APS Instruction			APS-PF code of practice
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Contents

1 PURPOSE

The purpose of this instruction is to describe the Code of Practice that will advise staff of the dangers of fires in milling systems, associated hoppers and equipment, and to ensure safe operating techniques are adopted to minimise the risk of fires and explosions in those systems. Emergency action guidelines are also included.

2 SCOPE

This instruction applies to all staff involved in the operation of pulverised fuel firing and associated equipment.

3 REFERENCES

Electricity Industry Safety Handbook
Electricity Industry Safety rules

4 INTRODUCTION

The purpose of this code of practice is to ensure that staff appreciate the dangers of fires in milling systems and adopt safe operating techniques to minimise the possibility of fires and explosions in those systems. It is not intended to cover all possible variations in operation, and therefore relies on discretion at all times in conjunction with established procedures. Application of the guidelines contained in this code will minimise the hazards involved in operation and maintenance of plant within the milling systems. For the purpose of this document the milling systems consist of the following plant items:

(a) the coal bunkers, bunker coal valves and coal feeders.

(b) the pulveriser mills, mill reject hoppers and P.F. pipework.

(c) the primary air fans, primary air heaters, secondary air heaters and associated plant items.

The Furnace Safeguard Supervisory System (FSSS) ensures that the boiler and associated plant are operated within predetermined procedures and limits - failure to comply with these results in the FSSS automatically tripping plant out. This P.F. Code of Practice establishes operating guidelines for the milling systems - these either meet or exceed the demands of the FSSS on plant under its surveillance and form an operational procedure for plant not under FSSS surveillance.

4.1 The Nature of Explosions

The fundamental reaction utilised in thermal power generation is the oxidation of fuel. When the fuel is coal this reaction takes place whenever air is present although the rate of oxidation and hence the rate of heat release, depends very strongly on temperature. As the temperature of a coal air mixture is increased there will be a point at which the reaction rate increases dramatically and the coal glows and gives off smoke. This is known as the ignition temperature and its magnitude is dependent on the coal characteristics (volatile content, size distribution etc.) and the physical configuration of the system.

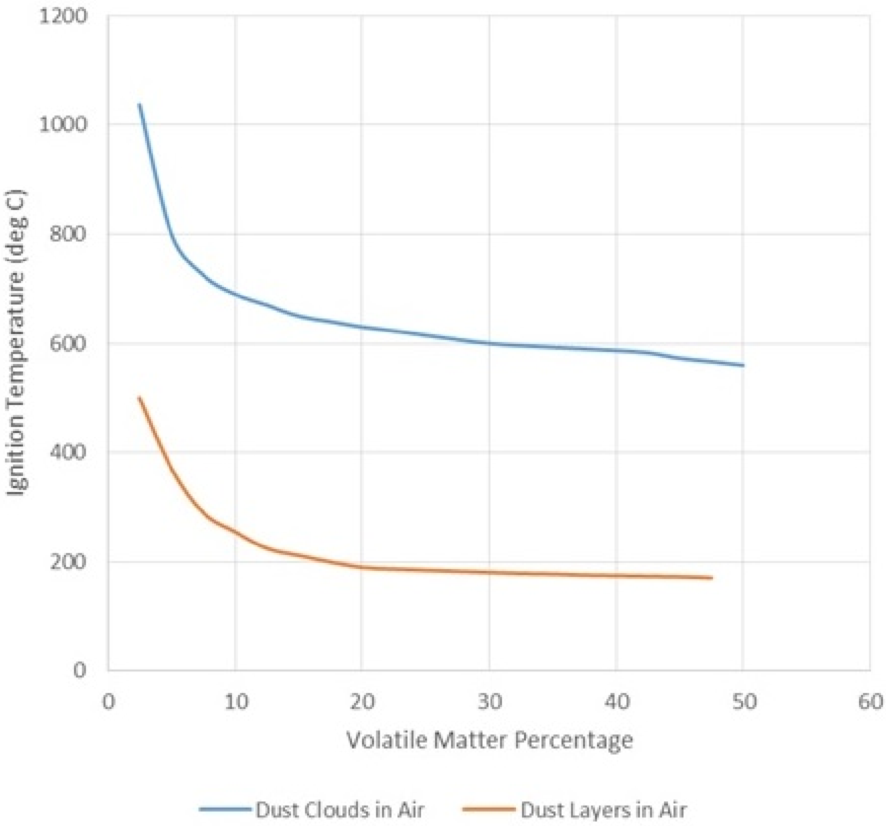

Figure 1:

Figure 1 shows the dependence of ignition on volatile content for a minus 200 mesh coal both in suspension and as a layer in air. (Supplied coal is typically 40% volatiles).

This illustrates that a significantly lower temperature is required to ignite a layer of coal compared to a suspension in air.

It is possible for a layer of coal in air to achieve ignition temperature through a spontaneous oxidation process and for auto ignition to occur. This is illustrated by Figure 2 below for a minus 200 mesh, 25% volatile 6% ash coal (Supplied coal typically 7% ash).

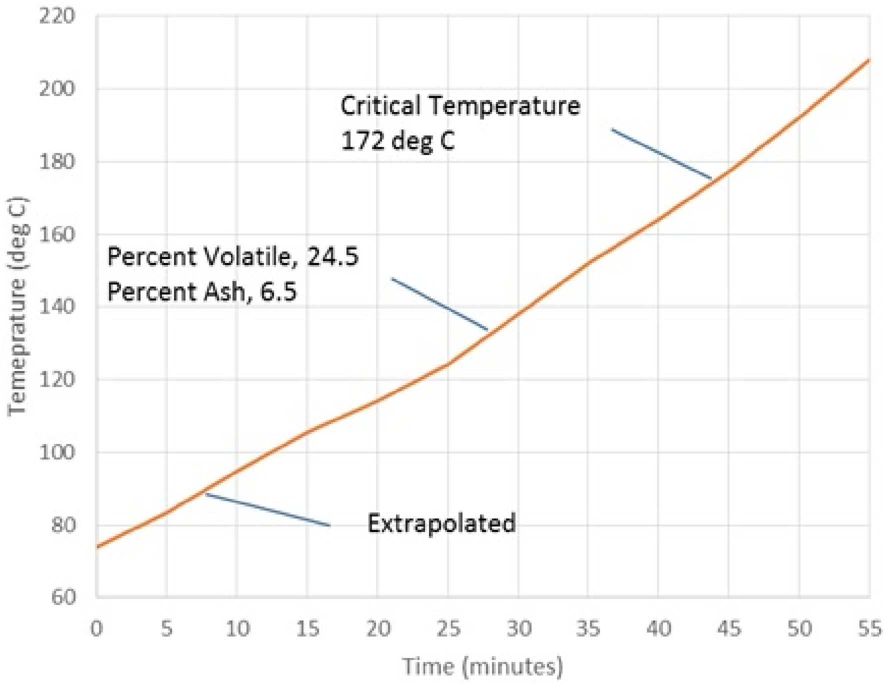

Figure 2:

The auto ignition time of a coal layer is therefore dependant on the initial temperature, coal rank (volatile content etc.) and rate of temperature increase (accessibility of oxygen, layer thickness etc).

Only the rate of oxidation differentiates normal combustion from an explosion. In normal combustion the rate of release of energy is very high and may lead to the generation of a pressure wave. A mixture of coal in air is capable of sustaining combustion over a wide range of air to fuel ratios, only a part of this range could be considered as explosive. It is thought that the explosive range covers approximately 85% to 115% of the stoichemetric air/P.F. ratio by weight.

At the ACME Power Plant the stoichmetric air/P.F. ratio by weight is approximately 8 (Figure 3). This gives an estimated explosive range between the air/P.F. weight ratios of 6.8 to 9.2.

Above the upper and below the lower values estimated the combustibility will range from rapid to slow and eventually to non-combustible. These values are presented for illustration only and are not to be taken as exact. It was a standard recommendation within the CEGB that continuous operation with an air/P.F. weight ratio greater than 5 be avoided.

Figure 3 over plots the air/P.F. weight ratio against feeder speed for the mills at the ACME Power Plant. The ratios have been calculated from the raw coal feed and airflow and are therefore correct in the classifier/mill outlet area only. In the mill body the ratios will be significantly lower than these because of coal recirculation in the mill.

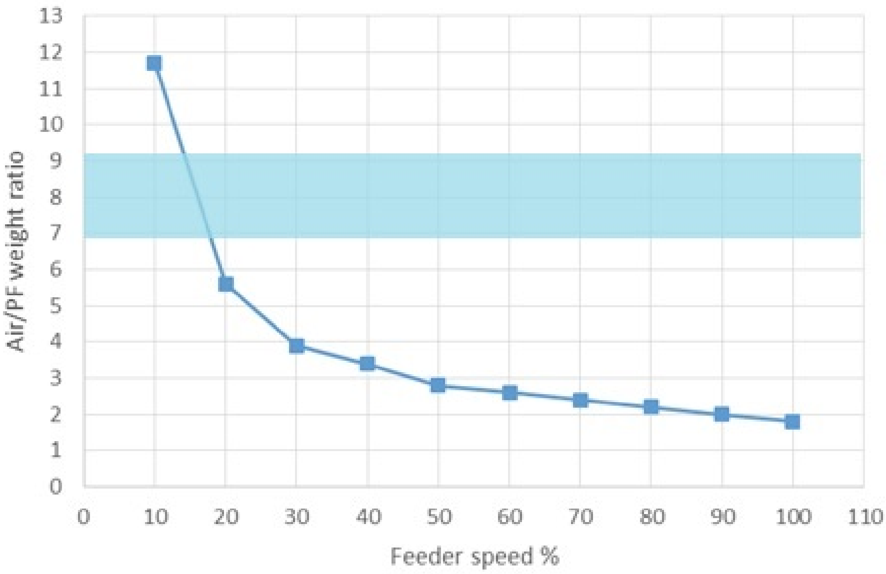

Figure 3: Blue shaded area show approximate explosive range

This illustrates that at low feeder speed a relatively small increase in airflow or decrease in coal flow causes the air/P.F. weight ratio in the mill outlet area to approach the rapid combustion or explosive range. At higher feeder speeds the effect of variations in air or coal flow are not as significant.

If the recirculation within the mill is assumed to be 75% of the coal flow, the resultant air/P.F. ratios in the general mill body are approximately half the values plotted above. This indicates that a rapid combustion/explosion event is less likely to occur in the general mill body than in the mill outlet area. However it is still possible for an accumulation of P.F. to spontaneously ignite and smoulder in the mill body if conditions are correct.

The two separate topics discussed here in general terms, ignition source and combustible mixture, need to be present together for a rapid combustion/explosion event to occur.

The development of an explosive concentration of P.F. is an unavoidable routine event in a mill system, although it is a transient occurrence. Every time a pulverised fuel mill enters or leaves service the fuel/air mixture passes through the explosive range, since the mixture must change from very weak to very rich or vice versa.

An explosive accumulation may also result from abnormal operating conditions caused by a temporary loss of coal feed or increase in air flow.

Special precautions must be taken at all times in order to prevent coal or coal dust accumulation in any areas - these present a very dangerous fire and explosion hazard and must be removed either by vacuum cleaning or hosing down with a water spray. On no account is P.F. to be removed by compressed air since an extremely dangerous dust cloud will result and this could lead to an explosion.

4.2 Sources of Ignition in a Mill System

Pulverized fuel in suspension cannot be ignited by hot primary air alone (within the maximum PA temperatures achievable at the ACME Power Plant). However if un-cooled deposits of coal are allowed to stand in a mill system (e.g. in the mill rejects hopper, air duct etc), they are likely to catch fire eventually by spontaneous combustion and the fire can then spread from this ignition source. Risk of this occurring is increased in a hot mill system.

Metal-to-metal or metal-to-mineral contact may generate sufficient sparking/heating to constitute a source of ignition in the mill system also. Heating in this fashion is obviously more likely to result in fires when hot rather than cold primary air is delivered to the mill.

The ACME Power Plant mills are specifically designed to operate without metal-to-metal contact at all times. If metal-to-metal contact is suspected at any stage of mill operation, a mill shutdown should be carried out. NEVER place a mill back into service after such an occurrence until an inspection has been carried out by the appropriate technical staff.

5 GENERAL PRECAUTIONS

Cleanliness and care in operation must be observed at all times. All P.F. leaks should be promptly reported and repaired - no accumulations of coal or dust should be allowed to form. Cleaning must be done in a manner to avoid the creation of suspended dust. Use of the vacuum cleaning plant will minimise the possibility of suspended clouds of dust being formed - however, this plant requires special operating procedures when cleaning P.F. - refer to the operational procedure sheets for the vacuum cleaning plant.

NEVER direct an air, water or steam jet on burning or smoldering coal or mill rejects and NEVER use compressed air in an attempt to blow out a fire. DO NOT stir or disturb burning or smoldering material since this allows more air to feed the combustion, and will promote a more vigorous reaction.

If internal access is required to a pulveriser, the nozzle blanking plates (sledge gates) must be used to isolate the pulveriser from the boiler furnace. This is because furnace pressure excursions can cause significant blowbacks into pulveriser internals through closed pulveriser discharge valves.

If a feeder cannot be run empty before an access permit to enter a mill is required, the feeder and inlet gate is to be included within the access permit isolation boundary. The mill atmosphere is to be checked before any staff enter the mill.

Unnecessary scaffolding, tools or other equipment must not be allowed to impede access to running plant or operating areas. Good housekeeping must be practiced at all times.

6 NORMAL OPERATIONS

The instructions below are not intended as a complete mill operating procedure but merely sets out to emphasize operational safety precautions. Various permissive and safety interlocks are imposed by the FSSS and Bailey Boiler Automatic Control Systems which ensure safe startup conditions and proper operating sequences. These systems remain in force for both automatic and manual mode operation. In either mode an automatic mill trip will result from adverse operating conditions.

Mills should not be operated for extended periods at less than 50% feeder speed unless absolutely necessary. This mode of operation is considered to be undesirable for two reasons. The reduced airflow may allow P.F. accumulation to occur more readily in the mill body and thus increase the possibility of a small fire from spontaneous heating and ignition. At low feeder speeds the air/P.F. weight ratio is more sensitive to changes in either air or coal flow thus increasing the possibility of an explosive mixture in the mill outlet area.

6.1 Mill Group Start Procedure

6.1.1

Check that the associated coal nozzle pipe blanking plates (sledge gates) are not in place.

6.1.2

Check alarm fascia for standing alarms and defective lamps.

6.1.3

Sound Mill Bay Alarms in sufficient time to allow personal to leave the area prior to starting the mill.

6.1.4

Manually increase the Primary Air Duct Pressure to 80 mbar on the units with the variable duct pressure control, observe PA Fan loading.

6.1.5

Ensure that furnace hopper ashing is not being carried out. When a mill is put in service the furnace pressure goes unstable for a short time which could be dangerous for personnel.

6.1.6

Prior to starting a mill, a 'Mill Ready' status including support energy must be established by satisfying the prestart permissives for that mill.

NOTE: At least one primary air fan is required to be in service and the primary air duct pressure adequate. One primary air fan is capable of supplying only two mills. It is therefore essential to start the second primary air fan prior to starting the third mill. Failure to comply with this requirement will lead to a mill trip.

6.1.7

When the mill prestart permissives and plant checks have been satisfied, the mill can be started and purged using cold air with the hot air gate shut for 3 - 4 minutes. The hot air gate can then be opened and the mill warmed up at a preferred rate of 1.83°C/min but not to exceed 2.75°C/min. See appendix "B". By reading the present outlet temp and checking it against the graph, the time it should take to reach 65°C can be worked out. A certain amount of leakage past the hot air damper may make this warm up time period difficult to achieve. Aim for 65°C on the DPS to make sure the mill is properly warmed up and heat soaked. (From a "cold" mill this should take a minimum of 20 – 30 minutes). Watch the duct pressure for fluctuations. When the outlet temperature reaches 65°C, the feeder may be started which will automatically run to its preset starting speed (FSSS controlled to 40%), in order to initially load the mill. When the mill is adequately loaded, the feeder is released and returns to the minimum speed of 25%. Stop mill bay alarms, check Mill kW's and rejects.

6.1.8

Check that furnace P.F. ignition occurs by observing a positive-going furnace draught pressure change and by observation of the furnace television. Stability of the flame should be monitored by the furnace television. If ignition is not observed, the feeder should be tripped and an investigation carried out to determine the reasons for lack of ignition.

15 seconds after feeder start, check that the in service fuel is backing off to compensate for the incoming fuel.

6.1.9

Check and correct if necessary, the boiler drum level and furnace draught pressure.

6.1.10

The feeder speed should be increased to above 50% feeder speed (20t/hr) as quickly as possible without causing an excessive drop in mill outlet temperature or excessive rejects. The outlet temp will drop and should not be allowed to fall below 49°C. If this low temperature is reached, check the inlet air flow and temperature to the mill and if it cannot be raised, reduce the feeder speed to minimum and stop the feeder. Warm up the mill again, and attempt another feeder start.

6.1.11

A single feeder in service for 50 seconds at minimum feeder speed constitutes 'FIREBALL' - it is possible to remove support energy 3 minutes after feeder was put in service. The fireball will then be monitored by main flame scanners. However, good operator practice should be to maintain support energy until two adjacent elevations are in service at greater than 50% loading to increase the fireball intensity and ensure stable fireball combustion. This "good practice" would include having the support energy (Gas or Coal) below the incoming mill when possible.

Full ignition support energy should be maintained for at least three minutes after starting the second feeder and until both feeders are in service at greater than 50% feeder speed.

It is preferable that an elevation adjacent to the one already in service be started. When non adjacent elevations are in service support energy will be in service for each until both feeders reach 50% speed. If elevations twice removed (A & D) are in service, support energy should be in service at all times.

6.1.12

Reduce the duct pressure setpoint to 45 mbar when the incoming mill has settled down.

6.2 Mill Group Shut Down Procedure

6.2.1

Mill support energy must be available prior to attempting a mill shutdown. Support energy must be placed in service whenever only two mills remain in service at less than 50% feeder speed. This support energy must be an adjacent mill at above 50% feeder speed or an adjacent elevation of gas or oil preferably below the outgoing mill.

6.2.2

Manually increase the Primary Air Duct Pressure setpoint to 80mbar on the units with the variable duct pressure control, observe PA Fan loading.

6.2.3

To stop the mill, support energy is placed in service and the feeder speed is run to 50%. The outlet temperature set-point is then carefully dialed down until the hot air damper closes. Keep reducing the set-point slowly, maintaining the hot air damper just closed and this will require constant adjustment as the mill outlet temperature drops. Do not reduce the set-point past the value required to maintain the hot air damper closed as the cold air damper will open more than necessary and increase the air flow through the mill. If 44°C cannot be achieved within a reasonable time, (should take approx 10 minutes to cool the mill) close the hot air gate. Sound Mill Bay Alarms in sufficient time to allow personal to leave the area prior to stopping the feeder. Once 44°C has been achieved, the feeder can be brought to minimum speed and stopped. The hot air gate should trip closed and the Primary Air Heater Outlet Damper should close with the last hot air gate. Ensure the "support energy required" light has gone out and the mill kW's have dropped to minimum. Keep the mill running for at least five more minutes, stop Mill Bay Alarms and reject the mill to ensure it is completely empty before stopping.

6.2.4

Reduce the duct pressure setpoint to 45mbar when the outgoing mill is shutdown.

6.3 Mill Group Change Over

Mill changes can be done without gas support energy provided at least two mills with feeder speeds above 50% no more than one elevation removed from each other remain in service. Support energy must be an established adjacent mill at above 50% feeder speed or an adjacent elevation of gas preferably below the incoming/outgoing mill.

Ensure the duct pressure set-point is raised to 80 mbar during this changeover process to allow full airflow for thorough purging as the cold air damper runs to a fixed position.

6.4 Mill General Running

6.4.1

When firing one elevation of coal with gas in service – select gas as the base fuel and maintain feeder speed to ensure the gas header pressure stays above fireball. It is recommended for safe operating and practice that this supporting elevation be adjacent and under the mill when possible.

6.4.2

Also note that firing coal at low feeder speeds adversely affects the performance of the scanners. Any scanner faults should be treated as a high priority.

6.4.3

To run the coal off the feeder belt, the feeder inlet gate can be closed while the mill is in the cooling process. The feeder will then run until no coal is detected on the belt and the feeder will trip.

6.4.4

Reversing the feeder belt to removed jammed debris. The correct reverse wired cell must be used to suit whichever end of the 415V board supplying the feeder as per procedure.

6.5 Coal Bunkers

6.5.1

On a regular basis (depending on wetness of bunkered coal), each of the coal bunkers should be run low and checked for coal hang-ups. Hang-ups must be freed by either rodding or lashing, if left, hang-ups in the bunkers could ignite by spontaneous combustion and lead to a bunker fire.

6.5.2

Coal bunkers should be emptied whenever it is intended to leave the mill group out of service for an extended period (more than six weeks for example).

NOTE: If the 'no coal in bunker' alarm annunciates when emptying a bunker using a mill, ensure support energy is in service, reduce feeder speed to 50%, shut the feeder inlet gate, start cooling the mill by closing the mill hot air gate, and continue to run the feeder, which will soon automatically trip. The feeder inlet valve must be shut as described, in order to maintain seal air and mill differential pressures at normal values and to avoid hot air and P.F. flowing from the mill to the bunker. After the feeder has tripped, continue as for a normal mill shutdown.

6.6 Furnace Bottom Ash and Mill Reject Hoppers

No ashing out or dumping of ash/rejects from hoppers is to be undertaken without first notifying the Unit Operator. During ashing/dumping operations the Unit Operator should hold the unit load as steady as possible to minimise the possibility of transient pressure surges which could endanger ashing staff. If the furnace pressure can not be stabilised, ashing can continue as long as the ashing staff are aware of the increased risk of surges and that all inspection and extraction doors remain closed. Extra care may need to be taken if sootblowing is in progress or needs to be initiated.

7 EMERGENCY OPERATIONS

7.1 Coal Bunker Fires and Emergency Bunker Emptying

7.1.1

If a coal bunker fire is suspected, or an alarm has annunciated, the inspection team must follow BA equipped site policies and procedures. On no account are people to remain in the bunker house if CO is detected, unless appropriate breathing apparatus is used and these site policies and procedures are being followed.

7.1.2

Coal bunker fires may start by spontaneous combustion in coal which has hung up in the bunker for some time. If this occurs, the bunker must be emptied of coal as soon as possible, either by running the feeder at maximum speed, or running the coal off through the de-bunkering chute. The means of emptying the bunker must be decided upon after an assessment of a number of factors (including):

(a) the amount of coal in the bunker.

(b) the extent of the fire – i.e. a judgment of the amount of coal burning.

(c) the operating status and availability of the mill group associated with the particular bunker.

The last factor is obviously effected by unit load and availability. As a general guide, it must be appreciated that the feeder belt is not immune to damage by fire - the belt is made from strengthened rubber. For this reason, NO burning coal should be run through the feeder. It must also be appreciated that a mill fire could result when running hot burning coal through a feeder for emergency bunker emptying.

7.1.3

If it is decided to emergency empty a bunker through a mill group, an observer must be positioned at the feeder to monitor the feeder belt to confirm that it does not suffer from operating at the higher temperature. If possible, have support energy in service at all times during this process if there is likelihood of a feeder trip. As stated previously, NO burning coal should not be run through a feeder because of the danger of damaging the belt. If it is necessary to shutdown a feeder while running hot/burning coal through it, ensure support energy is in service, the feeder inlet gate must be shut and the feeder run clear of coal. If a feeder trips while running hot or burning coal through it, simultaneously initiate Mill Fire Suppression sprays (check HVWS pump has gone into service), raise Primary Air Duct Pressure to 80 mbar, (observe PA Fan loading), close the mill hot air gate.

7.1.4

In the event of a large fire establishing itself in a bunker, the bunker should be emptied using the emergency bunker emptying chute. This is achieved by shutting the feeder coal valve, running the feeder until the feeder inlet pipe is empty and then installing the diverter chute into the feeder inlet pipe. In this instance, the coal must be emptied into trucks for disposal. The coal should be damped down as emptying proceeds, and should be dumped away from the coal stock, but in the stocking area, where further damping should be carried out. In all instances fire fighting equipment must be laid out as a precaution.

7.2 Mill Emergency Operations

7.2.1 Mill Fires

In the event of a mill fire, DO NOT shut down the mill or feeder until all methods of extinguishing the fire have failed and NEVER open mill inspection doors until it has been POSITIVELY established that the fire is out. This is best seen by the mill outlet temperature indicator. Three main types of mill fires have been encountered at the ACME Power Plant to date; mill body fires, flash fires and underbowl fires.

(a) Mill Body Fires

The control room indications of mill body fire are:

- **(i)** unstable and/or rising P.F. outlet temperature.
- **(ii)** falling air inlet temperature.
- **(iii)** unstable mill underbody and differential pressure (causing unstable mill airflow).
- **(iv)** a step increase or increasing trend in the mill heat ratio

If a mill fire is suspected, the following steps should be taken:

- **(i)** Select the feeder speed to manual.
- **(ii)** Ensure that the hot and cold air dampers are on auto and the outlet temperature set point is approximately 65°C.
- **(iii)** inspect the mill exterior. Look, smell and feel for localized heat on all parts of the mill body. (e.g. blistering paint)
- **(iv)** monitor the mill operating conditions. Decreasing inlet temperature indicates a mill fire. Any other changes in conditions should be investigated.

(b) If a fire is confirmed in a pulveriser, SOUND MILL BAY ALARMS and CLEAR PERSONNEL from the area surrounding the pulveriser, its associated feeder and fuel piping. Simultaneously establish support energy, initiate Mill Fire Suppression sprays (check HVWS pump has gone into service), raise Primary Air Duct Pressure to 80 mbar, (observe PA Fan loading), close the mill hot air gate and continue feeding the coal mill at a coal flow of 29 tonnes per hour. This is the known maximum rate that will not cause excessive spillage into the underbowel area and be possible to smother the fire. Observe the mill kW's for recirculation problems within the mill also mill body pressure for PF pipe plugging and furnace pressure stability.

(c) The above actions should extinguish a confirmed fire, but should this fail, ensure support energy is in service, increase furnace suction, reduce the feeder speed to minimum, stop the feeder and leave the mill in service until the fire goes out and the mill is cold. The fire suppression sprays can now be stopped.

(d) Once the fire is reported out (outlet temperature steady at 20 - 25°C), run the mill on cold air for another 5 - 30 minutes. A drop in outlet temperature to 20°C is acceptable. The mill is then to be carefully inspected internally. The pulveriser outlet pipes will also require inspection for coal dust hang-up.

(e) An internal inspection should be carried out by the appropriate staff after every mill fire to ensure that corrective action is taken (if necessary). Prior consultation with the Boiler Engineer must take place before allowing the mill to return to or remain in service.

(f) Mill flash Fires
A flash fire is more likely to occur at low feeder speeds in the classifier area and is evident by a rapid increase in mill outlet temperature. (The transmitter is ranged 0 - 150°C.) Confirm the outlet temperature indication using the panel indicator and hot air damper controller discrepancy indicator (these are from separate transmitters). If the temperature is correct, staff should be immediately sent to cautiously inspect the mill. The fire fighting procedures described in a), b), c) and d) should be followed. If the investigating party reports that the P.F. discharge bends have fractured, an emergency shutdown should be performed immediately.

(g) An internal inspection must be carried out for all flash fire incidents.

(h) Mill Underbowl Fires
Underbowl fires occur when coal accumulates in this area and is heated by the inlet primary air. An underbowl fire is evident by glowing or burning rejects, paint blistering or smoke out of the reject hopper or gear box top.

(i) When these or other symptoms cause an underbowl fire to be suspected, lower the feeder speed to ensure no spillage into the underbowel area thus giving the fire fuel, the mill outlet temperature should be lowered, and the mill rejected frequently. Extreme care must be taken when rejecting due to the placement of the reject hopper under the mill inlet air duct. The aim is to cool the burning coal and clear it from the underbowl area. When dumping burning rejects, fire fighting equipment should be ready in case they flare up when exposed to air.

(j) If an underbowl fire continues to burn, CLEAR PERSONEL from the area surrounding the pulveriser, its associated feeder and fuel piping and establish support energy. Close the hot air gate, increase furnace suction, reduce the feeder speed to minimum, stop the feeder, and leave the mill in service until the fire goes out and the pulveriser is cold. Ensure reject hopper empty and no hot rejects present. Prior consultation with the Boiler Engineer must take place before allowing the mill to return to or remain in service.

7.2.2 Pulverised Fuel Pipeline Fires

(a) Accumulations of P.F. inside pipelines do occur at the ACME Power Plant under normal operating conditions. Measurements have shown that the accumulations are very mobile and are therefore unlikely to spontaneously heat and ignite. The accumulations are definitely cleared when a mill is shutdown in the normal manner. Staff should remain vigilant and regularly check mill airflow and P.F. pipeline condition. Whilst the mill airflow is automatically adjusted at all times, it should be kept under scrutiny to ensure it does not fall below its design condition and therefore increase the possibility of P.F. fall out (the table in Appendix A gives the air/coal flow relationship for the ACME Power Plant mills). High mill bowl differentials are indicative of increased P.F. fall out in pipelines. NEVER hammer fuel lines unless it is known there is sufficient air flow through the system to carry dislodged P.F. through to the furnace. Mill air flow must never drop below 53 T/Hr (70% full load air flow).

(b) Accumulations of P.F. inside pipes may however ignite by spontaneous combustion, especially following shutdown, when the pipework is hot. The only indication of a P.F. pipeline fire is the blistering/smoldering of paint and possible pipe-glow caused by the heating.

(c) If a confirmed pipeline fire occurs, it should be dealt with in the same manner as a mill fire. NEVER place a mill back into service after a P.F. pipeline fire until an inspection has been performed by the appropriate staff.

7.2.3 Mill fire with unit off line or a unit trip situation

If a fire is located in a mill after a unit trip, two shift, or during a shut down period, firstly, clear any personnel from the area. Check all the combustion air supplies are closed to the mill and feeder i.e. :-

1. Hot and Cold air gates
2. Seal air supplies to mill and feeder
3. Feeder inspection doors
4. Mill discharge dampers
5. Feeder inlet gate from the coal hopper

Connect and apply CO_2 inerting. After the mill has cooled down to an ambient temperature, an access permit can be applied, the mill carefully opened and inspected.

7.2.4 Classifier Blockages

(a) It is possible, particularly after cleaning the raw coal pipe of a blockage, for wet coal to stick to the bottom of the classifier return cone. (see figure 4 below).

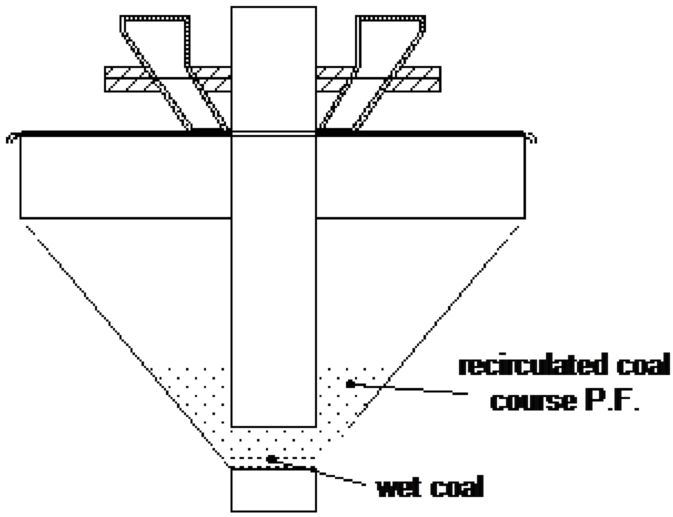

Figure 4:

This can cause recirculating P.F. to accumulate in the classifier return cone and partially or completely block the bottom outlet. The cone will fill up in time and force the mill to act in a 'once through' fashion. The P.F. outlet flow will be maintained but the fineness will deteriorate significantly.

(b) Indications of a classifier blockage are:

(i) lower than normal mill kilowatts related to coal flow.

(ii) lower than normal air inlet temperatures with stable correct, mill outlet temperature.

(iii) lower than normal mill differential pressure (because there is no re-circulating coal flow off the table.)

(iv) higher than expected total fuel flow to the boiler relative to steam flow (the coarse coal supplied by the mill with the blocked classifier does not burn as efficiently.)

(v) excessive slagging on the furnace walls and superheater lower horizontal platen. Large quantities of fused ash in the ash hopper.

(c) When a classifier blockage is confirmed, the mill should be shut down, isolated and an Access Permit applied. Suspected classifier blockages must be thoroughly investigated before shutting the mill down. It is important that a mill fire is not diagnosed as a classifier blockage and the mill shut down as a serious explosion could occur.

7.2.5 Reject Hopper Blockages/Fires

(a) The most likely cause of a reject hopper fire is an excessive accumulation of rejects being allowed to sit in the hopper for an extended period. The mill reject hoppers must be inspected and discharged on a regular basis while the mill is running to avoid such an occurrence. Reject hoppers should also be checked before the mill is started and emptied after the mill is shut down.

(b) If a mill reject hopper is found to be on fire it should be emptied immediately and the associated mill kept under observation to ensure the fire was in the hopper only (fire fighting equipment should be ready).

(c) If there appears to be no rejects from an in service mill over a period of time, it is possible the reject chute is blocked. Warmth in the chute is a useful indication. Inspect the mill, checking for scraping noises from the underbowl area. Once it is confirmed that rejects are building up in the underbowl area, the mill must be shut down and the reject chute cleared. If rejects are allowed to remain in the underbowl area, they can be drawn into the hot air path where they can heat and ignite. This glowing / burning coal is only then removed by the air flow. This allows an ignition and heat source within the mill.

7.2.6 Loss of Coal Supply

(a) A loss of coal supply to the feeder and, hence to the mill, is detected by the SECOAL nuclear detectors which automatically alarm (DWA and DPS). If the loss of coal supply persists for 30 seconds, the feeder will automatically trip (bunker blocked).

(b) When the alarm annunciates introduce support energy immediately and run the feeder speed down to a maximum of 50%. Once support energy is available, run the feeder speed to minimum, close the hot air gate and wait until the mill outlet temperature has fallen below 44°C before shutting down the feeder. If the feeder trips automatically before this, check to ensure that the hot air gate has closed and the cold air damper opened. Run the mill until the outlet temperature reduces to less than 44°C before shutting it down. Check locally for the reason for loss of coal supply and if possible take corrective action to return the mill and feeder to service.

(c) The ACME Power P.F. plant has a history of blockages in the raw coal pipes between the feeders and mills and on the feeder outlet hoppers. These are caused by deposits of fine coal on the sides of the stainless steel chutes or hoppers building up until the flow becomes totally blocked. This is more likely to occur when running coal reclaimed off the stockpile during very wet conditions, the factors that cause the blockages appear to be high moisture content and a large percentage of fines.

(d) Build ups in the raw coal pipes can be detected by monitoring the feeder body pressure, as a blockage builds up, the flow of seal air from the feeder to mill becomes restricted and the feeder body pressure rises. This pressure is set to alarm on the DPS to provide the operator with an early warning of a potential blockage. The alarm level is related to feeder speed, 20mbar from 0-40%, then ramping from 20-50mbar between 40-100% feeder speed. On receipt of an alarm the body pressure should be monitored, if it continues to rise the feeder should be removed from service for inspection/cleaning. Blockages in the outlet hopper area can also be detected with the feeder body pressure transmitter however they should normally be visually detected at a much earlier stage. An outlet hopper blockage should never be allowed to result in a feeder trip. The feeder should be shut down and the coal deposits cleaned off before a total blockage occurs. If the feeder is left in service a much worse blockage will result and there is a risk of damaging the feeder belt. If repeated blockages are occurring indicating that blockage type coal is being run the mill group should be shutdown periodically for inspection.

(e) A raw coal pipe blockage will cause the mill to run out of coal and it will therefore indicate low kW. The feeder will then trip as the coal builds up around the sonic detector at the feeder outlet hopper and stops it from vibrating.

(f) When cleaning a raw coal pipe or feeder outlet hopper after a blockage, care must be taken to ensure all coal is removed. Repeat blockages in one mill are most frequently caused by inadequate cleaning. The inside of the classifier in the mill should also be checked to ensure that no coal has dropped onto and stuck to this surface.

7.2.7 Manual Emergency Shutdown

(a) The type of emergency will dictate the urgency to have the mill shut down e.g. loss of mill motor water cooling supply requires an immediate trip whereas an overheating mill motor bearing could allow a shutdown to be carried out in a controlled manner. The availability of support energy also indicates the type of shutdown possible (since the plant is under the control of the FSSS). In the event that support energy is not available, an automatic mill trip will result when the feeder is shut down. At low unit loads, increasing the excess O2 will assist the general boiler control to adjust for the instant drop of the available combustion air.

(b) Ensure support energy is in service, then select the relevant mill group hand/auto stations to hand. It will not generally be possible to allow the feeder to run until the mill outlet temperature has fallen to the normal feeder shut down point of less than 44°C, so the best approach is to close the hot air slide gate which opens the cold air damper and starts cooling the mill. Once this is achieved, shut the feeder down but leave the mill in service until mill kilowatts have reduced to the idle value, then stop the mill. If possible, continue to cool the mill until the exit temperature has reduced to less than 44°C. If insufficient time is available to establish support energy, a mill trip should be performed, after first running the feeder speed to minimum.

(c) Further actions may be necessary following a mill emergency shutdown, dependent upon the type of emergency. As these would be too many and varied to list it is left up to the Unit Operator's discretion to decide what further actions need to be taken and whether additional isolation is necessary.

7.2.8 Mill Trip

(a) Automatic mill trips are initiated by the FSSS whenever adverse conditions prevail. The mill trip command affects the following plant items as described:

- **(i)** trips the mill
- **(ii)** trips the feeder
- **(iii)** shuts the hot air damper
- **(iv)** shuts the hot air gate
- **(v)** sets the cold air damper to 70t/hr approx

(b) A mill trip results in both raw and pulverised coal laying in the mill which may ignite by spontaneous combustion. Mill groups which have tripped should be placed back in service as soon as possible to avoid manual emptying being necessary. When the mill prestart permissives have been satisfied including support energy and primary air duct pressure at 80 mbar, the mill should be placed in service and emptied of coal using cold air only. When the mill has been emptied in this manner, hot air and coal can be returned to the mill as per normal start up.

(c) If the mill group cannot be restarted within one hour to clear it of coal, it should be left to cool to ambient temperature. During this period, frequent checks must be made to ensure no fires have developed. The mill should then be isolated and all doors opened to allow gasses to vent from the mill. If possible, the mill should be manually emptied, exercising CAUTION since roll pressure on the coal bed may cause the bowl to rotate unexpectedly. The mill atmosphere should be checked before any staff enter the mill.

8 BOILER TRIP

(a) A boiler trip results in all in-service mills tripping automatically. The mill discharge valves must not be shut when this occurs, since it would prevent combustible gases venting from the mill and could lead to an explosion. In a “black” unit trip situation, the natural purge of the boiler that exists when the ID and FD dampers run fully open will assist this process.

(b) Carry out an initial Boiler purge at an increased furnace suction with the mill discharge valves open to ensure any combustible gases that may be present in the Mills are evacuated. When preparing for the boiler purge proper, return furnace suction to normal and close all mill discharge valves. (the 820 will close the discharge valves of the mills that were in service prior to the boiler trip). At the completion of the purge, fire the boiler and satisfy the mill prestart permissives including support energy and primary air duct pressure at 80 mbar. It is then necessary to tackle each mill in turn carrying out a manual startup by opening only that mills associated discharge valves, starting and emptying it of coal using cold air only. Indication will be shown on the mill kW meter as the coal in the mill is reduced. Continue in this manner until all mills have been cleared of coal. This is very high priority as soon as a fire is established in the boiler. It is accepted this action delays the unit return to service. Monitor furnace conditions while completing mill purging (aux air dampers can trip to hand).

(c) In the event that insufficient unit load is available to leave mills in service as they are being started, it will be necessary to clear the other mills of coal in turn, and then shut them down. In this case, run the mill using cold air only. As the mill empties itself, do not open the hot air gate nor start the feeder. Continue to run the mill until the mill outlet temperature reduces to less than 44°C and shut it down. Proceed in this manner until all mills are emptied.

9 AIRHEATER FIRES

9.1 General

9.1.1

Airheater fires are usually caused by sooty deposits coating the airheater elements during oil firing periods. These can ignite as the airheater heats up when the firing rate increases. For this reason, particular attention must be paid to airheater operation during and after start-up and when on oil firing. Fires are unlikely to occur at MCR conditions.

9.1.2

Each of the two secondary and the one primary airheaters per boiler are fitted with a fire detection and fire fighting system. The fire detection system alarms in the control room, plant fire alarm panel and local to the heaters. The fire fighting system is manually started and controlled.

9.1.3

Prompt action must be taken to deal with airheater fires since extensive damage can easily result. It is essential that immediate action be taken upon first detection.

9.1.4

At the first proven evidence of a fire from either, alarm on the Fire Detection System or actual observation at the Airpreheater, the following steps should be taken.

(a) Discontinue pulverised fuel firing as soon as possible, stop both primary air fans and shut down the Boiler.

(b) Close air and flue gas isolating dampers and maintain rotor operation.

(c) Water should be admitted to the Airpreheater in sufficient quantities to be effective.

Do not be conservative with water quantities if the fire has progressed to the point where the heating element is involved, for under these conditions temperatures in the order of 1650°C - 2200°C will be encountered.

Caution Do not attempt to smother the fire with CO_2 or similar fire fighting compounds as they are not effective. Once the metal has started to burn the fire becomes self-sustaining until such a time as the temperature has been reduced below the ignition point of the metal.

(d) Check that the hopper drains are fully operational and also check the Primary Air Fan casing for possible back-up of water.

9.1.5

It is essential to keep the airheater rotating in the event of a fire. Stopping the rotation may result in the fire not being put out and also severely distort or damage the rotor.

NOTE: It cannot be over emphasised the amount of damage that can be caused by Airpreheater fires. It is therefore essential that the appropriate actions be taken at the first detection of any possible fire. Early action will save many dollars in repair costs and loss of generation.

9.1.6

If water is used for an airheater fire, danger tape off all access around any ducting to that airheater. Ducting can collapse under the weight of water.

9.2 Primary Airheater Fires

9.2.1

In order to box the airheater, the flue gas inlet gate (METRAFLEX) and flue gas outlet damper must be shut. Both P.A. fan discharge dampers must be OPEN and the variable inlet vanes SHUT prior to admission of fire fighting water.

9.2.2

Open the P.A. fan casing drains in order to drain water from the casing as fire fighting progresses. The discharge dampers and casing drains must be kept open to prevent the ductwork back-filling and collapsing under the weight of the fire fighting water. In addition, the flue gas side hopper inlet valves must be open to drain the gas side of the heater. The airheater and economiser grit ejectors should be started to assist in removal of fire fighting water. Start fire fighting water sprays by opening the manual fire fighting valve local to the airheater. Water drainage from the P.A. fan casing and grit hoppers must be observed to ensure no back-up of water occurs.

9.3 Secondary Airheater Fires

9.3.1

After the fans have been shut down, box the affected airheater by closing the flue gas outlet damper. Ensure that the variable inlet vanes of the associated FD are SHUT and that the discharge damper is OPEN. Check the FD discharge crossover damper is closed.

9.3.2

Open the FD fan casing drain valve in order to drain water from the casing as fire fighting progresses. The outlet damper and casing drain must be kept OPEN to prevent the ductwork back-filling and collapsing under the weight of the fire fighting water. Open the flue gas side hopper outlet valves and start the airheater and economiser grit hopper ejectors to assist in removal of fire fighting water.

Water drainage from the FD fan casing and grit hoppers must be observed to ensure no back-up of water occurs. Start fire fighting water sprays by opening the manual fire fighting valve local to the airheater.

10 BURNER CORNER EXTERNAL FIRES

(a) Cleanliness is important in reducing the likelihood of external fires and restricting the amount to which one may spread once started. Oil leakage and P.F. accumulations should be thoroughly cleaned up as soon as possible after they occur. Each burner corner is fitted with rate of rise detectors which will raise an alarm in the control room and sound an audible alarm in the boiler-house. In the event of a burner corner external fire, the first action must be to notify the control room.

(b) Carry out a local inspection to identify the cause of the fire and if possible isolate the offending fuel supply to prevent an enlargement of the hazard. Fuel oil, igniter gas, main gas and P.F. plant can be shut off as required by the unit operator from the main control room.

(c) High velocity water sprays (HVWS) are located at each burner corner for fire fighting purposes. The manual isolating valves are located on the 126m level, one for corners 1 and 2 (south side) and one for corners 3 and 4 (north side). This system should be put into service only under the authorization of the Unit Operator.

11 WINDBOX INTERNAL FIRES

(a) In the event of a wind-box internal fire developing, the first action is to notify the control room.

(b) Carry out a local inspection to identify the cause of the fire (e.g. ruptured oil gun flexible hose). If possible isolate the offending fuel supply to prevent an enlargement of the hazard. Fuel oil, igniter gas, main gas and P.F. plant can be shut off as required by the unit operator from the main control room.

(c) When the offending fuel supply has been isolated check to ensure that the fire burns itself out. Gas fires should extinguish immediately after the supply has been isolated - oil or P.F. may continue to burn for a short time. Do not attempt to reinstate the fuel supply until an inspection has been carried out.

A Air/P.F. Weight Ratio Calculation

Air/P.F. Weight ratio calculation

From the Operations Manual V 1 tab 2, at full load

air for combustion ⟶ 1,009,500 kg/hr

coal flow ⟶ 120,000 kg/hr

excess air ⟶ 3.5%

Stoichemetric air/P.F. weight ratio

$$= \frac{1,009,500 \times (100\% - 3.5\%)}{120,000}$$

$$= 8.1$$

From the Operations manual V2 Tab 10, figure 10.5 gives the relationship between airflow and feeder speed.

(Maximum airflow has been changed to 76t/hr, maximum coal flow is 43t/hr).

Feeder speed %	**Coal flow t/hr**	**Air flow %**	**Air flow t/hr**	**Air/P.F. weight ratio**
10	4.3	70.0	53.0	12.3
20	8.6	70.0	53.0	6.2
30	12.9	70.0	53.0	4.1
40	17.2	74.0	53.0	3.1
50	21.5	79.0	56.8	2.6
60	25.8	84.5	60.7	2.4
70	30.1	89.5	64.5	2.1
80	34.4	95.0	68.3	2.0
90	38.7	100.0	72.2	1.9
100	43.0	100.0	76.0	1.8

B Mill Warmup Graph

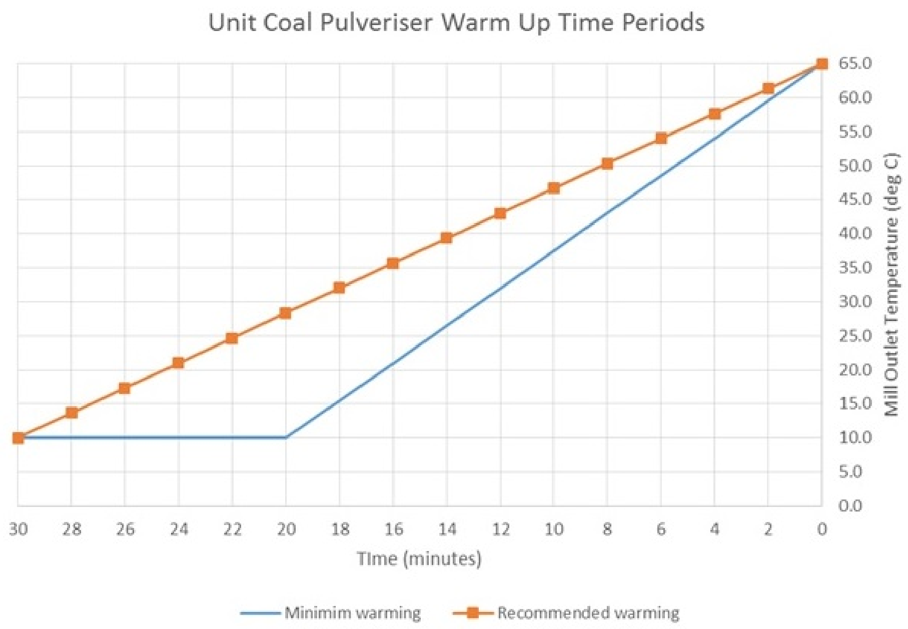

Figure 5:

Notes: **(a)** Feeder may be started when the outlet temperature reaches 65°C.

(b) The outlet temperature should not be allowed to drop below 49°C.

Example: The outlet temperature on the mill is 15°C, by reading the X-axis, the warm up time should take 27 minutes.

C Alarm, Trips, Limits and Notes

	Units	Normal	DPS Alarm	Trip	Result / Notes
Furnace Draft Pressure	mbar	-2.0	-6.0, +2.0	-25, +25	Trips the boiler
Primary Air Duct Pressure	mbar	Variable 45 - 80	38	14	If the duct pressure fall to 14mbar or less, all mills in service are tripped instantaneously. Mill pre-start is 44mbar. On auto pressure control duct pressure controls to a value of the highest Mill underbowl pressure plus 10 mbar with a minimum pressure of 45mbar.
Mill Air Flow	T/hr	Variable 53 - 72	47.2	46.5 T/hr or less for one minute	Mill Trip providing the mill hot air gate is open.
Mill Seal Air/Underbowl pressure	mbar	50	30	15	Trips the feeder, mill and closes the hot air gate.
Loss of Seal Air Fan	mbar				Seal air DP pressure down to 30mbar and falling, Standby fan will start if selected to Standby.
Mill Bowl differential pressure	mbar	15	25	27	Causes an automatic feeder runback to minimum feeder speed until cleared.
Mill Motor Load	kW		392	412	Boiler Run Back
Mill Outlet temperature	deg C	65	70	93	Opens cold air damper to preset position Closes hot air damper Closes hot air gate after 30 seconds

Description	**Plant Status**	
Boiler Conbustibles	Unit On Load	The explosive effects of incorrect fuel and air ratios cannot be under-estimated. Extreme care must be taken to,ensure the boiler is not operated in an unsafe condition. The correct action to be taken is to manually REDUCE THE FUEL,while maintaining a consistent air flow and leaving the FSSS system to monitor the security of the flame and the boiler.
Loss of PA Fans	At least one Mill in service	be under-estimated. Extreme care must be taken to
Loss of: a) One of two PA fans in service or b) One of two BLR Circ pumps in service or c) One of two ID fans in service or d) One of two FD fans in service or e) Steam feed pump	Unit On Load	Plant Run Back to preset value (135 MW approx), If any one or any two mills are in service, no mill trippings will take place, however, should more than two mills be in service, the following sequence will take place. (The trips will only reduce the number of in service mills to a minimum of two) 1. Instant trip of D mill and feeder if in service. 2. If three mills are still in service after 2 seconds, “C” mill and feeder trip initiated.

D Definitions - Support Energy

Support Energy - (FSSS Minimum Requirements).

Indications
Support Energy Light **Steady On**.
When support energy is required and is available thus advising operator not to remove support fuel.

Support Energy Light **Flashing**.
When support energy is required and is not available thus advising operator to bring on support fuel.

Support Energy Light **Off**.
When support energy is not required.

Oil.
Oil is seen as support energy if an adjacent oil elevation is in service with 3 out of four burners established with an oil header pressure above 4.5bar

Gas.
Gas is seen as support energy if an adjacent gas elevation is in service with 3 out of four burners established.

Coal.
Coal is seen as support energy if an adjacent coal elevation is in service with the feeder speed above 50% for more than 50 seconds and steam flow above 30%. Note :- A coal elevation is not self supporting until it has been in service for more than 3 minutes.

e.g. Feeder placed in service initially goes to 40%, drops to 25%. Support energy is left in service for minimum of three minutes and support energy light steady on. This mill is now proven. Support energy removed, support light will flash, and mill group will stay in service. This mill group is self supporting providing the steam flow is above 30% and the feeder speed must be raised above 50% to be seen as support energy.

If feeders are proven and steam flow is greater than 30%, support energy is required but not essential from oil or gas.