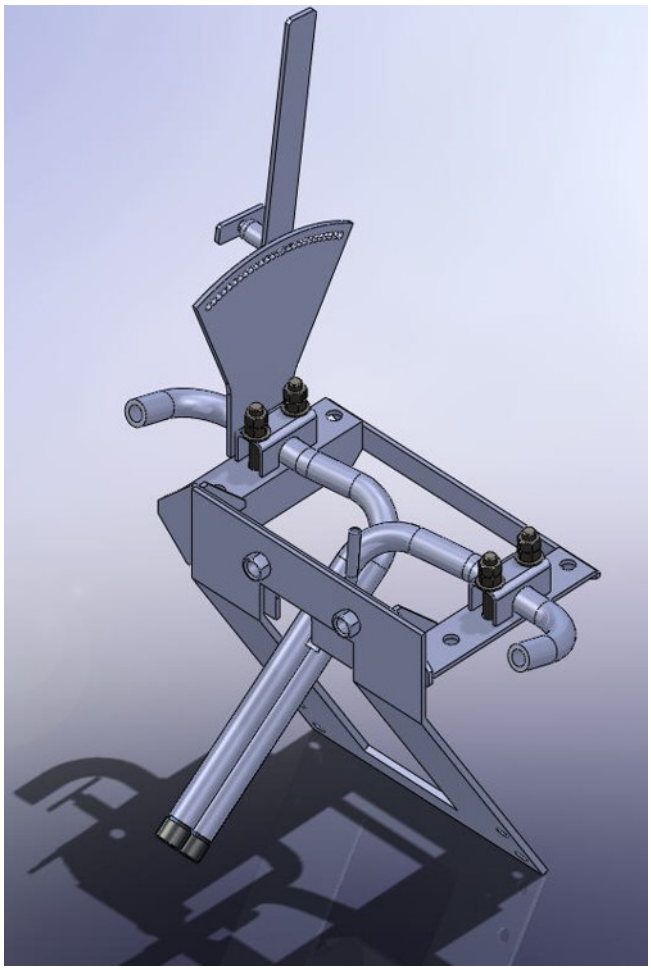
Smelt build-up on shatter jets and primary shatter jet failure	Inadequate shattering of smelt leaving spout	Dual shatter jet nozzle design and built in water cleaning system
Reserved for Photo Dual Shatter Jet Assembly		
Control smelt splatter and build-up on spout hoods	Chemical temperature burns to personnel who are rodding spouts, hood warpage	Improvements in smelt spout hood design. External shifting to internal water cooling of hood to minimize warpage
Reserved for Photo External Water Hood Wash System		
Control smelt splatter and build-up on spout hoods	Chemical temperature burns to personnel who are rodding spouts	Improvements in smelt shatter jet design and implementation

Reserved for Photo Angle and Depth Adjustable Shatter Jet System		
Primary shatter jet failure	Inadequate shattering of smelt leaving spout	Dual shatter jet nozzle design and built in water cooling system
Reserved for Photo Dual Shatter Jet Assembly with Internal Water Cooling		
Draining decanting beds in preparation for an outage	Removing hot smelt from a decanting lower furnace	Utilize a smelt pumping system
Reserved for Photo Smelt Pumping System		
Smelt build up/splatter up in spout trough	Chemical temperature burns to personnel who are rodding spouts	Automatically rods spout with “blades” that scrape both sides of the spout trough
Reserved for Photo Automatic Spout Cleaner		

Smelt buildup/splatter from spouts	Chemical temperature burns to personnel who are rodding spouts.	Automatically rods spout.

Automatic Spout Cleaner

Smelt buildup/splatter from spouts	Improperly shattered smelt, build up on walls and hoods resulting in splashing and excessive smelt build up	Adjustable shatter jet with built in back up shatter jet



Adjustable Shatter Jet with Backup Shatter Spray

Smelt buildup/splatter from spouts	Improperly shattered smelt, build up on walls and hoods resulting in splashing and excessive smelt build up	Adjustable shatter jet with built in back up shatter jet
Reserved for Photo Adjustable Shatter Jet		